FUE Hair Transplantation

A Minimally Invasive Approach

Reza P. Azar

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The book is dedicated to my soul mate and lovely wife, Tanja. She is a constant source of love, inspiration, motivation, and support in my life.

Preface

Although hair loss personally affects nearly every third person at least once in their life, these people often regard it as something of a taboo and rarely discuss it in polite company. This attitude is changing, for hair loss and hair transplantation are increasingly becoming topics of public discussion thanks to numerous prominent supporters. Once a procedure that was performed quietly and discretely, hair transplantation has since become a socially acceptable topic in the wake of extensive informative reporting and documentation.

Modern hair transplantation can indeed help in many cases, yet many affected people and even physicians are not sufficiently familiar with its methods. This book offers insights into the various methods and discusses their respective advantages and disadvantages.

Although hair restoration surgery has since come to represent a recognized surgical discipline of great benefit to persons affected by hair loss, this surgical intervention has yet to be included in specialist catalogs and thus has yet to be assigned to any particular course of specialist training. The inevitable consequence is that there are only a few hair surgeons who have learned their trade in a few specialized private clinics. Medical schools currently concern themselves neither with hair restoration surgery nor with applied basic research. This has led to a great need for information and education among both affected persons and physicians with respect to this broad topic.

By way of example, I would compare the current situation of hair restoration surgery with the beginnings of minimally invasive surgical techniques in orthopedics in the 1980s. At the time, open knee surgery was the accepted method of choice. As the technique of knee arthroscopy gradually became more common, it was initially regarded extremely critically by conservative surgeons. The accepted opinion was that the individual anatomic structures had to be broadly exposed during the operation. According to medical knowledge at the time, it was still inconceivable that minimally invasive arthroscopic knee surgery could offer comparable or even superior therapeutic options compared with conventional open surgery. Today the tissue-sparing and minimally scarring endoscopic methods are used nearly exclusively and the once standard open surgical intervention has nearly become tantamount to malpractice or even battery.

This paradigm shift is precisely my point of departure with this book. Aimed at physicians seeking to inform their patients comprehensively, the book explains how baldness from androgenetic hair loss is an ongoing process that cannot be effectively

managed with conventional surgical methods that traumatize tissue. It goes on to illustrate the severe complications that can result from conventional procedures due to their traumatic nature, the intent being to avoid such complications in the future.

In addition to this, the book presents a far less traumatic option, the minimally invasive hair transplantation method, and discusses its advantages. The minimally invasive FUE method is by far the most tissue-sparing and sustainable method of hair transplantation. It is the only method that can be used effectively against progressive hair loss without causing any significant tissue damage in the donor area.

The acronym FUE stands for "follicle unit extraction." This term refers to the sole anatomic, atraumatic, and minimally invasive method of removing individual follicular units in modern hair transplantation. The donor hairs are harvested as individual follicular units from areas unaffected by hair loss using special microneedles or extraction needles and are then individually implanted in the bald spots. The application of this method also enables the hair restoration surgeon to go beyond conventional removal of donor hair from the hair fringe and harvest body hair, thus exploiting a significant additional source of donor hair.

As a physician who since the beginnings of minimally invasive hair transplantation in Germany has performed hair transplants himself every day without delegating any steps of the procedure, I have experienced the developments of the past decade firsthand and remain in continuous direct contact with many patients. Unfortunately, the experience of my daily practice has shown me an increasing problem to which I draw the reader's attention in this book. This is the problem of improperly performed hair transplantation treatments and their sequelae. Unfortunately, the quantitative increase in hair restoration surgery treatments on the market has been accompanied by increasing deterioration of the quality of treatment. There are two main reasons for this development. On the one hand, "cut-rate" treatments in countries such as Turkey significantly erode the standard of quality compared with other countries. On the other hand, delegating procedures that require a physician to nonphysician practitioners in the interest of cutting costs has also resulted in an enormous decrease in quality. Both developments violate ethical standards as they entail great risks for the patients and diminish the quality of treatment and consequently of the results as well.

With this book I draw the reader's attention to currently existing conditions. My intent is not to level accusations at individual clinics or colleagues but to demonstrate and criticize inadequacies and in so doing hopefully to bring about an improvement in the situation for patients.

This specialist publication is intended for plastic and aesthetic surgeons, practicing dermatologists, and in certain cases interested scientists engaged in hair follicle research who desire further background information about the minimally invasive transplantation method. The book gives these physicians extensive and qualified insights into the current methods and possibilities of minimally invasive hair transplantation. It comprehensively informs the reader about the topic of hair transplantation in addition to discussing its potential for future development.

Autumn 2017
Berlin, Germany Reza P. Azar

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History of Autologous Hair Transplantation

1

The first experiments with hair transplantation were performed in Würzburg, Germany, in the early nineteenth century. However, all the conventional procedures, the strip method, punch method, and FUE method, originated in Japan.

In the 1930s the Japanese physicians Okuda and Tamura began to perform autologous hair transplants. Okuda initially harvested the transplants using a classic biopsy punch and transplanted the "hair-bearing skin islands" into the recipient region and thus laid the groundwork for the punch method [1].

Tamura, however, employed a different procedure. He harvested transplants by excising skin which he later divided into small pieces and transplanted. In this way he became a forerunner of the strip method, also known as the FUT method [2].

The harvesting of individual follicular units (FUs) using a 1 mm cannulated needle was first described by the Japanese practitioner Masumi Inaba in 1988. This tissue-sparing procedure, described as "follicular unit extraction" (FUE), remains to this day the only minimally invasive harvesting method in hair transplantation (Table 1.1).

The method described by Okuda for harvesting autologous grafts using a skin biopsy punch was adopted by the American physician Orentreich in the late 1950s. This is how autologous hair transplantation was first introduced into the Western world. Orentreich published his clinical results in connection with the treatment of patients with androgenetic hair loss and introduced the term "donor dominance" [3]. The term first described that the autologous hair follicle retains its healthy characteristics, namely, its insensitivity to dihydrotestosterone (DHT), after being transplanted to bald areas of the scalp affected by androgenetic alopecia. This means that the transplanted hair follicle will produce healthy hair even in a new location as its insensitivity to DHT is unaffected by androgenetic alopecia and will remain so in the future.

The cosmetically unsatisfactory and unnatural results of direct transplantation of hair-bearing skin islands 3.5–4 mm in size led to the development of new methods. Initially relatively large, the skin islands were dissected to ever smaller grafts. This division was performed without regard to the anatomy of the hair follicles growing

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Table 1.1 History of hair transplantation

Time	Event
Early nineteenth century	• First experimental attempts in Würzburg
1930s	• Beginnings of autologous hair transplantation with the punch and strip methods
1939	• Dr. Okuda described the punch method by means of a biopsy punch
1943	• Dr. Tamura, pioneer of the current strip method, first described removing a flap of skin and subsequently dividing it into individual grafts
Late 1950s	• Donor dominance discovered and first described by Orentreich [3]
1980s	• Headington [4] first described the follicular units • Masumi Inaba first described the FUE method of harvesting individual follicular units
1993	• International Society of Hair Restoration Surgery (ISHRS) founded
2000 and later	• Minimally invasive harvesting method becomes increasingly common and optimized
2011	• FUE Europe founded

in groups as follicular units. These "hair groups" were referred to as micrografts with 1–2 hairs and as minigrafts with 3–6 hairs.

Later the hair-bearing skin islands or skin strips were divided into differentiated anatomic units, follicular units, which increasingly led to superior clinical results compared with the earlier micrografts and minigrafts.

The cosmetically unnatural results of the punch method coupled with the relatively difficult procedure of dividing the harvested tissue into smaller grafts led many physicians to prefer the strip method of hair transplantation. Yet because of its traumatic nature and the resulting scarring, this method cannot represent a sustainable solution for androgenetic hair loss, a progressive condition.

From the mid-1990s on, the tissue-sparing technique of harvesting individual follicular units increasingly gained acceptance among physicians and especially among patients. This method of minimally invasive hair transplantation minimizes traumatization of the patient while maximizing cosmetic results by achieving a natural appearance. It may thus be regarded as the most promising method for the future.

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Fundamentals

2

2.1 Hair Restoration Surgery Terms

Understanding relationships in hair restoration surgery requires familiarity with a number of hair restoration surgery concepts which are explained in the following section.

For example, the anatomic distinction between a hair follicle and a follicular unit (FU) is of great significance in hair restoration surgery from the standpoint of surgical technique.

2.1.1 Hair Follicle (HF)

A hair follicle (HF) refers to one of the anatomically smallest and most complex human organs which is able to produce a single hair throughout life.

2.1.2 Follicular Unit (FU)

To avoid any terminological confusion, I would first like to point out that in this book I often abbreviate the anatomically correct term "follicular unit" as "FU."

In contrast to the hair follicle (HF), the follicular unit is a functional unit that includes from one to four (rarely five) individual hair follicles and in this aggregate produces a corresponding number of hairs. Accordingly, a follicular unit (FU) can occur as a single unit comprising one hair follicle with one hair (1-hair FU) or in the form of a multiple unit combining two hair follicles with two hairs (2-hair FU) or three hair follicles with three hairs (3-hair FU) or four hair follicles with four hairs (4-hair FU). Very rarely it may also occur as an aggregate of five hair follicles with five hairs (5-hair FU) (Figs. 2.1 and 2.2).

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Fig. 2.1 Occipital view of the hair fringe consisting of numerous follicular units (FU)

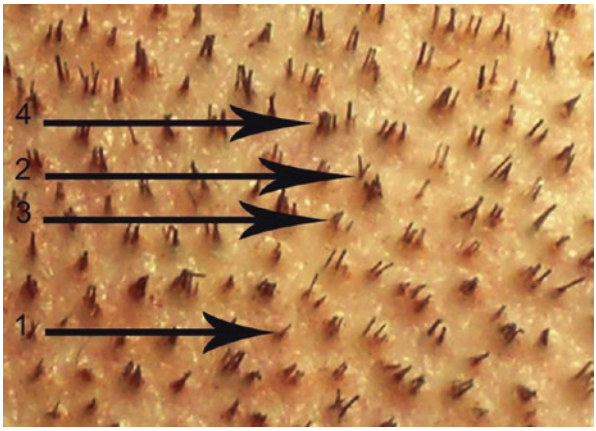

Fig. 2.2 View of the trimmed hairs in the occipital region of the hair fringe. 1 denotes a single unit (1-hair FU). 2 denotes a multiple unit (2-hair FU). 3 denotes a multiple unit (3-hair FU). 4 denotes a multiple unit (4-hair FU).

The FUs can be regarded as the building blocks of hair transplantation, which can be placed together in different combinations or placed individually to create a composition with a natural appearance.

2.1.3 Graft

This term comes from a time when hair surgeons did not yet have a deeper understanding of the structure of functional anatomic units. The term graft says nothing about the number of hair follicles included and as such is confusing and can also be used deceptively.

This is one example of deceptive use: A physician plans on using 1000 “grafts” for a hair transplant. To do this, he harvests 500 2-hair follicular units (2-hair FUs) and splits these functional units into 1000 “grafts.” Consequently, while the physician does indeed transplant the 1000 “grafts” promised, this is only half of the hair

he would have transplanted had he transplanted 1000 2-hair FUs. As the patient is usually unaware of the distinction between graft and follicular unit, the term graft can be used in a confusing and deceptive manner. Therefore, the term follicular unit should be used instead of graft.

2.1.4 Minigraft and Micrograft

A micrograft contains 1–2 hairs.
A minigraft contains 3–6 hairs.

2.1.5 Hair Density (HD)

The hair density is specified as the number of hairs per cm^2.

2.1.6 Follicular Density (FD)

Follicular density (FD) is understood as the number of follicular units (FUs) per cm^2.

2.1.7 Hairs per Follicular Unit or Hair Count per Follicular Unit (HFU)

The number of hairs per follicular unit (HFU) specifies the average number of hairs per follicular unit.

2.1.8 Transplanted Follicular Density (TFD)

Transplanted follicular density (TFD) is understood as the number FUs per cm^2 after transplantation.

2.1.9 Extraction Quotient

The extraction quotient is the number of extracted FUs per cm^2.

2.1.10 Survival Rate

The survival rate provides information about the proportion of hairs that have survived after transplantation relative to the total number of hairs transplanted.

2.1.11 Donor Hairs

Occasionally the term “donor hair” is used. Depending on the context, it can refer to a hair follicle, a follicular unit, or all of the donor grafts considered as a whole (Figs. 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, and 2.10; Table 2.1).

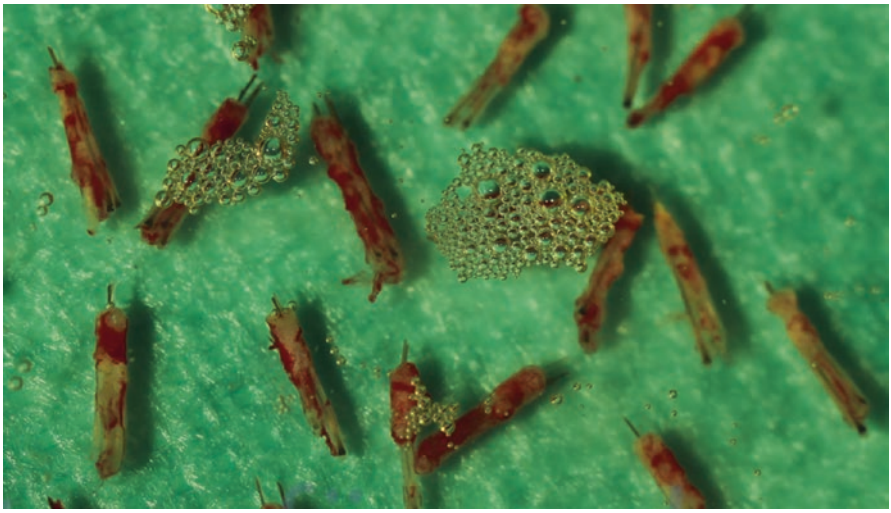

Fig. 2.3 Follicular units after extraction from the occipital hair fringe

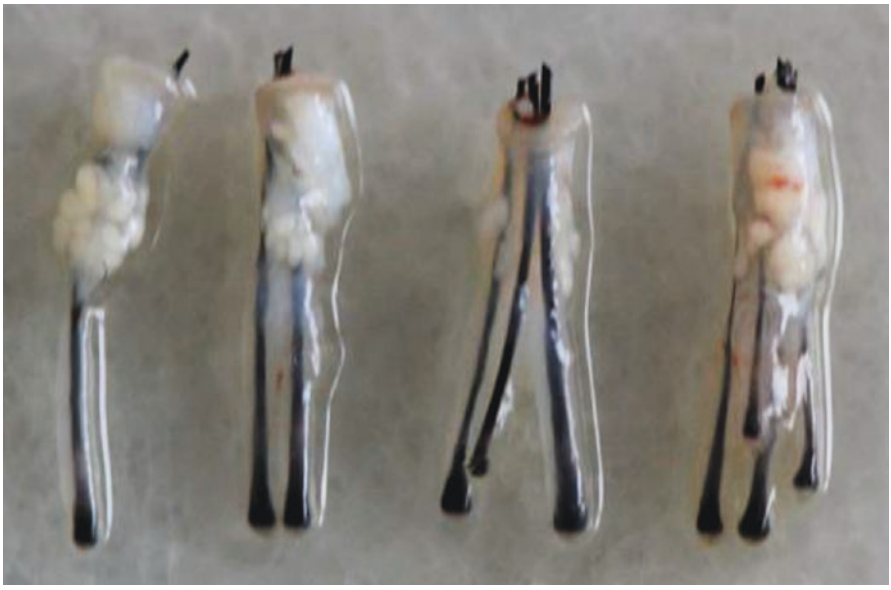

Fig. 2.4 Follicular units after extraction. From left to right: 1-hair, 2-hair, 3-hair, and 4-hair follicular units

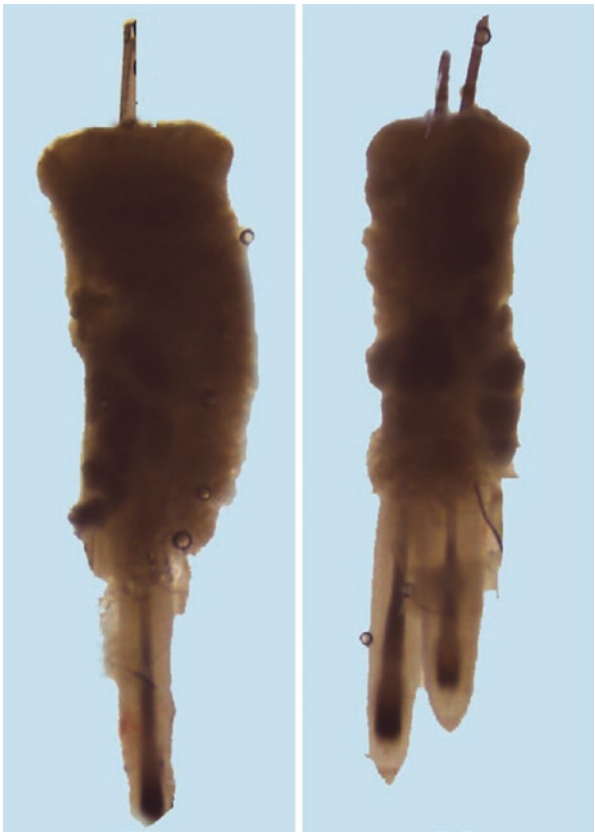

Fig. 2.5 Microscopic view. Left: Individual extracted hair follicles. Right: Extracted follicular unit consisting of two hair follicles or two hairs

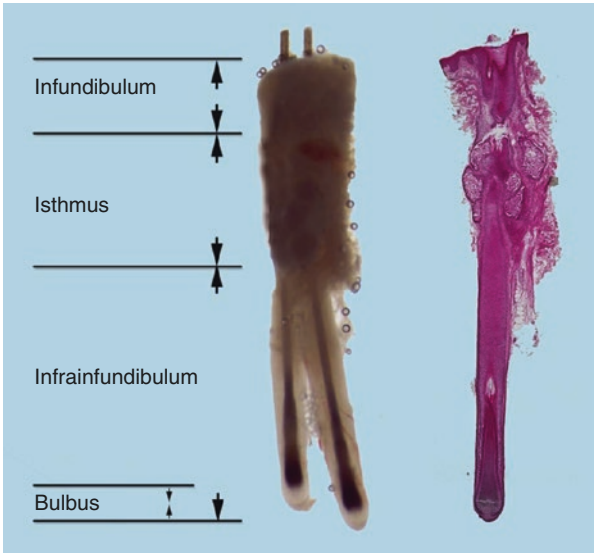

Fig. 2.6 Left: Microscopic image of a follicular unit with two hair follicles. Right: Longitudinal section through a hair follicle

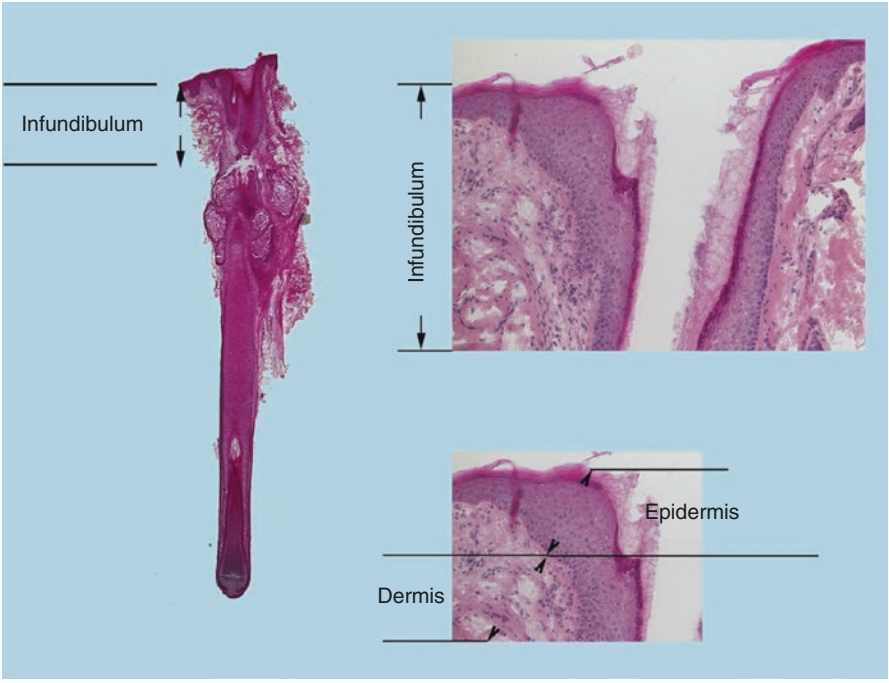

Fig. 2.7 Histologic representation of the infundibulum of a hair follicle, defined as the section between the follicular opening on the surface of the skin and the opening of the sebaceous duct into the hair canal

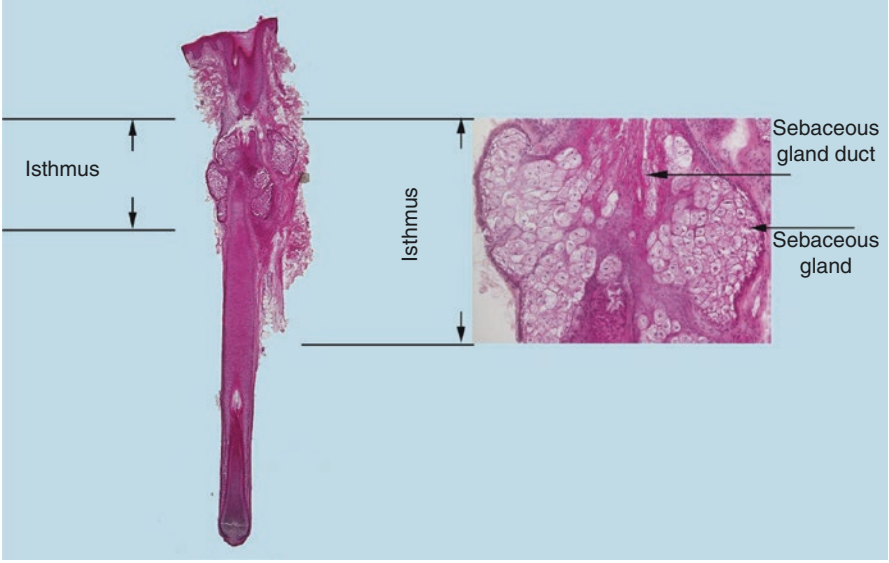

Fig. 2.8 Histologic representation of the isthmus, defined as the section between the opening of the sebaceous duct into the hair canal and the insertion of the arrector pili muscle

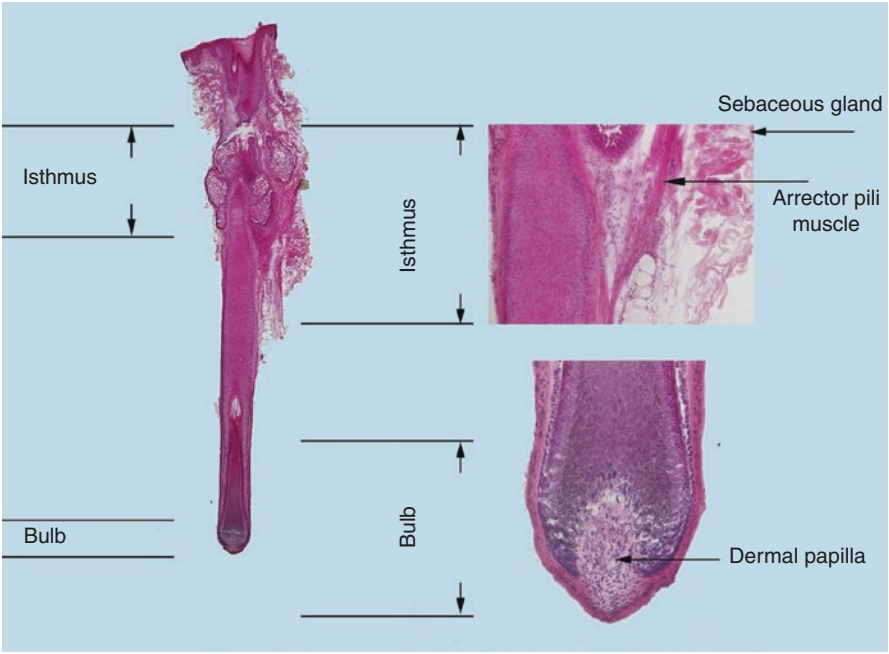

Fig. 2.9 Histologic representation of the arrector pili in the isthmus and the hair bulb with the dermal papilla

2.2 Hair Transplantation as a Surgical Procedure to Redistribute Healthy Hair Follicles

Hair transplantation is also referred to as hair restoration or hair grafting. To understand the procedure of hair transplantation, it is important to note that hair transplantation can only produce new hairs indirectly. Thus, hair transplantation is actually a redistribution of the healthy hair-producing follicles responsible for hair production.

Regardless of the various methods, which will be discussed in greater detail in the following section, each hair transplantation includes the following steps:

- Extraction of the FUs
- Temporary storage and processing of the FUs in a storage medium
- Placement of the FUs or grafts

The fragile hair follicles are harvested from areas with healthy hair coverage (such as the back of the head, chest, or back) and then placed in previously prepared recipient sites at the desired location, where they continue to grow throughout the patient's life. Thus, hair transplantation makes it possible to implant healthy hairs

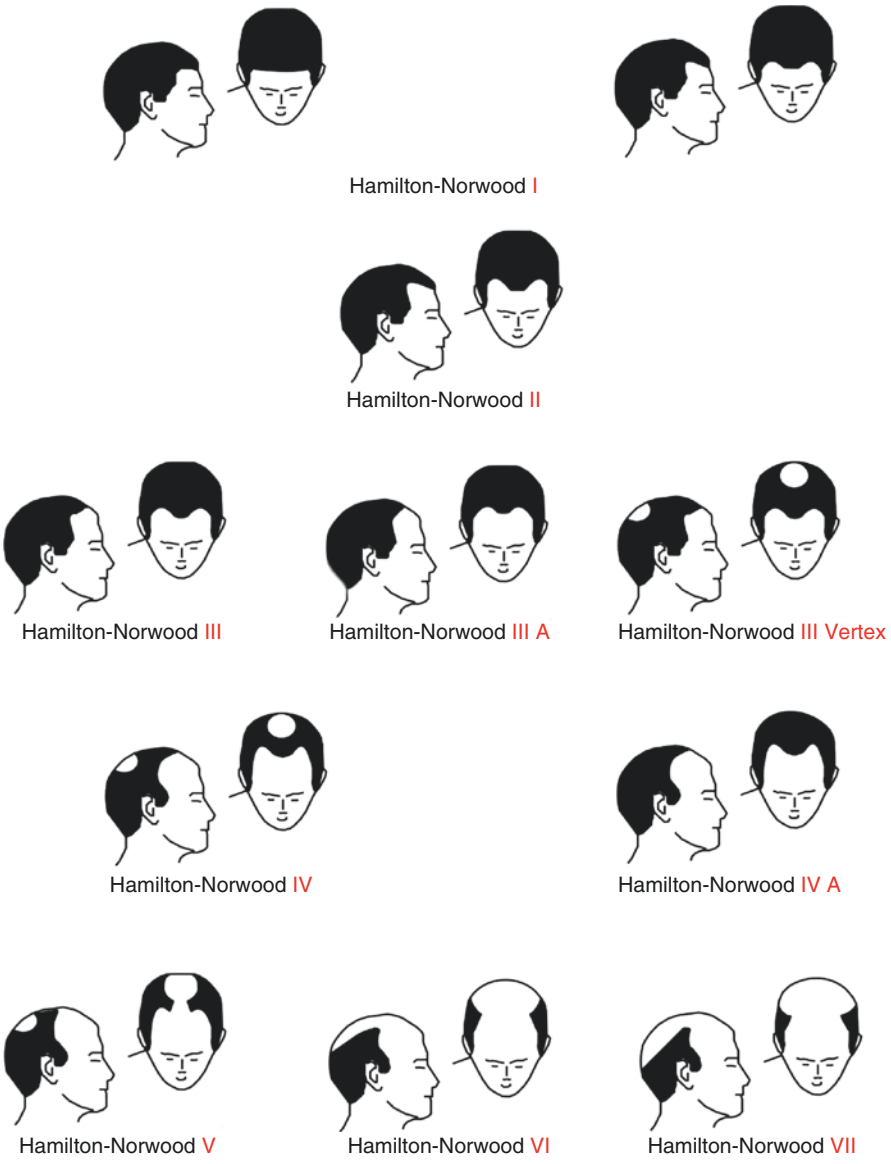

Fig. 2.10 Hamilton-Norwood classification system for androgenetic hair loss in men

even in regions of the body affected by hair loss, where the implanted hairs can exhibit healthy, long-term growth.

However, hair transplantation is only possible with the patient's own hair. This means that hair can be harvested and transplanted in a different location only in one and the same individual as the body would reject hair from another donor.

Table 2.1 Overview of important terms in hair restoration surgery

Hair follicle (HF)	Smallest human organ which is able to produce a single hair
Follicular unit (FU)	Group of up to five hair follicles combined in a single functional unit producing the appropriate number of hairs
Graft	Imprecise term for a transplant containing an unspecified number of hair follicles and producing an unspecified number of hairs
Minitransplants and microtransplants	Grafts sorted by the number of hairs preserved
Hair density (HD)	Number of hairs per cm^2
Follicular density (FD)	Number of follicular units (FUs) per cm^2
Transplanted follicular density (TFD)	Number of transplanted FUs per cm^2
Survival rate	Ratio of the number of hairs that have survived after transplantation relative to the total number of hairs transplanted
Extraction density	Number of extracted FUs per cm^2
Number of hairs per follicular unit (HFU)	Average number of hairs per FU

2.3 Androgenetic Alopecia (AGA), the Most Common Form of Hair Loss

Given the high prevalence of androgenetic hair loss, we will discuss the etiology and pathogenesis of this androgen-induced, genetically determined, and age-dependent process in greater detail in the following section.

About 95% of all patients suffer from the symptoms of AGA, which is characterized by an increasingly shortened hair growth cycle and simultaneous miniaturization of the hair follicles in certain regions of the scalp.

As the name suggests, androgens play a crucial role in the development of this disorder especially in men. Hamilton [1] defined three decisive factors that determine androgenetic hair loss:

- **Genetics, androgen dependency, and age**

He was the one who introduced the term “androgenetic alopecia” [1].

This type of genetically induced hair loss affects both men and women although there are typical sex-specific differences in the severity and progression of the disorder, which we will discuss below.

AGA was long thought to be an autosomal dominant disorder in men and an autosomal recessive disorder in women [2]. Kuster and Happle disproved this assumption in 1984 and documented the polygenetic inheritance pattern of AGA [3].

The logical consequence of this is to assume AGA is a complex disorder caused by several different gene variations or genetic defects and possibly other factors as well.

2.3.1 Androgenetic Alopecia in Men

Randall et al. demonstrated increased intracellular formation of androgen receptors in the areas of the scalp affected by hair loss [4].

Such androgen receptors in men usually decisively influence the differentiation of epithelial cells and the formation of terminal hairs. However, the increased number and thus the heightened activity of the androgen receptors lead here to an opposing effect characterized by the following symptoms:

- Miniaturization of the hair follicles: the follicles shrink and produce thinner and shorter hairs.
- Change in the physiologic growth phases: the anagen phase (growth phase) shortens, whereas the telogen phase (resting phase) lengthens [5].

2.3.1.1 Classification of Male Hair Loss

With few exceptions, AGA in men progresses with a typical pattern of hair loss. The Hamilton-Norwood classification system was introduced to facilitate comparability with respect to the degree of hair loss in men affected by AGA. According to this system, androgenetic hair loss in men is divided into different stages which are assigned to seven hair loss patterns (I through VII).

Although this classification fails to take individual patterns of hair loss and certain mixed forms into consideration, it does clearly visualize the possible manifestations of hair loss and permits standardized medical documentation. This classification has become an integral part of the routine clinical practice of modern hair restoration surgery.

The classification system received its name from Hamilton, who diagrammed the classification of the progression of male hair loss in 1951, and from Norwood, who modified and further developed the scheme in 1975 [6]. For practical reasons, we will refer to this joint classification in this book as the Norwood classification system and abbreviate it as NW.

2.3.1.2 Clinical Course of Androgenetic Hair Loss in Men

With few exceptions, AGA in men progresses with a typical pattern of hair loss.

Hair loss begins with bilateral frontotemporal balding, accompanied by thinning and receding of the anterior hairline (NW I–III).

The hair loss then extends over the vertex region (NW IV) and can progress to complete vertex baldness (NW V–VII).

The alopecia later extends to the temporoparietal, occipitoparietal, and occipital regions of the hair fringe (NW V–VII).

The individual patterns of hair loss progress as follows (I through VII).

2.3.1.3 Type I

This type can occur in two different forms:

- Without bilateral frontotemporal balding
- With slight bilateral frontotemporal balding

In both cases, the frontal hairline is not affected by hair loss.

2.3.1.4 Type II

This type is characterized by frontotemporal hair loss with formation of distinct frontotemporal corners. The apexes of the frontotemporal corners lie anterior to the imaginary line that lies 2 cm anterior to the external acoustic meatus in the transverse plane. The mid-frontal hairline shows beginning hair loss and thinning.

2.3.1.5 Type III

The frontotemporal corners extend posteriorly, and their apexes now lie posterior to the imaginary line that lies 2 cm anterior to the external acoustic meatus in the transverse plane.

2.3.1.6 Type III A

Compared with Type III, the anterior hairline recedes to the level of the apex of the areas of bilateral frontotemporal balding so that they are nearly in line with the hairline.

2.3.1.7 Type III Vertex

Areas of bilateral frontotemporal balding are present which involve the vertex region.

2.3.1.8 Type IV

The hair loss in the frontal hair line continues, and the areas of bilateral frontotemporal balding and hairline are confluent. All that remains of the frontal hairline is a posterior bridge of band of hair a few centimeters wide which forms the anterior border of the vertex region. The hair loss also continues in the vertex region.

2.3.1.9 Type IV A

The hair loss progresses over the entire scalp without involvement of the vertex region.

2.3.1.10 Type V

The bridge of hair narrows or consists of only individual hairs. The hair fringe becomes smaller.

2.3.1.11 Type VI

The bald spots become increasingly enlarged with additional narrowing of the hair fringe. The vertex region expands further inferiorly and laterally, whereas the lateral hair fringe recedes further inferiorly.

2.3.1.12 Type VII

This type represents the final stage of hair loss. The entire hair fringe has receded a long way. In extreme cases, the lateral hair fringe can extend inferiorly as far as the outer ears. The posterior portion of the hair fringe can shrink to only 3–4 cm in extreme cases.

2.3.2 Androgenetic Alopecia in Women

Little is known about the pathophysiology of female AGA in comparison to male hair loss. However, recent findings over the last few years have supported the assumption that androgens play a subordinate role with respect to hair loss in women.

The typical symptoms of hyperandrogenemia are lacking in female hair loss, and an elevated androgen level is not detectable in most affected women. Consequently, increased androgen secretion may be assumed to play an insignificant role in causing AGA. The lack of response to finasteride therapy in postmenopausal women with hair loss supports this assumption [7].

The subordinate role of androgens has increasingly shifted the focus of research to the aromatase enzyme as a possible cause of androgenetic hair loss in women. The sex-specifically increased expression of the aromatase enzyme at female hair follicles, which catalyzes the endogenous conversion of androgens to estrogens, represents a new explanation of this phenomenon. The hair follicles are receptive to estrogen due to their many estrogen receptors [8].

Estrogen is thought to have a stimulating effect on hair growth [9]. The reduced aromatase activity and the resulting reduction in estrogen formation appear to promote AGA in women. The estrogens stimulate the formation of sex hormone-binding globulin (SHBG), which is a specific transport protein for sex hormones and androgens in particular. The reduced estrogen formation leads to a decrease in peripheral SHBG concentration and thus to an increase in peripheral androgen concentration. This theory is consistent with studies that have reported an inverse correlation between sex hormone-binding globulin and the severity of female hair loss [10].

The precise causes of AGA in men and women remain unproven and require further studies.

2.3.2.1 Classification of Female Hair Loss

Androgenetic hair loss in women has a different clinical course than in men. For this reason, different classification systems are used such as the Ludwig, Olsen, Savin, and Sinclair schemes. One frequently used classification system for female AGA is

the Ludwig scheme, according to which hair loss begins in the region of the vertex and spreads laterally and anteriorly. In contrast to male hair loss, the frontal hairline in the Ludwig scheme remains totally or partially intact. Our clinical experience has shown that hair loss in women usually begins in the anterior vertex region and then spreads along the midline toward the vertex as well as toward the frontal hairline before finally spreading increasingly into the lateral parietal region as time passes. In about 80% of all cases, we have also observed diffuse thinning of the entire hair fringe with increasing age.

The typical male hair loss with complete loss of the hair in the frontotemporal and vertex region does not generally occur in women. They usually retain at least sparse, thinned areas of hair in the hairline and on the top of the head (Figs. 2.11 and 2.12).

Fig. 2.11 Ludwig I: Diffuse thinning in the central frontal region of the hairline

Fig. 2.12 Left: Ludwig II: Diffuse thinning in the central frontal region of the hairline extending into the parietal region in a 30-year-old female patient. Right: Ludwig III: Advanced alopecia that partially spares the frontal hairline

2.3.3 Medical Therapy of Androgenetic Alopecia

Statistically, AGA will affect 80% of light-skinned men by age 60 at the latest. In planning effective therapy of AGA, it is crucial to regard this form of hair loss as a chronic disorder that usually exhibits a progressive clinical course. In light of the goal of permanently providing the patient with more hair, this circumstance requires long-term forward-looking therapy planning that goes beyond a simple hair transplant.

Supplementing the hair transplant with initial medical therapy represents an effective therapeutic combination. An effective combined therapy consists of surgical reconstruction of the areas of the scalp affected by hair loss by means of hair transplants coupled with simultaneous medical treatment of the genetically predetermined progressive hair loss.

We will describe the two most effective active ingredients against AGA, namely, minoxidil and finasteride, below. Both medications protect the follicle against atrophy and thus delay the genetically predetermined hair loss. Additionally, they can even reverse the miniaturization process. Some of the miniaturized hairs are transformed back into genuine terminal hairs, maximizing hair density and increasingly improving the patient's appearance. Under the supervision of a physician, oral finasteride can be combined with topical minoxidil. Used in combination, they may be able to achieve a better result than each agent separately.

My Conclusion
To achieve the greatest possible benefit to the patient with AGA, an individualized combination therapy with finasteride and minoxidil should be applied, and in applicable cases one or more minimally invasive hair transplants should be performed.

2.3.3.1 Minoxidil

Minoxidil is a vasodilator that was used as early as the 1970s in tablet form to treat hypertensive crises. With undesirable side effects such as severely decreased blood pressure and hypertrichosis, the drug increasingly fell from favor in the treatment of arterial hypertension.

The positive effect of minoxidil on hair growth in AGA led to increasing use of the substance in the topical treatment of AGA [11]. It was initially applied as a liquid and later as a foam as well. However, it is necessary to apply minoxidil directly to the scalp twice a day to achieve a positive effect.

Minoxidil foam, in contrast to minoxidil solution, contains no propylene glycol and thus leads to less skin irritation such as itching, erythema, or dryness of the scalp. The recommended concentration of both forms of minoxidil is 5% for men.

A recommended concentration of only 2% is regarded as sufficient in women to minimize the risk of unwanted body and facial hair.

The exact mechanism of action of minoxidil on AGA is unknown. However, the vasodilating effect of minoxidil presumably plays a secondary role if at all.

The topical application of minoxidil led to an increased hair count and an increase in hair shaft diameter within a few months [12]. Increased optical density can be achieved in 30–42% of patients within 1 year [13].

2.3.3.2 Finasteride

Finasteride has an effect on the hair follicle similar to that of minoxidil. Therapy with finasteride alters the ratio of telogen hairs to anagen hairs and therefore increases the number of hairs and the hair shaft diameter [14].

Between 70% and 90% of male AGA patients can stop or significantly slow their hair loss for 2–5 years with 1 mg finasteride therapy. An optical improvement in hair density can be achieved in 48% of patients within the first year of treatment and in 66% within the second year [15].

The positive effect of finasteride on male AGA is not restricted to the vertex region but can also be achieved in the frontal and central region of the head hair [16] (Fig. 2.13).

In male AGA, the scalp and hair follicles exhibit an elevated concentration of androgen receptors. The affinity of dihydrotestosterone (DHT), an active cleavage

Fig. 2.13 A 28-year-old male patient with expected NW V hair loss under 5-month finasteride therapy: Upper left: Before finasteride therapy. Upper middle: Status post 1 month of finasteride therapy. Upper right: Status post 2 months of finasteride therapy. Lower left: Status post 3 months of finasteride therapy. Lower middle: Status post 4 months of finasteride therapy. Lower right: Status post 5 months of finasteride therapy

product testosterone, for the androgen receptors is many times higher than the affinity of the testosterone molecule itself.

The catalytic cleavage of testosterone to DHT is brought about by the enzyme 5alpha-reductase II. Binding of DHT androgen receptors of the hair follicle plays a decisive role in the pathogenesis of male AGA.

Although the pathogenetic mechanisms of DHT in AGA are not yet sufficiently known, decreasing its concentration in plasma and in the scalp with 5alpha-reductase II blockers is one of the most effective forms of medical treatment.

The daily recommended dose for treating male AGA contains 1 mg [17]. Drake showed that a daily dose of 0.2 mg of finasteride decreases the concentration of DHT in the scalp by up to 68%. In a control group with a daily dose of 1 mg of finasteride, there was a decrease in DHT concentration in the scalp of up to 72%. Based on these findings, an optimal finasteride therapy of AGA can be achieved with a minimum daily dose of 0.2 mg [18].

Two important conclusions can be drawn from these results. First, the lower dose places less of a burden on the patient. Second, the lesser amount of active ingredient reduces the cost of treatment.

Note, however, that taking finasteride can also lead to undesirable side effects. One of the most commonly feared side effects is sexual dysfunction, which can take the form of impotence or decreased libido.

Various studies are said to corroborate or disprove a causal relationship between finasteride and sexual dysfunction. Of 100 patients receiving a daily dose of 1 mg of the active ingredient finasteride over a period of 6 months, only two candidates complained of sexual dysfunction. In the placebo group, only one candidate complained of symptoms of sexual dysfunction.

Due to its teratogenic effect in women of childbearing age and its lack of efficacy in postmenopausal women, finasteride is not used in the treatment of female AGA patients.

My Conclusion

Due to the enormous efficacy of finasteride and minoxidil and the comparatively slight side effects, finasteride and minoxidil are the agents of choice for treating male AGA.

In my routine clinical practice, many patients report that physicians have advised against these medications, citing the risk of the side effects mentioned above. The duties of the physician should include educating patients about the harmlessness of these relatively safe medications or at least putting possible side effects in a realistic perspective. Exaggerated claims and scaremongering on the Internet that worry patients and persuade them not to use these agents further complicate the situation. Naturally, any medication may be expected to cause side effects in some cases. Yet from a rational perspective, these are agents that offer great potential benefits compared with a relatively slight risk of side effects.

My clinical experience has shown that finasteride is significantly more effective than the topical application of minoxidil in the treatment of male hair loss. For this reason, the two agents must not be regarded as equivalent. Finasteride

should be the first choice in androgenetic hair loss in men, and minoxidil should be used as a complementary treatment in applicable cases. The two agents are not equivalent.

2.4 Donor Dominance as the Basis of Hair Transplantation

Although the origins of hair transplantation go as far back as the nineteenth century, it was only in 1959 that the publication by the American physician Norman Orentreich laid the first milestone in hair restoration surgery. He was the first to recognize and describe the fact that healthy donor hairs retain their vital physiologic characteristics after transplantation. This also applies when the recipient site is located in an area affected by genetically determined hair loss.

Consequently, transplants are also able to stimulate long-term hair growth and produce healthy hairs even in a new location. Orentreich coined the term "donor dominance" in genetic hair loss, which he used to describe this phenomenon.

Donor Dominance. The hair roots from the fringe of hair and the body hairs are not usually affected by genetic hair loss. They continue to produce hair throughout the patient's life after being redistributed in bald areas affected by AGA. This characteristic is referred to as donor dominance.

2.5 The Donor Area

In patients with genetic hair loss, the hair-covered part of the skull is divided into two major areas: the reliable donor area and the unreliable donor area.

One could regard the area of the head affected by androgenetic hair loss as an unreliable donor area, in which hair loss will increasingly occur as time passes. At the onset of hair loss, this unreliable donor area contains healthy hair follicles but which over time will progressively be affected by androgenetic hair loss.

In contrast, the "reliable donor area" contains healthy hair follicles that exhibit insensitivity to dihydrotestosterone (DHT) and are thus not affected by genetic hair loss and even in the later clinical course will be minimally affected.

In order for the hair follicles to develop permanent hair growth, it is crucial to harvest exclusively DHT-insensitive follicles from the reliable donor area as only these will ensure long-term growth.

Reliable Donor Area. The reliable donor area contains healthy FUs that are insensitive to dihydrotestosterone (DHT). These hairs are not affected by genetic hair loss and are therefore suitable for hair transplantation.

Unreliable Donor Area. The unreliable donor area contains affected FUs that are sensitive to dihydrotestosterone (DHT). These hairs are affected by genetic hair loss and are therefore **not** suitable for hair transplantation. Because of their sensitivity to DHT, these hairs would also fall out at a new location.

Determining the reliable donor area is thus of very great importance as only this area of the head is suitable over the long term as a donor area for harvesting transplants.

To maximize the benefit to the patient, the reliable area should always be determined on a highly individual basis in contrast to numerous very general descriptions in the literature. Here, a comprehensive family history provides an important foundation.

Whereas conventional methods (strip method, punch method) are rudimentary in this respect and regard the "fringe of hair" as a reliable donor area, minimally invasive hair transplantation is far more specific. In addition to the fringe of hair as a donor area, one can also use body hair for harvesting grafts. This significantly expands the potential extent of transplantation in most patients. Particularly patients with little remaining donor hair on the head benefit for the opportunity to use body hair as donor hair.

2.6 The Recipient Area

The recipient area refers to the area of the body affected by hair loss from various causes, which accordingly is the site that is to receive new hair. In AGA, this is usually the anterior and vertex region of the head, which is characterized by hypersensitivity to the steroid hormone dihydrotestosterone (DHT) and thus affected by genetic hair loss.

If one transplants hairs that are insensitive to DHT from the reliable donor area into this region, they will retain their insensitivity to DHT and thus will not fall out after being transplanted into the recipient area.

For eyebrow, eyelash, or beard hair transplantation, the recipient area already lies in the appropriate position.

2.6.1 Graft Placement

Placement of the grafts in the recipient area proceeds nearly identically in all methods. Small recipient sites in which the hairs will later grow are dissected at the site. The grafts are placed in these recipient sites and grow together with the scalp (or eyelid or eyebrow skin), where they will later produce hairs. (The recipient area and graft placement are described in detail in Sects. 3.3 and 4.9.4).

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The Techniques and Methods of Hair Transplantation

3

3.1 "Conventional" and "Minimally Invasive Technique"

As has been described, all methods of hair transplantation include the harvesting phase, the storage phase, and the graft placement phase.

All commonly used methods of hair transplantation discussed in greater detail in the following chapters have similarities in certain phases. For example, the grafts are harvested from what is known as the donor area, that is, from the part of the head not affected by hair loss, usually the fringe of hair. Even the placement of individual FUs in the bald areas is essentially identical in the different methods.

The greatest difference, and the crucial one, between the various methods may be seen in the extraction technique, meaning the technique of harvesting the hair follicles. The technical methods of harvesting grafts are divided into two groups, the so-called conventional harvesting techniques and the minimally invasive harvesting technique.

For the sake of completeness, it should be noted that hair transplantation is currently possible only with autologous graft material, meaning that which belongs to the same individual.

Technical Methods for Harvesting Grafts

- **Conventional harvesting techniques**: punch method or punch biopsy method and strip or FUT method
- **Minimally invasive harvesting technique**: FUE method (or optimized IFUE method)

Each method of hair transplantation leaves behind its characteristic traces in the form of skin damage or lack of scarring as well as the appearance of the transplantation result. This will be discussed further in the explanations of the respective methods.

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3.2 The Methods of Conventional Harvesting Techniques

3.2.1 The Punch Method or Punch Biopsy Method

Originating in Japan, the graft harvesting method described by Okuda found its way to the Western world via the American physician Orentreich.

Yet in light of the poor, cosmetically unnatural clinical results, the initial euphoria and hope died down quickly. This is because the direct insertion of transplants harvested with a 4 mm punch created very unnatural tufted results (Fig. 3.1).

The unaesthetic result in the recipient area was addressed in two ways: first, by using smaller punches and, second, by finely dissecting the large hair-covered skin cylinders into smaller grafts (Fig. 3.2).

The initial dissection into minigrafts and micrografts produced unsatisfactory results. As the understanding of the anatomy of the follicular units and their arrangement improved, the minigrafts and micrografts increasingly fell from favor.

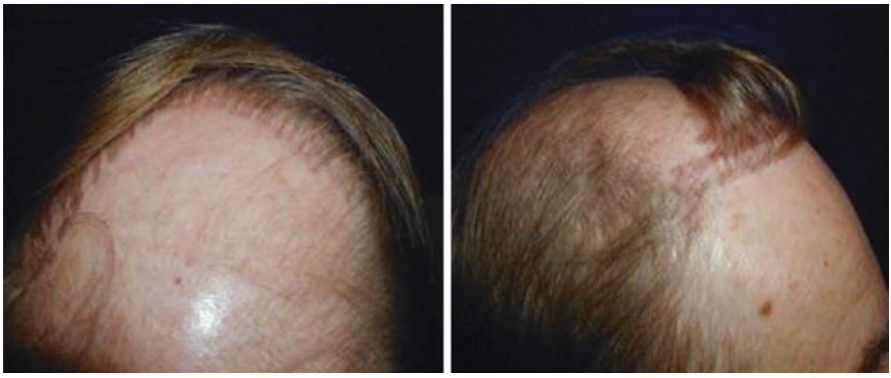

Fig. 3.1 The insertion of roughly dissected grafts with several hairs per graft as in minigrafts leads to what is known as the "doll-head effect." This effect was often observed earlier in conjunction with the punch method

Fig. 3.2 Left: Occipital harvesting scars left by the punch method using a punch with an inner diameter of 4 mm. Right: Occipital harvesting scars left by the punch method using a punch with an inner diameter of 1.7 mm

The slight yield of grafts obtained with the punch method coupled with large, cosmetically unacceptable circular or elliptical scars in the donor area have remained the major disadvantages of this treatment method despite new dissection techniques and better clinical results in the recipient area.

To maximize graft yield and allow further treatments in a patient in the future, the hair restoration surgeon must expand the donor area to include the entire occipitoparietal and occipital region, row by row. This covers the entire hair fringe with large scars (Fig. 3.3).

Some physicians employ a modified form of the punch method. The punch process is performed using a motorized 3.5–4 mm punch. The edges of the punch holes overlap to produce a long continuous wound edge that heals to form a horizontal scar resembling a string of pearls. The overlapping of the punch holes leads to greater tissue damage than the classic punch method (Figs 3.4 and 3.5).

Fig. 3.3 A 46-year-old patient with progressive AGA, NW IV, showing numerous elliptical harvesting scars following seven hair transplants with the punch method

Fig. 3.4 Occipital "string of pearls" harvesting scars 5–7 mm wide in a 28-year-old male patient resulting from a modified punch method

Fig. 3.5 Female patient, Ludwig I, status post shock loss after hair transplantation using a modified punch method. Left: Acute-onset effluvium shock loss after postoperative day 7. Middle: Status post third week postoperatively. Right: Status post sixth week postoperatively

There are two reasons for the slight graft yield from the punch method:

- **Graft loss from iatrogenic destruction of adjacent hair follicles**: a punch with a diameter of 4 mm necessarily causes damage to or destruction of the anatomically adjacent hair follicles. The number hair follicles damaged or destroyed is probably about 3 FUs per punch cycle. To harvest 1000 grafts, the surgeon must repeat the punch cycle about 80 times whereby the resulting graft loss due to iatrogenic destruction of adjacent hair follicles totals about 240 FUs.
- **Graft loss from iatrogenic destruction of telogen hairs as a result of the dissection procedure**: every punched 4 mm graft contains about 12 FUs. Usually 15% of these are in the telogen phase and consequently are not visually detectable. This corresponds to about 1.8 FUs per punch cycle. At 80 punch cycles, the corresponding loss is about 144 FUs.

The total loss when harvesting 1000 grafts therefore amounts to about 384 FUs, in other words over 38%.

Unsurprisingly, this conventional method was hardly popular among patients and has therefore increasingly fallen from favor.

Evaluation of the Punch Method

The disadvantages of the punch method include:

- Severe tissue trauma in the donor area.
- Extensive scarring.
- Low graft yield.
- Graft loss due from iatrogenic destruction of neighboring hair follicles.
- Graft loss due from iatrogenic destruction of telogen hair follicles.
- Multiple dissection cycles of the hair-covered skin cylinder increase the risk of tissue trauma and lead to decreased survival rates.
- Iatrogenic telogen effluvium shock loss with possible irreversible thinning in the donor area.

My Conclusion
The punch method is a traumatic harvesting technique with very little benefit to the patient. Yet a good transplantation result must minimize trauma to the donor area in particular, which may not be sacrificed for harvesting grafts. This is not the case with the punch method. Consequently, the number of possible repetitions is severely limited.

3.2.2 The Strip Method (FUT Method)

First introduced by Tamura, the method of harvesting strips of skin that are then divided and subsequently implanted in the recipient area fell from favor somewhat and experienced something of a renaissance in the 1980s. Progress in research and work with microscopes has increased hair restoration surgeons' understanding of the FU as an anatomic unit. The individual steps in the dissection have undergone increasing optimization, which has driven the further development of the strip method.

Currently, it is estimated that over 90% of all hair transplants are performed using the strip method. Because this method is used so often, we will discuss and analyze the individual steps in the procedure in greater detail.

3.2.2.1 The Steps in the Strip Method

The term FUT is an acronym for "follicular unit transplantation" and is synonymous with the strip method. The term FUT is probably a bit misleading as it does not describe the harvesting technique but the insertion technique, which has since become identical for every method of hair transplantation.

FUT does not involve harvesting the individual FUs but removing a complete strip from the back of the patient's head. As the term "strip method" describes the method more accurately and is less confusing, we will consistently use it in the rest of this book.

The strip method treatment essentially consists of four consecutive transplantation steps:

- Dissection of a strip of skin from the back of the head
- Division and processing of the strip into individual FUs or grafts
- Creating the recipient incisions
- Placement of the grafts

In the following section, we will briefly explain the individual steps and evaluate the respective advantages and disadvantages in the form of complications and/or risks.

3.2.2.2 Dissection of the Strip of Skin from the Back of the Head

Depending on the scope of the intervention, a long strip of skin is harvested from the occipitoparietal region of the back of the head.

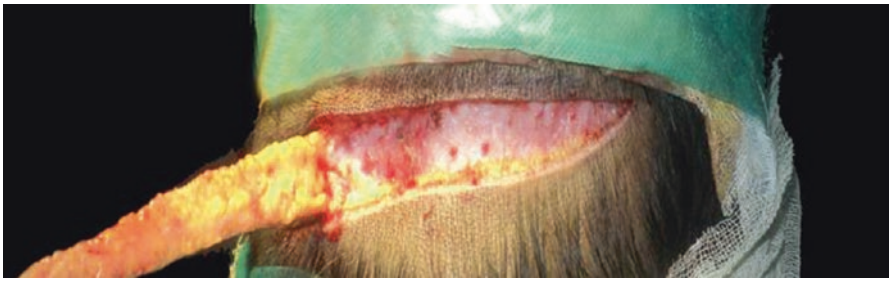

Fig. 3.6 Harvesting an occipital skin flap with the strip method

To harvest the graft, the scalpel is placed in the direction of hair growth and drawn obliquely and inferosuperiorly to make a spindle-shaped or elliptical incision. Bleeding from vascular injury caused by harvesting the graft is controlled by electrocautery. The resulting donor site wound appears as a gap in the skin that can be closed with sutures or staples (Fig. 3.6).

3.2.2.3 Advantages of the Steps of the Dissection

Compared with the punch method described above, the incision used in this method limits the scarring to a predefined area in the occipitoparietal region. Compared with the FUE method, the harvesting phase is significantly shorter.

3.2.2.4 Disadvantages and Complications

The traumatic character of the dissection is reflected in numerous complications:

3.2.2.5 Extensive Scarring

Excision of the strip of skin creates a scar with a length of about 15–24 cm. Ideally, the scar has a width of about 3 mm. However, this minimal scar only 3 mm in width requires that the harvested strip be no wider than 10 mm. Harvesting a 15-mm-wide strip creates a scar three times that width, up to 9 mm.

There is a known correlation between the width of the harvested strip and the subsequent width of the scar [1].

Harvesting the strip reduces the physiologic laxity of the skin, leading to excessive tension on the edges of the wound and thus to widening of the scar. This reactive behavior in response to biomechanical stresses is known as “stretch-back” and usually occurs within 6 months of treatment.

3.2.2.6 The Following Factors Promote Scar Stretching:

- Harvesting a strip wider than 10 mm
- Low laxity or mobility of the scalp skin
- Failure to sufficiently undermine the wound edges prior to closure
- Insufficient wound closure
- Early participation in sports activities that place strong stresses on the muscles of the posterior neck and shoulders within the first 6 months postoperatively

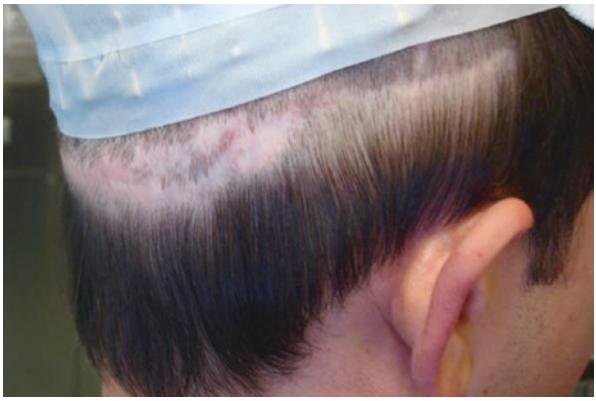

Fig. 3.7 Partial inferosuperior widening of donor site scars to 2 cm after two hair transplants using the strip method

Fig. 3.8 Complete inferosuperior widening of donor site scars to 2.5 cm after three hair transplants using the strip method

- Occupational activities involving heavy physical work
- Subsequent treatments with the strip method that lead to decreasing laxity of the skin and inferosuperior widening of the donor site scar (Figs. 3.7 and 3.8)

The resulting scars in the donor area are usually hidden by wearing the hair longer. This not only impairs the patient in daily life but also dictates the patient's choice of hairstyle. Widening of the scar should be seen as a complication and often causes patients insecurity and anxiety especially in windy weather, during sports activities, when swimming, when visiting a hair stylist, and with the partner and family. In some patients, this anxiety can cause them to withdraw from social activities.

Other complications associated with scarring include donor site pain and even irreversible paresthesias in the scars and adjacent areas.

3.2.2.7 Trauma-Induced Hair Loss and Miniaturization of Native Hair in the Donor Area

The term "telogen effluvium" describes sudden diffuse hair loss such as can occur after an operation on the scalp. A well-known example of this postoperative complication in aesthetic surgery is the temporal effluvium secondary to a facelift, which may be reversible or irreversible.

Fig. 3.9 Hair thinning in the donor area with miniaturization of the FUs below the scar following hair transplantation with the strip method in four different patients

The telogen effluvium that is associated with tissue trauma after a hair transplant and involves the sudden loss of native hair in the region adjacent to the donor site is referred to as shock loss.

Following treatment with the strip method, thinning of the hair density around the donor site is often observed. This is associated with miniaturization that usually occurs below the scar.

The severity of the hair loss and iatrogenic miniaturization can vary greatly depending on the severity and extent of the trauma. In the worst case, it can be irreversible. Not only do the additional hair loss and miniaturization of native hair impair the patient's appearance, they also make it difficult to comb hair over the scar. Furthermore, the stock of potential donor hair for subsequent treatments is reduced (Fig. 3.9).

3.2.2.8 Graft Loss from Injury to Adjacent Hair Follicles

Making the incision to harvest the strip and later dividing it into individual grafts results in the transection of adjacent FUs. This loss probably amounts to about 10–15% [2].

Example: when harvesting a 24-cm-long 1-cm-wide strip with a follicular density of 70 FUs per cm^2, the number of FUs included is 1680. At an estimated loss of 10%, 168 FUs will be lost to transection.

3.2.2.9 Lack of a Basis for Calculation and Inability to Determine Dosage

The extent of the intervention should be precisely defined prior to every hair transplant. This calculation should also stipulate exactly how many grafts are to be harvested.

As the strip method removes an entire strip of skin, it does not allow one to harvest a precisely defined number of grafts. Depending on the size of the harvested strip and the hair density on it, the number of harvested FUs will vary. Thus, only approximately as many FUs can be harvested as were calculated. Possibly too many FUs are harvested or too few. Both cases have unfavorable consequences for the patient. Either too many FUs are harvested and wasted or too few grafts are obtained to achieve the intended goal. When too few grafts are harvested, it is often the case that FUs are split to achieve the intended number of grafts. However, splitting these anatomic units not only leads to delayed hair growth, it also leads to a significantly lower survival rate and to the development of hairs with significantly smaller hair shaft diameters.

3.2.2.10 Division and Processing of the Strip into Individual FUs or Grafts

After the strip is harvested, technical assistants divide it into yet smaller strips in a series of steps. The grafts are then dissected out of these strips under the microscope.

3.2.2.11 Advantages of the Strip Method

The steps of dividing the strip of skin and the subsequent dissection of grafts can be performed by non-physicians. Consequently, costs can be kept down or, respectively, the provider can achieve a higher profit margin.

Proponents of the strip method often claim that a single treatment with the strip method can harvest significantly larger quantities of grafts (from over 2500 to 5000 grafts) in comparison with other methods.

However, this statement is not entirely correct. Assuming a strip with a length of 24 cm and a width of 1 cm and an average follicular density (FD) of 70 FUs per cm^2, the surgeon can harvest 1680 FUs or grafts. There are only two ways to increase or double the number of grafts:

- One increases or doubles the width of the strip, thus accepting more severe tissue trauma and a scar width greater than 1 cm.
- One splits the follicular units and thus obtains a greater number or even double the number of grafts. Consequently, the FUs are damaged and one accepts a significantly decreased survival rate.

3.2.2.12 Disadvantages of the Strip Method

Lower Survival Rates as a Result of Multiple Dissections

The strip of skin is divided and processed into grafts in several steps in the strip method. Because the sensitive tissue is subjected to mechanical alteration and

dehydration during processing, it becomes damaged, which is reflected in a reduced survival rate.

Long Graft Storage Times

A certain amount of time passes between the harvesting of the skin flap and completion of the grafts obtained from it. During this time the tissue is outside the human body. This storage time exposes the grafts to an increased risk of hypoxic cell damage and necrosis.

Reduction of the Donor Reservoir from Loss of Telogen Hair

The amount of graft loss is further increased because in the strip method even the telogen hair follicles, i.e., follicles that at the time of harvesting are in the resting phase and not producing growth, are completely destroyed and lost.

About 15% of all hair follicles on the scalp are in the telogen phase and are not visually detectable although they are present. When the harvested strip is divided and processed into individual FUs, these invisible follicles are permanently destroyed although they would have produced hairs later. The number of telogen hairs lost in the example with 1680 FUs discussed above is about 252 FUs. The total in our example amounts to about 420 FUs, corresponding to 25% of the total quantity (loss from incision and transection and loss of telogen hairs).

3.3 Incision of the Recipient Sites and Placement of the Grafts

All methods of hair transplantation are identical only in the final part of the treatment, which consists of two important steps:

- Incision of the recipient holes or slits
- The subsequent placement of the FUs or grafts

The highest priority in this final decisive part of the procedure should be as tissue-sparing as possible to avoid traumatizing the recipient area. This final part of the treatment is what determines whether the grafts will survive, and thus it is absolutely crucial to achieving a good result.

An incision instrument is used to create recipient sites in the recipient area. It is particularly important to place the grafts at the proper angle so as to give the hair a natural direction of growth and ensure a natural and aesthetic appearance. If the grafts are not placed at the proper angle, the result will be inhomogeneous hair growth in different directions, creating an unnatural appearance.

A detailed description of the incision and placement of the grafts follows in Sects. 4.9.3 and 4.9.4.

3.3.1 Requirements for Successful Graft Placement

The following requirements must be met to maximize the survival rate of the grafts:

It should be clear that the transplantation process, i.e., the complete placement of the grafts, is the physician's personal duty which must NOT be delegated to non-physician practitioners.

We will discuss this important aspect in greater depth in Sect. 3.6.

Delegating individual steps of the procedure to non-physician, and thus unauthorized, personnel is illegal in certain countries such as Germany. In addition, it is unethical conduct with respect to the patient as it is immoral. First, non-physician practitioners will have no further contact with the patient after doing their work. Second, if the physician does not personally perform this absolutely important step or is not even present in person, this will create personal and professional distance to the patient that necessarily leads to "friction loss" and incomplete familiarity with the patient's situation.

Should the operation proceed less than optimally or fail, the physician will be unable to render a valid assessment of the causes during the follow-up examination as the physician was not present in person. This means that no conclusive error analysis can be undertaken, and the errors will be repeated in the future. The lack of feedback about one's personal work means that neither the physician nor the non-physician practitioner will learn from the experience.

Unfortunately, delegating the placement of grafts for cost reasons is nonetheless a feature of daily clinical practice in many practices and clinics. This introduces enormous risks and problems, which we will examine in the following section.

The other adverse effects on patients are considerable and naturally lead to multiple corrective interventions at enormous financial cost.

The most common errors in graft placement include:

- Improper handling of the grafts with forceps causes lacerations and crush injuries that reduce the survival rate of the grafts.
- The size of the recipient incisions is not optimally matched to the size of the grafts, leading to repeated attempts at placement and causing crush injuries and lacerations of the grafts. In practical terms this means that the recipient incision is too small in relation to the size of the graft or the depth of the recipient incision is less than the length of the graft.
- The grafts are placed at the wrong angle. The recipient incisions created by the physician prior to graft placement have different angles. These angles usually follow the direction of the growth of existing adjacent hair. These angles can deviate from the natural direction of growth when agreed upon by the physician and patient.

Aside from these errors, there is the risk of contaminating the donor area during the insertion procedure. In addition to lack of hair growth with severe scarring, necrosis of the subcutis can often occur. Without initial antibiotic therapy and early surgical revision, severe complications can result.

3.4 Effects of Conventional Harvesting Techniques on the Treatment Result

In the conventional techniques, removal of the hair-bearing strip of skin is followed by the steps of dividing and processing the strip. Removal is associated with severe tissue trauma and thus with unavoidable sequelae. Repeating the treatment with conventional methods exacerbates the trauma and sequelae and for this reason cannot be considered a viable solution for treating progressive hair loss.

Possible sequelae of conventional harvesting techniques include:

- High graft loss resulting in a poor graft yield.
- Iatrogenic traumatic effluvium.
- Excessive scarring.
- Painful scars.
- Reversible or irreversible paresthesias in the scarred region.
- Compensatory postures can lead to postural deficiencies, headache, backache, and muscle tension.
- Hematomas.
- Infections.
- Gangrene.

A long-term consequence of the conventional method is unaesthetic scarring that often prevents the patient from later opting for a short hairstyle or shaved head. Consequently, patients with progressive hair loss are continually forced to undergo further treatments as time passes.

Because the strip method is such a widely used treatment (currently accounting for about 90% of all hair transplants worldwide), we will examine this method in greater detail in the following section.

3.5 Evaluation of the Postoperative Transplantation Result

One advantage of the strip method is the short duration of treatment. However, this is offset by a number of disadvantages.

3.5.1 Disadvantages of the Strip Method

3.5.1.1 Extensive Damage to Anatomic Structures

The extent of the damage to anatomic structures is greater with the strip method than with all other methods of autologous hair transplantation. The specific injuries have been discussed with the various steps in the procedure.

3.5.1.2 Severe Pain

Despite anesthesia, patients who undergo treatment with the strip method must expect to experience severe pain in contrast to minimally invasive hair transplantation. This applies to the postoperative phase and includes hematomas, swelling, sutures, and pain from tension in the wound. This situation makes the first few postoperative days and especially nights very unpleasant and sleepless for the patient. The patient's general postoperative condition requires relaxation and sleep, but his wounds and swelling are hardly conducive to this. The strip of skin removed from the occipitoparietal region creates a large painful wound, often making it impossible for the patient to lie on the back of the head. Depending on the recipient area (at the hairline, the frontotemporal corners, the top of the head), the patient cannot lie on this part of the skin as the grafts could otherwise be damaged. In some cases the patient must sleep in a sitting position a few nights to avoid damage to the grafts and pain from friction.

3.5.1.3 Unnatural Appearance

The dissection of the strip into its individual FUs is not standardized with respect to size. This results in inhomogeneous hair growth. Rough dissection of the FUs with large amounts of adjacent connective tissue around the hair follicle leads to a marked increase in hair shaft diameters.

The result is that the hair transplanted with the strip method often appears thicker than the native hair. The hair shaft diameter of a transplanted hair can be up to 30% larger than a native hair on the same individual. The stark contrast between native hair and transplanted hair is disturbing to many patients especially at the frontal hairline, because it is readily apparent that the patient has received a hair transplant. However, in most cases the difference in hair shaft diameter disappears sooner or later. In some cases this does not occur.

3.5.1.4 Patients Are "Forced" to Undergo Further Hair Transplants

Over 90% of persons affected by hair loss suffer from AGA. In about 80% of these cases, this form of hair loss is progressive and thus cannot be effectively and permanently treated with a single hair transplant.

Given the more or less positive correlation between age and hair loss, young patients should never be treated with conventional methods.

3.6 Conclusion Regarding Conventional Hair Transplantation Methods and Their Application in Practice

The conventional hair transplantation methods do not represent a sustainable, unproblematic solution for the patient in most cases because of their highly traumatic effect of tissue.

In light of the complications discussed above, it is more than regrettable over 90% of all hair transplants worldwide are still performed using conventional techniques such as the strip method. And this is the case despite the availability of the far more tissue-sparing FUE method.

The previously described tissue trauma and complications become more pronounced with each subsequent treatment and are usually associated with massive thinning of the hair in the donor area. Because of this, using these methods to treat young patients unavoidably exhausts all therapeutic options. As a result, these patients usually come to be regarded as patients with no remaining treatment options at an early age. Often the physicians who previously treated them abandon them to their problems due to a lack of donor hair.

This poses the question as to why the conventional methods are preferred despite the availability of the significantly more patient-friendly and sustainable minimally invasive method.

When one examines the individual steps in the procedure (as is done in the following section using the example of the strip method), it becomes apparent that the advantages of the conventional treatment methods are clearly on the side of the attending physicians and less on the side of the patients.

3.6.1 Examination of the Steps of the Procedure with Respect to the Time Required and Their Effect on the Transplantation Result

3.6.1.1 Removal of a Strip of Skin

This step accounts for about 15% of the total operating time and influences the donor area (trauma including scarring), yet it has no effect whatsoever on the actual result of the transplant in the recipient area.

3.6.1.2 Dissection Including Dividing the Strip into Smaller Grafts

Dividing the strip of skin into individual grafts accounts for about 35% of the time required for surgery. In practice, this time-consuming step in the procedure is very often delegated to non-physician practitioners due to cost considerations. Although this cuts costs, it involves the following risks for the patient.

- Varying degrees of skill in dissection among employees mean that graft sizes are inhomogeneous, increasing the risk of hypertrophy or atrophy of the hair shafts, which in turn can lead to stagnation of hair growth.

- Multiple dissection procedures entail risks for the sensitive grafts: first, they can lead to mechanical alteration of the hair follicles. Second, long processing times involve long storage times, which increase graft damage in the form of dehydration and cell necrosis.

This step in the procedure in particular decisively influences the quality and aesthetics of the subsequent transplantation result and consequently should not be delegated to non-physician practitioners.

Several countries have particularly strict laws regulating the performance of surgical procedures. This legislation is intended to protect the consumer against improperly performed medical treatments. In Germany, for example, the law stipulates that certain examinations and services may only be performed by physicians. I personally find this a very sound principle because it at least protects the consumer as much as possible against improper treatments performed primarily for profit.

Applied to hair restoration surgery, the physician's nondelegable core tasks to be performed personally include:

- History
- Diagnosis and determining the indication
- Consultation
- Obtaining the patient's informed consent
- Therapeutic decision
- The hair transplant as a surgical intervention including all steps in the procedure that affect the patient's physical integrity

3.6.1.3 Creating the Recipient Incisions

In practice, this step is performed by the physician personally and accounts for about 10% of the time required for surgery. This greatly influences the subsequent treatment result, as the depth, angle, and density of the incisions must be precise and correct.

3.6.1.4 Graft Placement

This step is very time-consuming and cost-intensive, accounting for about 40% of the time required for surgery, which is why many physicians elect to delegate it to non-physician practitioners. This last step in the procedure has the greatest influence on the transplantation result aside from the processing of the grafts, and it must not be delegated.

The risks of delegating graft placement to non-physician practitioners include:

- Dehydration including cell necrosis of the grafts
- Crush injuries and mechanical alteration of the grafts
- Improper positioning of the grafts
- Improper insertion angle
- Improper insertion depth
- Increased risk of infection including stagnation of hair growth

Placement of the grafts represents the essential step in the procedure and the actual transplantation process in the sense of an organ transplant, and it decisively influences the transplantation result.

The aesthetic aspect is the fundamental intention of hair transplantation.

Given that a hair transplant is not normally a medical necessity and is thus performed for aesthetic reasons, meaning with the intent of bringing about a visual improvement in the existing condition, it is precisely this aesthetic aspect which is fundamental and must provide the basis for the medical procedure.

In a hair transplant in which the subsequent treatment result represents the absolutely paramount aspect of the intervention, one must consider not only medical risks but also risks with respect to the aesthetic aspects. This becomes all the more important as the resources in the form of donor hair for a hair transplant are limited.

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The Technique of Minimally Invasive Hair Transplantation

4

The term "atraumatic surgical technique" was probably first used by the American surgeon Sterling Bunnell [1]. He described the particularly careful handling of the various anatomic structures with the goal of minimizing trauma, which is known today as "minimally invasive surgical technique."

"Technique" refers to a particular skill in various fields of human endeavor. The minimally invasive technique involves a particular skill and finesse achieved through the use of minimally invasive instruments which produces minimal damage to organic structures.

The conventional techniques (strip method and punch method) utilize trauma-inducing instruments that damage the organs.

4.1 What Minimally Invasive Hair Transplantation Should Achieve

Hair transplantation is a purely cosmetic intervention, a minimally invasive surgical intervention normally performed without a medical indication. The purpose of the treatment is thus the subjectively perceived visual enhancement of the body, which places the focus on the aesthetic aspect of treatment. Eyelash and eyebrow transplants represent exceptions as the eyelashes and eyebrows also have physiologic functions such as protecting the eyes from dirt and sweat.

A requirement is essentially a statement about the quality or ability that is needed to achieve a goal. It follows from this that aesthetics is a crucial condition that minimally invasive hair transplantation must meet in order to achieve a good and satisfactory treatment result.

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In everyday language, "aesthetic" is used synonymously with "beautiful," "tasteful," or "appealing." This is the sense in which "aesthetic" will be used here, and this sense will be regarded as a crucial condition that minimally invasive hair transplantation must meet. When we speak of an "aesthetic result" in hair transplantation, this usually means an appealing result that looks as natural as possible. This applies to the aesthetics of the transplantation area (hairline, hair density, hair quality, and the direction of hair growth) as well as to the aesthetics of the donor area (hair density and lack of scarring).

This assumes that the procedure may not cause indiscriminate trauma as such trauma will leave traces in the form of irreversible scarring and thinning. Aesthetic and appealing treatment results are only possible using minimally invasive, atraumatic techniques that spare the various anatomic structures such as the hair follicles, skin, nerves, and blood vessels. These techniques demand a fine surgical instinct and great respect in order to minimize iatrogenic trauma.

4.2 Requirements for Minimally Invasive Hair Transplantation

The goal is to prevent or at least minimize scarring in the recipient and donor areas. To achieve this, the following requirements must be met.

4.2.1 Harvest Grafts by Direct Anatomic Extraction Only

Direct anatomic extraction spares the most skin tissue as only individual follicular units are harvested. The other non-anatomic extraction techniques harvest several follicular units together which are then dissected into individual FUs in several steps.

Anatomic extraction, meaning the extraction of individual FUs, also spares the resting (telogen) hair follicles that are not visible to the unaided eye; conventional methods unnecessarily damage or even completely destroy these follicles.

4.2.1.1 Harvesting Grafts of Standardized Size

The extraction of grafts of standardized size is important for the subsequent transplantation result as the transplanted hairs combine to form an aesthetic and harmonious whole without any visual contrast. This creates identical growth conditions for all grafts. Extraction needles of various diameters are used for this purpose.

4.2.1.2 Avoiding the Use of Tumescent Local Anesthesia

Tumescent local anesthesia is not suitable for hair transplantation as it leads to higher pressure within the tissue which has a negative effect on tissue perfusion and can lead to acute effluvium, shock loss, and even tissue necrosis. Effluvium (increased hair loss) due to iatrogenic trauma must be avoided in the donor area as well as the recipient area. Irreversible effluvium in the donor area would

significantly impair subsequent hair transplants or even render them impossible due to lack of donor hair. As the tumescent solution drains downward, it can produce unattractive postoperative facial swelling. This usually lasts about a week and can seriously impair the patient's visual appearance. Often the swelling is so severe that the patient will avoid appearing in public. These commonly used tumescent solutions are today considered obsolete.

4.3 Advantages of Minimally Invasive Hair Transplantation for the Patient

The items mentioned above have the following specific advantages for the patient:

- **Treatment is scalable and therefore repeatable.**

The number and location of grafts harvested can be precisely determined preoperatively, permitting precise and therefore optimal treatment without loss of grafts. This precise scalability spares the tissue so that the minimally invasive intervention can be performed repeatedly regardless of the patient's age. It can thus be adapted to the patient's individual situation. In contrast, removal of an entire strip of skin unavoidably leads to severe iatrogenic trauma in the donor area. Here, it is not possible to harvest the precise number of required grafts determined by preoperative calculations. Obtaining individual FUs also requires additional dissection steps that damage the grafts.

- **The patient can wear his hair long or short postoperatively without having to worry about revealing an unaesthetic scar.**
- **Even in cases of progressive genetic hair loss (80% of AGA cases), the patient has the option of deciding against further hair transplants postoperatively and even shaving his head without large scars that would make this impossible.**
- **There are no large postoperative scars and thus no painful scars, irreversible paresthesias, or sensitivity to weather in the scarred region.**

4.4 FUE: The Method of Minimally Invasive Hair Transplantation

"FUE" stands for "follicular unit extraction," the minimally invasive method of hair transplantation with direct anatomic extraction of follicular units. Hair grows in natural bundles that can contain up to five hairs. Hairs thus occur in groups containing variable numbers of hairs (from one to five) known as "follicular units."

In the FUE method, the follicular units are harvested individually yet as a complete anatomic unit.

In the first step of the procedure, the FUs are individually extracted from the hair fringe using tiny, specially designed extraction needles. The cannulated needle is

slid over the hair or hairs and applied obliquely inferosuperiorly in the direction of hair growth. With manually generated oscillating movements, the sharp extraction needles penetrate the epidermis, sometimes as deep as the upper or middle layer of the subcutis.

In the second step of the procedure, the FUs, which are still in the skin, are extracted from the skin tissue with fine extraction forceps. They are stored in a cool, sterile, physiologic saline solution until they are implanted in the recipient area. The micro-wounds created by the extraction are so small that they heal spontaneously within a few days, leaving practically no scars. This technique not only makes it possible to harvest individual FUs intact. It also usually leaves behind no visible traces in the form of significant scarring.

Properly performed, the method creates only minimal scalp trauma. As a result, neither hair thinning due to shock loss nor miniaturization of native hair occurs. This particularly tissue-sparing extraction technique coupled with the precisely scalable harvesting of grafts means that this effective and atraumatic procedure can be repeated at appropriate intervals, as may be necessary in patients with progressive AGA.

The FUE method also has another particular advantage. Because it does not damage the skin, it can be performed not only on the scalp but also on the body. This expands the donor region from the "reliable hair fringe" to include an additional large reservoir of donor hair, namely, beard and body hair.

Where the structure of the hair permits, follicular units can be harvested as donor hair from the chest, leg, and axillary regions as well. This is particularly advantageous for patients who do not have very much hair on their heads.

The FUE method is currently the only atraumatic extraction technique and thus the only minimally invasive procedure in hair transplantation.

4.5 Preoperative Procedure

4.5.1 History

The first preoperative step is to obtain a patient history. As was described earlier, due to the prevalence of the disorder, we are primarily dealing with patients with AGA. For this reason, we can largely ignore the history and differential diagnosis of other forms of hair loss. As AGA exhibits a polygenetic inheritance pattern, absolute priority should be given to obtaining a comprehensive family history. Precise analysis of the hair status of close family members will provide important information about the further clinical course of the hair loss and represents an important baseline for planning. The family history focuses on a meticulous, detailed analysis of the members of the immediate and extended family (to the third degree of consanguinity) also affected by hair loss. Wherever possible, patients should bring photographs of these family members, preferably taken at a young age. Many patients will already have found specific clues and developed certain suspicions as a result

of their own research and examination of photographs. Working together, the patient and physician can usually identify family members affected or likely to be affected by hair loss and confirm a suspicion.

The important thing is that individuals should not be categorized according to a certain pattern of androgenetic hair loss based on their hair color and/or hair structure. This is because the androgenetic trait of hair loss can be passed on independently of the traits of hair structure and hair color.

Although 70% of affected patients inherit their hair loss through the paternal line, the maternal line should also be examined in greater detail with respect to its hair loss pattern.

The common opinion that the paternal line has no influence on hair loss is not only incorrect; it also leads to a situation where many affected persons are given improper advice and consequently receive the wrong treatment.

The data collected when obtaining a family history serve to determine the current hair status and predict the extent of hair loss to be expected in the future. The next step involves comparing the patient's pattern of hair loss with the hair loss patterns of affected relatives in the immediate and extended family (to the third degree of consanguinity) and finally categorizing them with the person or persons having the most similar pattern. The Norwood classification is very helpful in this regard.

Where both grandfathers of a patient are or were affected by AGA, the more similar pattern of hair loss will provide an important clue as to the line of inheritance. This categorization must also make allowances for the patient's increasing age. The more or less positive correlation between hair loss and biological age continues until the age of 65, and only then may one expect the rate of hair loss to slow or stagnate [2]. Our experience has shown that with about 70% of patients, at least one relative can be found with a similar pattern of hair loss. Only with a comprehensive family history is the physician in a position to determine both the progression of the hair loss and the "reliable donor area" with the necessary precision and thus to arrive at a possible indication for surgical treatment.

4.5.2 Indication and Contraindication Criteria

The following criteria are important for determining whether a hair transplant is indicated or contraindicated:

- The family history findings
- The psychological strain of the affliction for the individual patient
- What the individual patient expects of a hair transplant
- The patient's age

These criteria vary with each patient and influence each other to a certain degree. The following section describes the individual criteria and combinations of criteria that are often encountered in the hair restoration surgeon's practice.

4.5.2.1 Patients with an Incomplete Family History

About 30% of patients cannot be categorized as having a hair loss pattern similar to a relative because their family history is incomplete. Important information about the further clinical course of the hair loss is missing in these cases. Therefore, one should be very careful before determining that intervention is indicated.

Determining whether hair transplantation is indicated becomes particularly difficult in patients under the age of 40 whose hair loss is not yet fully developed and who have no known relative with a similar pattern of hair loss. This is because the progressive hair loss could end in a Norwood Type VI or VII pattern, which could represent a contraindication to hair transplantation.

4.5.2.2 Unclear Family History in Combination with Young Age

The question arises as to the minimum age at which hair transplants may be helpful. For interventions using conventional techniques, the finding that hair transplantation is indicated at a young age (between 18 and 30) is rightfully the subject of intense controversy. The situation is a bit different for minimally invasive techniques because of their preservation of tissue and their scalability, which therefore allow subsequent repeat procedures. A great deal of caution should be exercised with young patients with an unclear family history. This requires the assessment of a very experienced physician who then works out what treatment is indicated in close consultation with the patient.

4.5.2.3 Patients' Expectations of Hair Transplantation

When obtaining the history, the physician should also assess the patient's specific expectations from a possible hair transplant.

Our experience has shown that young patients in particular (those between 20 and 30 who already have a Norwood Type I–III pattern) have very high expectations. This is because only a short time has passed since they had a full head of hair with a complete hairline. For these patients in particular, it is difficult to understand and accept the future progressive hair loss that will continue until about the age of 65. These patients usually require a particularly detailed and time-consuming consultation in order to fully comprehend their disorder and its ramifications.

These patients often hope that undergoing only a single hair transplant will allow them to regain natural hair density. However, this is clearly an unrealistic notion that gives the patient an exaggerated expectation of what hair transplantation can achieve. Such expectations on the part of patients are occasionally based on the unrealistic promises of certain clinics and physicians, often supported by unqualified posts on Internet forums. The physician must correct such exaggerated expectations of what a successful treatment can achieve and ensure that the patient has a realistic picture before treatment can begin. In cases in which the patient retains unrealistic expectations that even a realistic consultation has been unable to correct, treatment of the patient is contraindicated and should be refused.

4.5.2.4 Psychological Strain Due to Hair Loss

Very many patients suffer from progressive hereditary hair loss at a young age. Their hair loss will inevitably continue to progress in the future. The knowledge of having to suffer additional hair loss in the future is usually a great burden for affected persons. Yet for the attending physician, it is an important fact that must be addressed in the specific treatment of the patient. The intensity of this psychological strain on the patient is highly variable. Some people (although rather few) are not greatly disturbed, whereas others experience such an intense psychological strain that their quality of life is significantly compromised. The dialog with affected persons reveals that the hair loss often affects interpersonal communication and thus the patient's personal relationships with other people. The loss of hair is thus not only a physical change but also brings with it an emotional change that can greatly influence the affected patient's personality.

In many cases the personality change can cause the person to withdraw from social interaction and neglect school, education, work, and social activities. Hair loss is often accompanied by a loss of self-esteem and often leads to loneliness, isolation, and in the worst cases depression or even thoughts of suicide. In such a troubling situation, many affected persons see a hair transplant as the only way out of this viscous circle.

Once a comprehensive family history has been obtained to predict the degree of expected future hair loss, the psychological strain, which can be enormous, should be considered as it is a crucial criterion for determining what course of action is indicated.

Often it will be the case that family history findings point to a very unfavorable prognosis. The patient will have to expect such severe hair loss (Norwood VI–VII) that a hair transplant is not indicated. When in such cases the psychological strain is so great that the patient has difficulty in coping with the prognosis, there is still the option of initial medical therapy. Before a hair transplant is definitively rejected, initial medical therapy with finasteride can be attempted in an effort to slow down the hair loss. Complementary use of minoxidil can be considered as well. In such cases, our patients are given a prescription for finasteride and minoxidil. They are then instructed to take monthly photographs under standardized conditions to document the course of their hair status over time. After about 6 months, these patients can then return to our office. The physician will then reconsider the situation and in applicable cases determine that surgery is indicated. However, if it becomes apparent that taking finasteride and applying minoxidil have not brought any improvement, then the transplantation of head hair follicles must be rejected once and for all. In such cases, the only remaining option is to transplant body hair in the event that the patient has body hair in sufficient quantity.

4.5.2.5 Poor Hair Density in the Donor Area

Excessively poor hair density in the donor area can also represent a relative or absolute contraindication. The poor hair density may be due to the following causes:

- Diffuse unpatterned alopecia (DUPA): This rare form of hair disorder is characterized by generalized miniaturization of the scalp hair and a decrease in follicular density with less than 50 FUs per cm^2 (Fig. 4.1).
- Iatrogenic thinning and miniaturization of the hair fringe as a result of multiple past hair transplants (Fig. 4.2).

4.5.2.6 Nicotine Use

Due to the interplay of its hypoxic and vasoconstrictive effects, nicotine use leads to generally delayed wound healing [3].

As this initially compromises the vascular supply to the grafts, which receive less oxygen and fewer nutrients, it should be assumed that the survival rate of the grafts will be less than in nonsmokers. This is consistent with our clinical experience in treating patients who use nicotine. For this reason, hair transplantation is contraindicated in this patient group.

Fig. 4.1 Diffuse unpatterned alopecia (DUPA) showing beginning generalized hair miniaturization

Fig. 4.2 Left: Thinning and miniaturization of the hair in the donor area secondary to a single hair transplant using the strip method. Right: Thinning and miniaturization of the hair in the donor area secondary to two hair transplants using the strip method

4.6 Surgical Planning

One must not use the data from the patient's history as the sole basis for determining that a hair transplant is indicated. Supplementary use of modern methods of collecting diagnostic data is necessary to precisely weigh the specific benefit of a hair transplant to the patient and to determine what course of action is indicated.

The collected data provide a basis for long-term planning, and they give the patient an initial realistic assessment of the hair loss that may be expected in the future. Additionally, they show what the results of the surgery will be.

Diagnostic studies must obtain the following specific data:

- The area (in cm^2) of the present and expected future bald patches
- The area of the donor site
- The hair density in the donor site
- The number of grafts currently required
- The number of grafts required in the future
- Hair shaft diameter

Obtaining some of these data requires determining the position of the hairline in advance. For this reason, I would like to discuss hairline design before describing the items mentioned in greater detail.

4.6.1 The Hairline

A decisive factor in determining the area of the bald spots is to determine the anterior border of the scalp hair, the frontal hairline. Given its exposed position, the reconstruction of this line must meet the aesthetic requirements of a hairline design with a natural appearance.

The hairline is the strip of hair approximately 5 mm wide that forms the anterior portion of the hair-covered forehead. This arises from the apex at the level of the frontomedian line (FML) and laterally joins the temporal portion of the hair fringe to form the frontotemporal angle (FTA). When this angle expands due to thinning and/or hair loss, we refer to frontotemporal balding or frontotemporal corners. It should be noted that frontotemporal corners occur not only in the setting of androgenetic alopecia but can be present in some affected persons from birth as a genetic disposition (Fig. 4.3).

The particular topographical relationship of the hairline at the level of the frontotemporal angle to the canthus line (CL) should always be considered in surgical planning of the hairline. The canthus line usually courses at the level of the vertex of the FTA or medial to it (Fig. 4.4).

4.6.1.1 What Hairline Design Should Achieve

It is important to plan a forehead hairline appropriate to the patient's age. One should allow for the natural recession of the hairline of 2–3 cm with increasing age (especially in men).

Fig. 4.3 Left: Congenital frontotemporal corners in a 26-year-old male patient without AGA. Right: Congenital frontotemporal corners in a 19-year-old female patient without AGA

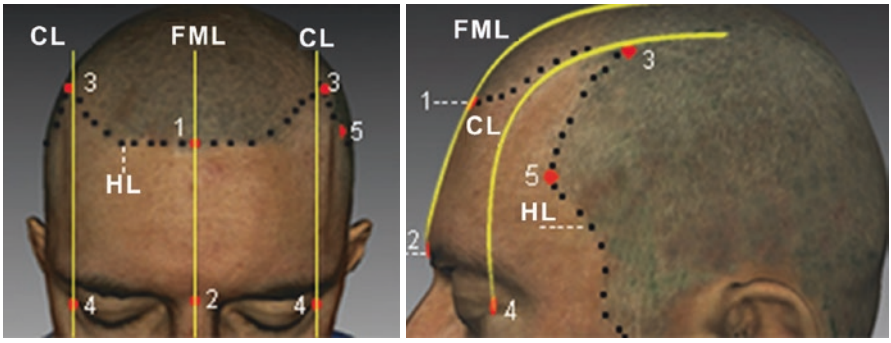

Fig. 4.4 Anatomic and topographic landmarks for determining the hairline. **Reference points**: (1) Apex, (2) glabella, (3) frontotemporal angle (FTA), (4) canthus line (CL), (5) temporal triangle. **Reference lines**: HL, hairline. FML, frontomedian line: It arises from the glabella and courses inferiorly over the tip of the nose and the midpoint of the upper lip to the tip of the chin. Superiorly, it courses from the glabella to the frontomedian apex of the hairline. CL, canthus line: It arises from the lateral canthus and courses superiorly parallel to the FML to the respective FTA

Patients with a poor prognosis and expected alopecia in the frontal and vertex region will require grafts for the entire bald area. Thus in every second of such patient, the desired hairline positioning will have to be subordinated to the overall aesthetic effect, and a compromise will have to be found.

The particular topographical relationship of the hairline to the canthus line (CL) must be considered in surgical planning.

As progressive hair loss over the entire top of the head including the vertex region may be expected in 50% of all patients, proper positioning of the hairline in the frontal plane is of immense importance. Overly aggressive positioning to achieve a youthful hairline risks exceeding the available quantity of donor hair needed for the hair transplants that progressive hair loss will later require.

Educating the patient about the risks of positioning the hairline too far anteriorly is one of the hair restoration surgeon's duties when obtaining the patient's informed consent in preoperative consultation. This particularly applies to patients with a poor prognosis or an unclear family history (Fig. 4.5).

Fig. 4.5 Left: A 46-year-old patient (NW VI) with no remaining treatment options from the standpoint of conventional hair restoration surgery, status post three transplants with the strip method. The patient exhibits ongoing progressive expansion of the bald areas over the entire hair fringe with a hairline positioned too far anteriorly. Right: A 25-year-old patient (NW III), status post hair transplant with the strip method with a hairline positioned far anteriorly. The apex of the frontotemporal angle also lies lateral to the CL, giving the hairline an unnatural course

Fig. 4.6 Drawing the FML and CL reference lines using a flexible ruler

4.6.1.2 Planning Hairline Design

The following section describes the procedure for tracing the frontal hairline.

First, the frontomedian line (FML) is drawn on the patient's skin with the aid of a flexible ruler (Fig. 4.6).

Both canthus lines are then drawn with the aid of the same ruler.

The level of the apex, the farthest anterior point of the hairline, is determined by the following criteria and drawn accordingly:

- The natural recession of the hairline by 2–3 cm with age.
- The expected future Norwood pattern as the most important criterion; the higher the expected pattern number, the farther posterior the apex should be positioned.
- Patient's wishes.

The most difficult step in determining the frontal hairline is defining the line between the apex and the FTA. Here, we differentiate between a typical female hairline and a typical male one (Fig. 4.7).

Fig. 4.7 Left: A 40-year-old woman with a typical female hairline: The temporal portion of the scalp hair lies much farther anterior, leading to narrowing of the superior forehead. Right: A 37-year-old man with a typical male hairline: The border of the hairline shows physiologic age-related recession with very slight temporal hair coverage and broadening of the superior forehead

Fig. 4.8 Left: The hairline is marked, taking into account the reference lines and the patient's wishes. Right: The final hairline is marked anterior to the first hairline, taking into account the Norwood type and the available quantity of donor hair

In men, one must also take into consideration the physiologic recession of the hairline with increasing age and the future Norwood pattern. In patients of Norwood Type IV and higher, only a partial transplantation of the frontotemporal corners should be performed as complete filling would require too many grafts (Fig. 4.8).

4.6.2 Calculating the Areas

4.6.2.1 Measuring Methods for Calculating the Present and Expected Bald Areas

Unfortunately there is no one standardized method for measuring bald areas of the scalp. I feel that previous attempts at measuring these bald areas by means of simple geometric area measurements cannot be applied because they are very imprecise and not reproducible, especially since hair loss patterns vary greatly between individuals.

Over the years I have used two measuring methods from other medical fields for calculating the area in my clinical practice. In the following section, I will present examples of calculations using these two methods and discuss their respective advantages and disadvantages. These methods are digital area calculation by means of the Visitrak device and three-dimensional measurement by means of the Blitz 3D Scanner or Eva 3D Scanner.

4.6.2.2 Digital Area Calculation by Means of the Visitrak Device

A grid film is placed over the bald recipient areas, and the edge contours of the circumscribed area are traced. Then the film is laid on a specially designed digital pad. The previously traced contours are then retraced with a special stylus, and the resulting areas can be precisely measured digitally (Fig. 4.9).

In addition to calculating the area of regions that are already bald, one should normally calculate the areas affected by further hair thinning and the bald areas to be expected in the future as well (Figs. 4.10 and 4.11).

Advantages of Visitrak:

- Quick and easy handling.
- Precise, reproducible data.
- Can be used with short or long hair.
- Sterile use during hair transplantation is possible.
- Relatively inexpensive.

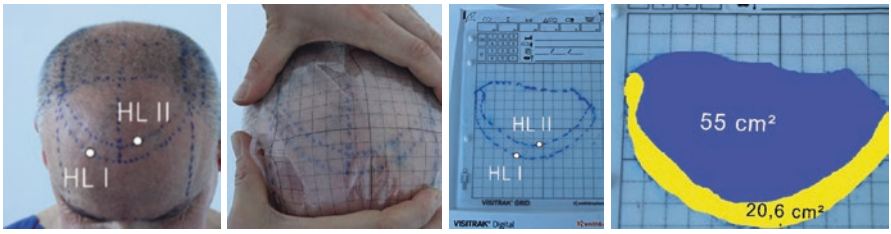

Fig. 4.9 Calculating area with Visitrak, example 1. Two different hairlines are traced, and the respective bald areas in the frontal region are calculated using Visitrak. In this case, hairline II was favored due to the current Norwood pattern (NW IV) and the expected future hair loss (NW V). The area between hairline I and hairline II measured 20.6 cm² and in the event of a transplant would have required about 400–500 FUs. In this case, we decided in consultation with the patient to opt for hairline II not merely for aesthetic reasons but also due to the small quantity of available donor hair

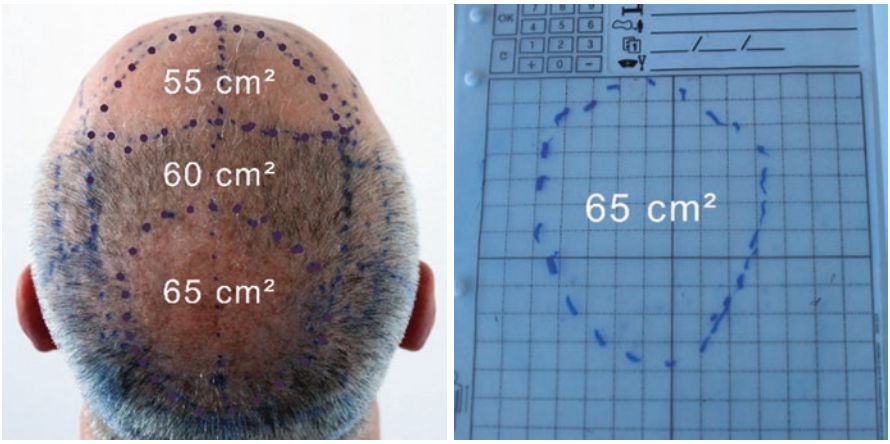

Fig. 4.10 Calculating area with Visitrak, example 2. The remaining bridge of hair (60 cm²) between the bald areas in the frontal region (55 cm²) and vertex region (65 cm²) shows 50% thinning. The thinned area within the hair bridge thus amounts to about 30 cm². The current bald area measures about 150 cm² in this 48-year-old male patient (NW IV). Due to the poor prognosis, complete baldness in the hair bridge is to be expected in the future. Therefore the total bald area to be expected in the future measures at least 180 cm², which must be taken into consideration when planning the hair transplant (Table 4.1)

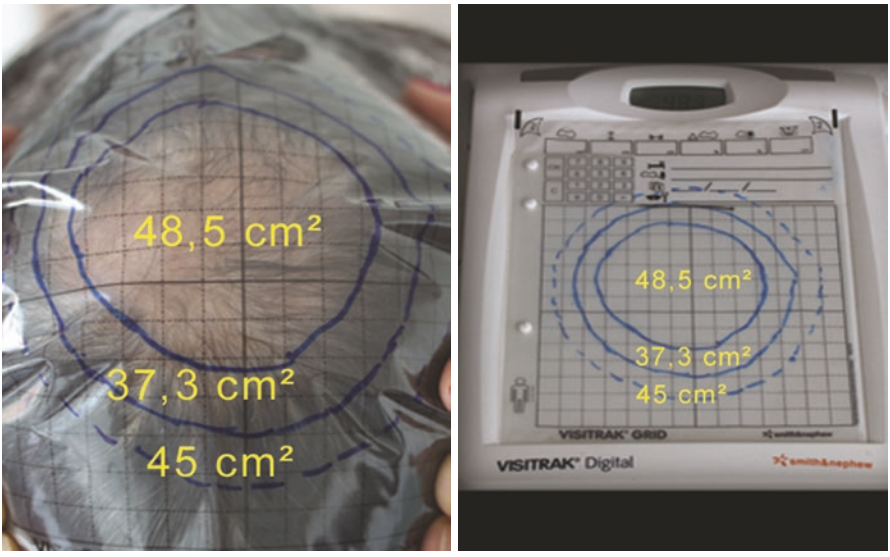

Fig. 4.11 Calculating area with Visitrak, example 3. Calculating the vertex region using Visitrak in a 38-year-old male patient (NW IV): The bald recipient area measures 48.5 cm²; The thinned recipient area measures 37.3 cm²; The total bald area to be expected in the future as a result of AGA measures 45 cm²

Table 4.1 Measured and calculated values as the basis for planning a hair transplant in our example

NW type	Current bald area	Total bald future area	Total number of hairs in the donor area	Maximum extractable donor hairs	Maximum extractable FUs	TFD at 180 cm^2	THD at 180 cm^2	HFU
IV	150 cm^2	180 cm^2	16,200	8100	4500	25	30.1	2

Disadvantages of Visitrak:

- Limited size of grid film and pad: The film and the working area on the pad measure 14 cm × 14 cm. This means that larger bald areas cannot currently be measured in a single pass. The area to be measured must be divided into two smaller areas, each of which must be traced and measured separately.
- Measured data can only be transferred manually.

4.6.2.3 Three-Dimensional Measurement Using the Blitz 3D Scanner or Eva 3D Scanner

The method allows digitalizing the bald areas without the use of a laser. The scanner acquires several images of the head per second and automatically aligns them in sequence to create a three-dimensional image. The process involves three steps:

- Image acquisition via scanner
- Merging of scanned images
- Texture generation

Special software can calculate the area of the bald patches based on the skull model generated (Fig. 4.12).

Advantages of the Blitz 3D Scanner or Eva 3D Scanner:

- Lightweight and easy handling
- Reproducible digitalized data with high precision
- Allows three-dimensional measurement

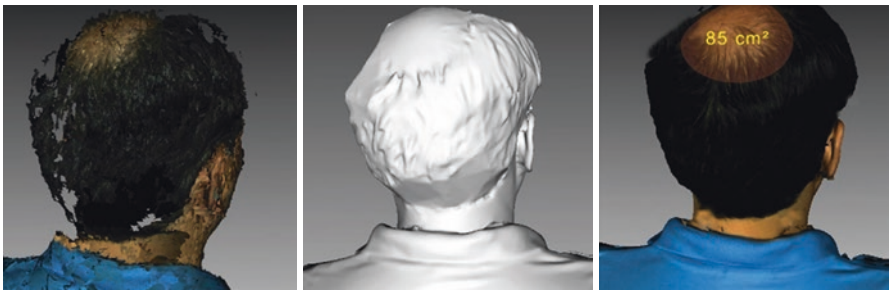

Fig. 4.12 Acquisition and alignment of images with subsequent image merging and texture generation

Disadvantages of the Blitz 3D Scanner or Eva 3D Scanner:

- Digital processing of the image files is largely automatic, which is rather time-consuming for large files and is thus not suitable for immediate use in the hair restoration surgeon's office.
- Precise representation showing the position of individual hairs in the texture is not possible.
- High procurement costs.
- Requires significant computing power.

4.6.2.4 Calculating the Reliable Donor Area Using a Coordinate System

A further important step in surgical planning is to calculate the size of the reliable donor area in the scalp hair, which includes nearly the entire temporoparietal and occipital hair fringe.

Determining the reliable donor area and measuring its area must be done for each patient on an individual basis.

In older AGA patients, macroscopic inspection of the scalp can readily distinguish the bald and thinned areas of the scalp from areas unaffected by hair loss. In younger patients below the age of 40, this is usually more difficult due to the fact that the process of hair loss has not yet run its course.

Therefore, the reliable donor area must always be determined on the basis of both inspection and family history data.

Past recommendations for determining the size of the donor area have always pertained to conventional methods of hair transplantation and therefore are not necessarily applicable to the minimally invasive FUE method. In contrast to conventional methods, the minimally invasive FUE method can be used in the entire hair fringe because of its tissue-sparing extraction technique and thus involves a significantly larger donor area.

In the following section, we will present a new measurement method for determining the size of the donor area for the FUE method.

To determine the size of the donor area for the FUE method in an individually reproducible and simplified manner, we use a special coordinate system of our own design based on reference points in the skull and soft tissue. Reference lines are used in addition to the reference points (Fig. 4.13).

I have also developed an app with which patients can easily calculate their bald area themselves, the Azar Hair Assist.

4.6.2.5 Digital Area Calculation Using the Azar Hair Assist

With the aid of Azar Hair Assist, an app I myself developed for calculating the size of bald areas, I offer patients the opportunity to calculate the area of their hairless patches themselves. This gives them valuable information regarding their thinned or bald areas, which provides an important baseline for a possible subsequent hair transplant.

My app Azar Hair Assist is available for patients to use free of charge on my website https://www.ifue-haartransplantation.de/azar-hair-assist/.

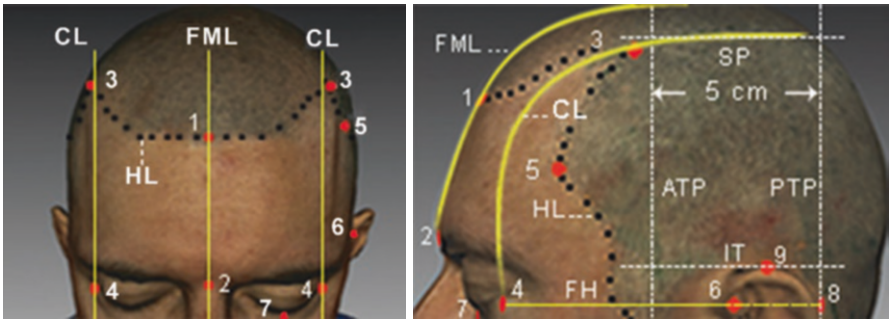

Fig. 4.13 Frontal and lateral views of the reference points and lines of the coordinate system. **Reference points**: (1) Apex, (2) glabella, (3) frontotemporal angle (FTA), (4) canthus, (5) temporal triangle, (6) tragion, (7) lower margin of the orbit, (8) auricular point (posterior margin of the helix at the level of the tragion), (9) highest point of the superior margin of the helix. **Reference lines**: HL, frontal hairline. FML, frontomedian line: It arises from the glabella and courses inferiorly over the tip of the nose and the midpoint of the upper lip to the tip of the chin. Superiorly, it courses from the glabella to the frontomedian apex (FMAP) of the hairline. CL, canthus line: It arises from the lateral canthus and courses superiorly parallel to the FML toward the FTA

4.6.2.6 Dividing the Donor Area into Component Areas

The area of expected future hair loss is determined on the basis of the data acquired from the examination and family history, and the reliable donor area is determined using the coordinate system. Next, the size of the reliable donor area is calculated.

To do this, the entire area of the donor is divided into two lateral/temporoparietal areas (area 1 and area 2) and three posterior areas, namely, a parietal area (area 3), an occipitoparietal area (area 4), and an occipital area (area 5).

4.6.2.7 Determining the Temporoparietal Areas

Determining the two temporoparietal areas provides the basis for calculating other areas (Figs. 4.14 and 4.15).

We distinguish two groups of patients when determining the reliable donor area.

Group I: patients with hair loss on the top of the head without the involvement of the vertex. This group includes hair loss Types I, II, and III according to the Norwood classification. This does not include Type NW III vertex. The incidence of group I in 60- to 69-year-old male patients according to the Norwood classification is 43% (Fig. 4.16).

4.6.2.8 Determining the Donor Area in Group I

The first three hair loss Types NW I–III exhibit a stable hair fringe. Therefore the coordinate system described above can be used to determine the donor area (Fig. 4.17).

Group II: This group encompasses all hair loss types that involve the vertex region. These include Types III vertex, IV, V, VI, and VII of the Norwood classification. The incidence for group II in 60- to 69-year-old male patients according to the Norwood classification is 57%.

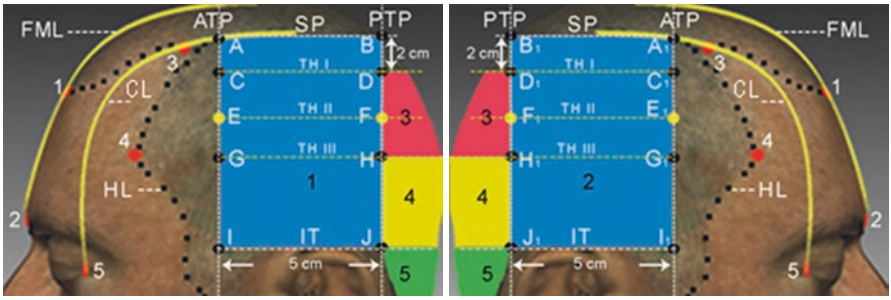

Fig. 4.14 Determining the temporoparietal component areas of the donor area using a coordinate system. **Reference points**: (1) Frontomedian apex (FMAP), (2) glabella, (3) frontotemporal angle (FTA), (4) temporal triangle, (5) canthus, (6) tragion, (7) lower margin of the orbit, (8) auricular point (posterior margin of the helix at the level of the tragion, the intersection of the PTP perpendicular and the posterior extension of the orbitomeatal plane), (9) highest point of the superior margin of the helix, (10) tragus, (11) helix. **Reference lines**: Frontal hair line (HL). Frontomedian line (FML): It arises from the glabella and courses inferiorly over the tip of the nose and the midpoint of the upper lip to the tip of the chin. Superiorly, it courses from the glabella to the frontomedian apex of the hairline. Canthus line (CL): It arises from the lateral canthus and courses parallel to the FML toward the FTA. Orbitomeatal (Frankfort) plane: It connects the tragion with the lower margin of the orbit. The tragion is the deepest indentation between the tragus and the helix (crus of the helix). Posterior temporoparietal line (PTP): It arises from the auricular point on the posterior margin of the helix and is perpendicular to the posterior extension of the orbitomeatal plane. Anterior temporoparietal line (ATP): This line is perpendicular to the orbitomeatal plane and courses parallel and approximately 5 cm anterior to the PTP. It represents the anterior margin of the temporoparietal area. Superior parietal line (SP): This horizontal line borders directly on the canthus line and defines the border of the superior portion of the temporoparietal areas. Inferior temporal line (IT): This horizontal line courses parallel to the SP at the superior margin of the helix borders directly on the canthus line and defines the border of the superior portion of the temporoparietal area. **Determining the temporoparietal areas**: The rectangular areas 1 and 2 marked in blue represent the donor area in the left and right temporal regions. The intersections of the areas with the surrounding reference lines are labeled as A, B, I, J and A1, B1, I1, J1, respectively. **The temporoparietal areas 1 and 2 are divided into four smaller rectangles by three horizontal dividing lines**: TH I lies 2 cm inferior to the SP line. It defines the superior margin of rectangular area 3 (the parietal area). TH III defines the inferior margin of rectangular area 3 (the parietal area) and the superior margin of rectangular area 4 (the occipitoparietal area) and also divides rectangle CDIJ in half. TH II divides rectangle CDGH and area 3 (the parietal area) in half

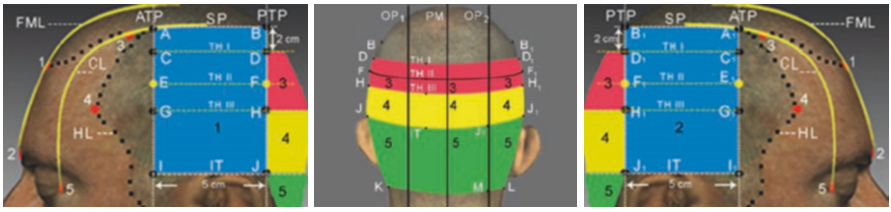

Fig. 4.15 Determining the posterior areas of the donor area using a coordinate system. **The donor area is divided into three posterior areas**: Parietal area (area 3): It borders on the two temporoparietal areas (areas 1 and 2). Its left border is defined by line DH and its right border by line D1H1. Superiorly, it is bounded by the extension of TH I and inferiorly by TH II. Occipitoparietal area (area 4): It borders laterally on the two temporoparietal areas (areas 1 and 2). Superiorly, it is bounded by TH III and inferiorly by the IT line. Occipital area (area 5): It is bounded superiorly by the IT line and inferiorly by the posterior hairline and CL. The two lateral contours JK and J1L define the lateral borders of the trapezoidal area

Fig. 4.16 Frontal and lateral views of patients with NW I–III hair loss: Left: NW I, incidence in 60- to 69-year-old male patients: 19% (according to the Norwood classification). Middle: NW II, incidence in 60- to 69-year-old male patients: 16% (according to the Norwood classification). Right: NW III, incidence in 60- to 69-year-old male patients: 8% (according to the Norwood classification)

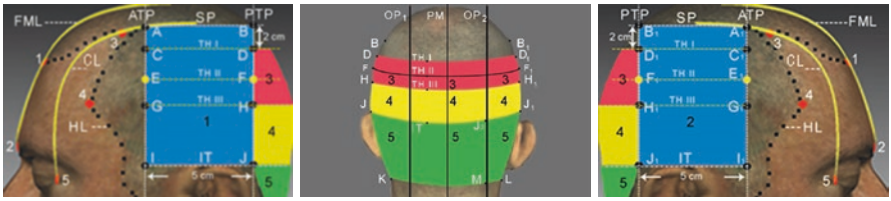

Fig. 4.17 Determining and calculating the donor area in group I (NW I, NW II, NW III). **Dividing the areas of the group I donor area into five smaller areas**: Two temporoparietal areas 1 and 2. One parietal area 3. One occipitoparietal area 4. One occipital area 5. **Calculating the area of the donor area**: Areas 1, 2, 3, and 4 as rectangles: F1 = AB × BJ. F2 = A1B1 × B1J1. F3 = DD1 × D H. F4 = HH1 × HJ. Area 5 as a trapezoid: F5 = ½ (JJ1 + KL) × J3M

The vertex region refers to the area posterior to the frontal region that begins at the vertex (the highest point of the skull aligned parallel to the orbitomeatal plane) and includes the cowlick region. The cowlick is the region around which the hair aligns to form a spiral or the shape of an S. The cowlick usually occurs in isolation and rarely is present as a double formation [4].

The thinning or the occurrence of bald spots in and around the cowlick is the characteristic feature of group II. We differentiate two variants of the hair loss pattern that occurs here (Figs. 4.18 and 4.19).

4.6.2.9 Determining the Donor Area in Group II

Norwood Type III Vertex

Incidence in 60- to 69-year-old male patients according to the Norwood classification: 7%.

The lateral hair fringe in the temporoparietal area is not affected by hair loss and can therefore be calculated according to the existing scheme for group I. The hair loss in the cowlick region can vary from slight to severe (Fig. 4.20).

Fig. 4.18 Alopecia of the vertex region: variant I. The hair loss begins in the cowlick (marked in black) and extends anteriorly toward the vertex. In some cases this is accompanied by a small area of thinning or balding in the shape of a half-moon immediately beneath the cowlick

Fig. 4.19 Alopecia of the vertex region: variant II. The hair loss begins in the cowlick (marked in black) and extends over a broad area posteriorly, into the occipitoparietal region, and anteriorly toward the vertex

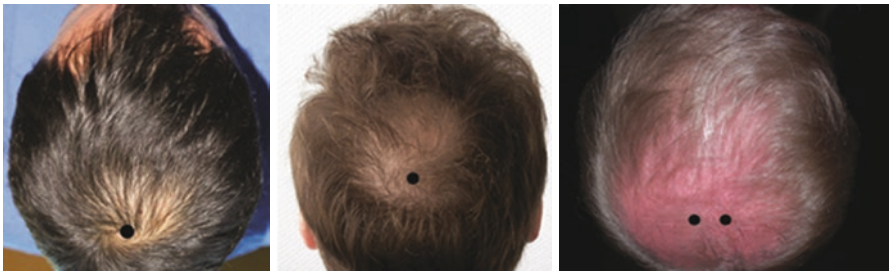

Fig. 4.20 Type III vertex. Varying severity and extent of the hair loss in the cowlick region (cowlick marked in black) in three different patients

Norwood Type IV

Incidence in 60- to 69-year-old male patients according to the Norwood classification: 12%.

The lateral hair fringe in the temporoparietal region remains largely stable. Compared with Type III vertex, there is also increasing hair loss of variable severity in the frontal region. However, a relatively dense bridge of hair remains in the area between the vertex area affected by hair loss and the frontal region (Figs. 4.21 and 4.22).

Norwood Type V

Incidence in 60- to 69-year-old male patients according to the Norwood classification: 15% (Fig. 4.23).

Fig. 4.21 NW IV. Varying severity and extent of the hair loss in the vertex region in three different patients. The bridge of hair between the frontal region and the vertex remains intact with relatively good hair density

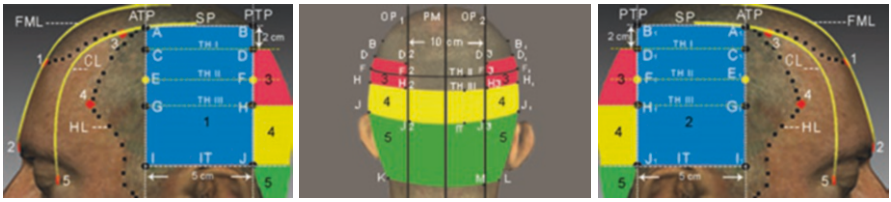

Fig. 4.22 Determining and calculating the donor area in group II (NW III vertex and NW IV). **We use additional reference lines to determine the donor area in the occipitoparietal area in group II**. The posteromedian line (PM) is defined as the extension of the frontomedian line and the vertical line between the glabella and inion (the salient point of the external occipital protuberance). The occipitoparietal lines OP 1 and OP 2 course at a respective distance of 5 cm parallel to the PM line. **Calculating the area of the donor area**: Areas 1, 2, 3, and 4 as rectangles: F1 = AB × BJ. F2 = A1B1 × B1J1. F3 = DD2 × DH + D1D3 × D1H1 = 2× (DD2 × DH). F4 = HH1 × HJ. Area 5 as a trapezoid: F5 = ½ (JJ1+KL) × J3M

Fig. 4.23 Hair loss pattern in NW V (top and lateral views) in two different patients

Here the frontotemporal hair loss is more prominent (marked in red in Fig. 4.24). The previously dense superior marginal portion of the temporoparietal area shows diffuse, inferiorly directed thinning (marked in blue in Fig. 4.24). The bridge of hair has largely disappeared.

Norwood Type VI

Incidence in 60- to 69-year-old male patients according to the Norwood classification: 13%.

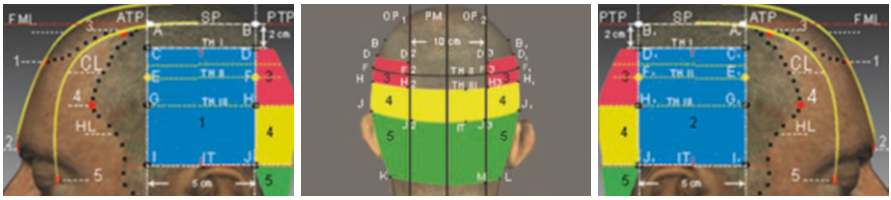

Fig. 4.24 Determining and calculating the donor area in group II (NW V). The vertex and cowlick regions show isolated hairs. There is increasing hair loss in the frontotemporal area and increasing thinning in the superior margin of the temporoparietal area. The hair density is well preserved throughout the entire donor area. **Calculating the area of the donor area**: Areas 1, 2, 3, and 4 as rectangles: F1 = CD × DJ. F2 = C1D1 × D1J1. F3 = DD2 × DH + D1D3 × D1H1 = 2× (DD2 × DH). F4 = HH1 × HJ. Area 5 as a trapezoid: F5 = ½ (JJ1 + KL) × J3M. In this patient, the area of the donor area, with an expected future NW V pattern, would amount to 202 cm²

Fig. 4.25 Hair loss pattern in NW VI (top and lateral views) in two different patients

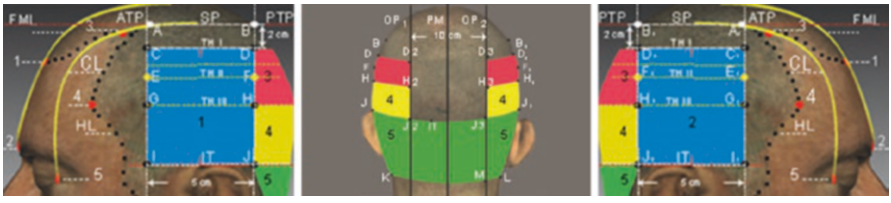

Fig. 4.26 Determining and calculating the donor area in group I (NW VI). Increasing miniaturization and thinning throughout the entire donor area. **Calculating the area of the donor area**: (areas 1, 2, 3, and 4 as rectangles). F1 = CD × DJ. F2 = C1D1 × D1J1. F3 = DD2 × DH + D1D3 × D1H 1 = 2× (DD2 × DH). F4 = HH2 × HJ + H1J1 × J1J3 = 2× (HH2 × HJ). Area 5 as a trapezoid: F5 = ½ (JJ1 + KL) × J3M

It can be difficult to distinguish NW V from NW VI in some cases. The increasing frontotemporal hair loss with further recession of the lateral hair fringe in the temporoparietal area (marked in blue in Fig. 4.25) and clearly visible progressive thinning in the entire donor area are the salient features of the NW VI hair loss pattern (Fig. 4.26).

Norwood Type VII

Incidence in 60- to 69-year-old male patients according to the Norwood classification: 10%.

Norwood Type VII hair loss represents a contraindication for hair transplantation due to the significantly reduced donor area. The increasing expansion of the bald areas dominates in the frontotemporal and temporoparietal areas. The miniaturization and thinning of hair in the donor area is more severe than in NW VI. As the hair loss progresses, the temporoparietal area recedes as far as the anterosuperior margin of the ear.

4.6.3 Determining the Number of Follicular Units or the Number of Hairs in the Donor Area

Having calculated the area of the donor site, we are still not in a position to draw any conclusions about the number of existing FUs or hairs. Although precise determination of the number of FUs or hairs in the reliable donor area is practically impossible, it should be estimated as precisely as possible because of its importance in determining whether one or more future hair transplants will be indicated (Figs. 4.27 and 4.28).

The total number of FUs or hairs in the donor area can be determined by multiplying the areas of the individual fields by the number of FUs or hairs measured there.

In our example of an NW IV patient, the total donor area was 245 cm^2, containing approximately 9000 FUs or 16,200 donor hairs. With a tissue-sparing, harmoniously distributed extraction performed in several sessions, half of the FUs or donor hairs (4500 and 8100, respectively) can in this case be used for transplantation into the bald patches to cover an area of 185 cm^2 without having to fear any visible thinning in the donor area.

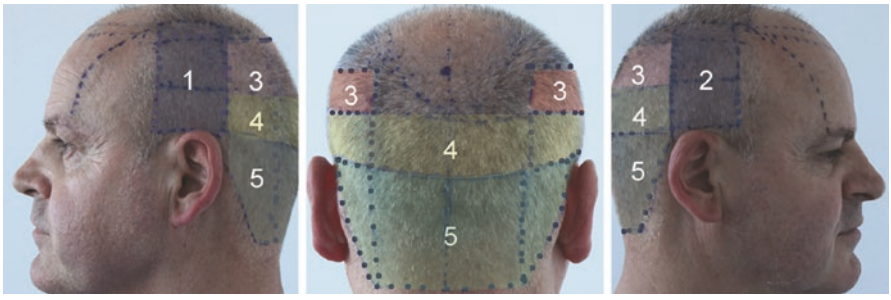

Fig. 4.27 Calculating the area in a 48-year-old male patient with NW IV. Using the coordinate described previously, the donor area was divided according to topographic anatomic criteria into six fields and measured: Field 1: The left temporoparietal area; F1 = 35 cm^2. Field 2: The right temporoparietal area; F2 = 35 cm^2. Field 3: The parietal area was subdivided into two separate fields, taking into consideration the vertex region; 2 × F3 = 30 cm^2. Field 4: The occipitoparietal area; F4 = 70 cm^2. Field 5: The occipital area; F5 = 75 cm^2. **Total area of the donor area: F1 + F 2 + 2(F3) + F4 + F5 = 245 cm^2**

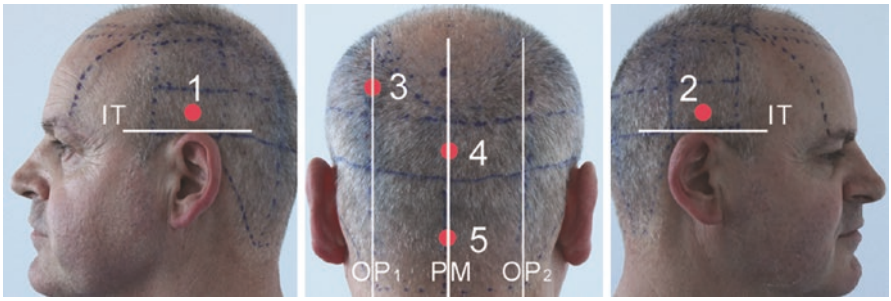

Fig. 4.28 Measuring points for trichoscopic determination of the number of FUs or hairs. **Location of the measuring points**: Measuring points 1 and 2 lie 2 cm superior to the superior margin of the auricle (IT line) and in the respective centers of the temporoparietal areas. Measuring point 3 lies in the parietal area on occipitoparietal line 1. Measuring point 4 lies in the center of the occipitoparietal area on the posteromedian line. Measuring point 5 lies in the center of the occipital area on the posteromedian line

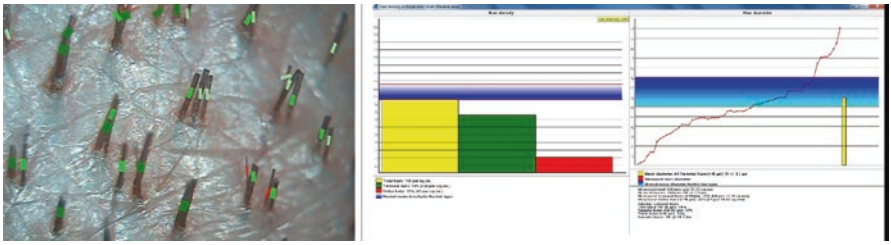

Fig. 4.29 Measuring the number of FUs or hairs in the occipital area (F5) using a trichoscope (TrichoSciencePro by Trichologic)

4.6.4 Planning and Calculating the Number of Grafts Required

The hair density is specified as the number of hairs per cm^2. Not only is it subject to ethnic variation, it also exhibits intraindividual differences. Whereas the parietal and occipitoparietal regions usually exhibit high hair density, the temporoparietal areas and to some extent the occipital region near the posterior hairline have a lesser density (Fig. 4.29).

Thus, it is hardly surprising that greatly differing statements about human hair density may be found in the literature. The numbers vary between 124 and 340 hairs per cm^2. Aside from ethnic variation, this difference is attributable to differences in the measuring points, measurement methods, and measurement accuracy. Even the data obtained by newer computerized measurement methods using magnifying lenses may not be termed precise as the collected data represent an extrapolation of hair density from a partial sample.

In light of our current understanding of the anatomy of the follicular unit and the great significance of its atraumatic harvesting and insertion for hair transplantation, we should also use the term follicular density (FD) in this context.

FD is understood to mean the number of follicular units per cm^2. Follicular density also exhibits ethnic and intraindividual differences. It varies between 60 and 100 FUs per cm^2 or 0.6 and 1 FU per mm^2. At a follicular density of 100 FUs per cm^2, each FU requires an area of about 1 mm^2, and at an FD of 60 FU per cm^2, the required area per FU is 1.7 mm^2.

The average number of hairs per follicular unit is calculated by dividing hair density (HD) by follicular density (FD). This number specifies the average number of hairs per FU. We will introduce the term "number of hairs per follicular unit" or HFU to refer to this relationship. HFU usually varies between 1.6 and 2.8 hairs.

To make a quantitative statement about the required or transplanted FUs per cm^2 in treated areas, we will use, for the sake of accuracy, the term "transplanted follicular density" (TFD) in place of FD and the term "transplanted hair density" (THD) in place of hair density (HD).

In the example of our patient with NW IV, a donor area of 245 cm^2 with 8100 donor hairs or 4500 FUs is available to cover what in the future will be a bald area of 180 cm^2. Based on these figures, it would be possible to treat the entire area with 25 FUs per cm^2 or 33.1 hairs per cm^2.

As a rule we can assume that the transplantation of even 20–25 FUs per cm^2 will achieve a good visual density. Every second male AGA patient develops hair loss of NW IV or higher. When transplanting one should not exceed a density of 20–25 FUs per cm^2, depending on the NW type.

4.6.5 Determining Hair Shaft Diameter

Hair shaft diameter or hair thickness greatly influences the visual hair density and the result of the hair transplant. Hair has a nearly cylindrical structure whose volume can be calculated with the formula $V = \pi r^2 h$ (where r = hair shaft diameter and h = hair length). If the hair length doubles, the volume doubles; if it triples, the volume triples as well.

Yet if the hair shaft diameter doubled, then the volume would quadruple.

Three types of hair are distinguished:

- Vellus hairs are fine nonpigmented hairs lacking medulla that form the body hair until puberty. With the onset of puberty, these thin vellus hairs become thick terminal hairs.
- Intermediate hairs assume a middle position between vellus and terminal hairs due to their diameter and are pigmented. They are either not yet fully developed terminal hairs in an early anagen phase or were originally terminal hairs that are changing into miniaturized hairs in the setting of androgenetic alopecia.
- Terminal hairs are medullary, usually pigmented hairs. They are the thickest hairs in the scalp hair, eyebrows, and eyelashes. Some of them are fully developed at birth (Table 4.2).

Table 4.2 Hair types and their hair shaft diameters

	Vellus hair	Intermediate hair	Terminal hair
Hair shaft diameter (μm)	<30 μm	30–60 μm	60–140 μm Fine terminal hair: 60–65 μm Medium thickness terminal hair: 65–80 μm Thick terminal hair: 80 μm

Hair shaft diameter can be determined in two ways: either by means of a micrometer or by computerized methods such as trichoscopy (TrichoSciencePro by Trichologic).

In patients of Norwood Type IV and higher with fine terminal hair, one should carefully consider whether hair transplantation is indicated.

4.7 The Operation: General Section

4.7.1 Operation Management

Ensuring a complication-free treatment for the patient and optimal treatment results requires more than the preoperative planning discussed above. A suitable, functional surgical environment must be created which comprises the components listed below.

4.7.1.1 Operating Room and Equipment

Performing a minimally invasive hair transplant does not require any special operating room. A separate intervention room in the physician's office or clinic equipped as outlined below will suffice.

Depending on the scope of the intervention, the length of the procedure can vary from a few hours to several sessions over a period of several days. Thus, a comfortable operating couch is required. A high-quality cosmetic couch will be suitable. It should be equipped with hydraulically adjustable height and positioning features and a well-cushioned aperture for the head.

Another separate room is required for preparing and sterilizing the surgical instruments. It should be equipped with an instrument sterilizer.

4.7.1.2 Surgical Instruments

Extraction instruments:

- Sterile extraction needles (cannulated needles)
  The choice of extraction needles is very important as the aim of the procedure is to avoid scarring wherever possible. The outer diameter of the needle must not exceed 1.05 mm. This corresponds to a cannulated needle with an inside diameter of 0.95 mm and a wall thickness of 0.05 mm. For patients with particularly thick hair, one may consider using extraction needles with an inside diameter of 1 mm and an outside diameter of 1.1 mm. However, one must expect significantly

greater scarring in such cases. This should be discussed in great detail and agreed with the patient.
- Sterile holder for extraction needles
- Sterile extraction forceps

Incision instruments:
- Sterile incision blades

Insertion instruments:
- Sterile insertion forceps

Other instruments
- Sterile compresses
- Cold packs
- Binocular loupe with at least three-power magnification
- Sterile powdered gloves
- Spray bottle with saline solution to spray the surgical site (to improve visibility of the site)
- Drapes
- Instrument table
- Surgical scissors (sharp jaws, curved)

4.7.1.3 The Surgical Team

Many providers of hair transplants strongly emphasize their "teamwork." There is nothing to be said against good teamwork. However, it must be clearly stipulated that only the physician as surgeon personally performs all steps of the treatment procedure that directly involve the patient's head. Aside from obtaining the patient's informed consent and administration of anesthesia, these tasks include the complete extraction and insertion of the grafts.

> Obtaining the patient's informed consent, administering anesthesia, and performing all surgical procedures on the patient's head are part of the physician's personal service obligation. As such they must be reserved for the physician alone and may not be delegated to non-physician practitioners under any circumstances.

Ideally, the surgical team consists of an experienced surgeon (physician) and usually one or at most two surgical assistants or nurses.

4.7.1.4 The Surgeon (Physician)

Achieving treatment results of uniformly good quality requires comprehensive specialized knowledge and specific practical expertise on the part of the surgeon. The surgeon's experience is so important for the simple reason that every patient presents with individual physical and emotional requirements and naturally responds to treatment individually as well.

Because the entire process from the transplantation to the final treatment result is extremely time-consuming, useful experience can only be obtained with numerous treatments over a period of many years.

Add to this that the medical field of hair loss and modern hair transplantation is so extensive that the hair transplantation surgeon should best be specialized in this field. Finally, the surgeon with practical experience can be recognized by the fact that he or she has specialized exclusively in the field of hair transplantation. A physician who is active in other specialties and performs other surgical interventions in addition to hair transplantation cannot have the same extensive experience as a physician who has specialized exclusively in this field.

4.7.1.5 The Surgical Assistants or Nurses

The following tasks lie within the scope of their responsibility:

- Preparing and reprocessing the instruments before and after surgery, including sterilization and preparation of instrument trays
- Passing instruments during the operation
- Ensuring that the petri dishes with saline solution are stored in a cool place (optimally at 4 °C)
- Sorting the follicular units by number of hairs
- Documenting the distribution of follicular units (how many 1-hair FUs, 2-hair FUs, etc.)

4.8 Die Operation: Patient-Specific Section

4.8.1 Obtaining the Patient's Informed Consent

Androgenetic alopecia is a progressive hereditary disorder. For this reason, the physician should educate the patient early (e.g., in the initial consultation) about the pathology of AGA and the available conservative, medical, and surgical treatment options.

Because of its tissue-sparing extraction technique, minimally invasive hair transplantation entails hardly any risks for the patient compared with conventional techniques. For this reason, the consent discussion regarding the surgery can also take place on the day of treatment by the attending physician. Such a short interval between consent discussion and treatment is not permissible with conventional methods as the patient is exposed to greater physical risks (from complications) and must therefore be given more time for reflection before consenting to the procedure.

Requirements for a low-risk treatment thus include having a surgeon carefully perform the operation without delegating the procedure to non-physician practitioners and avoiding the use of motorized extraction instruments and extraction robots. Furthermore, one should refrain from extracting more than 2500 FUs per session ("megasession") as this multiplies the effect of the minor tissue injuries and is not consistent with the tissue-sparing character of the minimally invasive FUE method.

As large bald patches cannot be treated satisfactorily or maybe even at all with a single hair transplant, the goal of the planned operation should be discussed in great detail with the patient.

The patient should also be comprehensively informed about the expected success rate as a percentage survival rate of the grafts. Optimistic promises such as "once again a full head of hair" or "we achieve consistently high graft survival rates of 90% and higher" regularly disappoint patients after failure to achieve a higher survival rate. Patients view the lower survival rate as a complication, which often leads to complaints and disappointment.

Furthermore, patients should be informed about the necessity and relevance of preoperatively trimming the scalp hair to a length of 1 mm. The extent of hair loss only becomes apparent when the existing hair is trimmed. Only then is it effectively treatable.

4.8.1.1 Wound Healing

Harvesting individual follicular units from the donor area with an extraction needle and incising the recipient incisions in the recipient area leaves behind small wounds that are associated with erythema. Whereas in the donor area the wounds heal and the erythema resolves completely between postoperative days 7 and 9, this healing process takes about 10–14 days in the recipient area with atraumatic transplantation.

4.8.1.2 Scarring

Minimally invasive hair transplantation usually produces no permanent visible scarring. However, this can never be entirely excluded as a personal predisposition may exist.

Whether the extraction wounds in the donor area heal without visible scars depends on two important factors:

- The outside diameter of the extraction needle: The use of extraction needles with a diameter of more than 1.1 mm is usually associated with the formation of small elliptical scars. Consequently, for an effective and nonscarring FUE hair transplant, one should exclusively use extraction needles with a maximum outside diameter of 1–1.1 mm and a maximum inside diameter of 0.95–1 mm.
- Conscientious postoperative care of the donor area with special ointments.

4.8.1.3 Growth Characteristics of the Grafts

In approximately 90% of transplanted hairs, the temporary longitudinal growth that begins in the first week postoperatively ceases, and the hairs fall out in the following 3 weeks. It is only between the third and fourth months postoperatively that the first big growth surge occurs in the first fine nonpigmented hairs that later develop into strong pigmented terminal hairs. The rest of the hair grows back in additional growth surges. The process usually lasts until the 12th month postoperatively.

Educating the patient about the growth characteristics of the grafts is one of the physician's most important tasks in obtaining the patient's informed consent. This is because the sudden loss of transplanted hair and its delayed, slowed regrowth, which can take up to a year, causes many patients to despair and panic.

4.8.1.4 Risk of Infection

The risk of infection with the FUE method is nearly 0%.

4.8.1.5 Postoperative Pain

Usually no pain should be expected in the first 3 days postoperatively. However, slight sensations of tension in the skin may occur.

Beginning on postoperative day 4, 15% of patients report nighttime sensations of pain and itching in the skin which can occur in conjunction with the regeneration of the cutaneous nerve fibers.

Following personal consultation with the physician about all the items mentioned above and after consenting to the procedure, the patient receives comfortable OR clothing. Ideally, the top should have buttons or a zipper so that it does not have to be pulled over the head as otherwise the patient would risk tearing out the grafts when changing clothes.

4.8.2 Photographic Documentation in Hair Restoration Surgery

"Before" photographs document the initial state of the hair prior to treatment. Prior to hair transplantation, "before" photographs should be obtained of the patient with long hair and with short hair immediately after being shaved.

Photographs should also be obtained immediately postoperatively to document the treatment result.

To ensure precise comparability with the "before" photographs, the photographs should be taken under standardized conditions (Fig. 4.30).

4.8.3 Complete or Partial Shaving of the Scalp Hair

Patients with hair loss often like to wear their hair longer to cover up their bald or thinned areas. It is understandable that they would not like to have their hair trimmed. However, the full extent of hair loss is only apparent, and thus treatable, when the hair in the recipient area is trimmed. Shaving all of the scalp hair down to a length of 1 mm is an absolute requirement for a successful hair transplant.

Shaving reveals the distances between the individual follicular units. One also sees the exact extent of thinning and miniaturization of the hair in the affected regions (usually the transitional zones between the bald and densely covered areas).

Fig. 4.30 Preoperative photographs from six standard perspectives: frontal view, left lateral view, posterior view, right lateral view, inclination view, and reclination view

4.8.3.1 Risks of Failing to Shave the Recipient Area

Failing to shave the recipient area poses the following risks:

- Thinned and miniaturized areas can be missed.
- Recipient incisions cannot be found or found only with difficulty because they are covered by hair.
- Insertion is rendered more difficult because the approach to the recipient incisions is covered by hair. This poses an additional risk of dehydration of the grafts due to delayed placement.
- Grafts can adhere to adjacent hairs, posing a risk of them being inadvertently avulsed.

It is also crucial to trim the hair in the donor area because only then is it possible to extract the follicular units intact. Only with an absolutely unhindered view of the hair stubble in the donor area can the physician determine the direction of hair growth, allow for it, and ensure that the FUs are extracted fully intact.

Advantages of completely shaving the donor area include:

- Extracting fully intact FUs is possible.
- Uniform, harmoniously distributed harvesting of grafts over the entire donor area is possible.
- Areas with lower hair density can be spared from additional hair removal.
- Aftercare is easier.

Exceptions include patients of Types NW I–III in whom the goal of treatment is simply the isolated transplantation of hair into the frontotemporal corners without any further grafting into the surrounding thinned areas. In such cases, partial shaving that spares the hair on the top of the head will suffice. However, the miniaturized and thinned areas adjacent to the frontotemporal corners should be trimmed for the hair transplant.

4.9 The Surgical Intervention

4.9.1 Skin Disinfection and Infiltration Anesthesia

After the surgical site (donor and recipient areas) has been shaved, it is disinfected. It is best to spray colorless kodan tincture onto the skin, which is then wiped with sterile compresses to completely moisturize the skin. In the further course of the surgical procedure, treated areas can be disinfected with octenisept without alcohol as the anesthesia wears off. The advantage of this is that the patient will not feel a burning sensation as the preparation is sprayed on the irritated skin (Fig. 4.31).

Local anesthesia by means of infiltration anesthesia acts on the sensory nerves in the subcutaneous tissue and ensures painless treatment during the transplantation. Commonly used local anesthetics include short-acting lidocaine and long-acting

Fig. 4.31 The skin is disinfected with kodan and octenisept without alcohol

Table 4.3 Anesthetic characteristics of lidocaine and bupivacaine

Anesthetic	Concentration	Onset of action (min)	Duration of action without epinephrine (min)	Duration of action with epinephrine (min)	Maximum dose without epinephrine (mg)	Maximum dose with epinephrine (mg)
Lidocaine	1–2%	3–4	30–60	120	300	500
Bupivacaine	0.25–0.50	5–10	120–240	500	175	225

bupivacaine, which are each supplied in ampules and single-dose vials. Adding epinephrine to the anesthetic solutions reduces absorption of the local anesthetics in tissue and thus prolongs their effect. This reduces the quantity of anesthetic required and with it the risk of a toxic effect.

The vasoconstrictive effect of epinephrine is a decisive advantage as it reduces bleeding from punch and incision wounds, ensuring a clear view of the relatively bloodless surgical site.

The generally recommended dose of diluted epinephrine varies between 1:100,000 and 1:200,000. Achieving this concentration of epinephrine in a 50 mL lidocaine solution will require 0.5 or 0.25 mL of epinephrine 1:1000, respectively (Table 4.3).

The infiltration anesthesia is injected in a fan-shaped pattern or diffusely into the subcutaneous tissue of the donor area. Targeted nerve blocks can also achieve the desired anesthetic effect. However, the absence of the vasoconstrictive effect of epinephrine will result in greater bleeding which will greatly interfere with the surgeon's view of the surgical site.

To avoid overdose and possible intoxication, one should always anesthetize only those areas that will be treated immediately. This assumes that the entire treatment is performed and monitored by the physician.

Many patients find infiltration anesthesia of the scalp painful, especially in the recipient area. This pain is not from the injection itself but is caused by the pressure of injected anesthetic on adjacent tissue and nerve cells. Thus, simple superficial anesthesia such as with EMLA cream cannot counteract this pain.

4.9.1.1 Anesthesia of the Donor Area

Injection of anesthetic solution briefly increases tissue pressure. However, it quickly normalizes due to the large space between tissue layers and the resulting greater mobility of the skin and usually has no lasting effect. Only in extreme cases can the injection of large volumes of anesthetic temporarily lead to insufficient arterial supply to the skin and hair follicles.

The added application of force in the surgical extraction of the grafts can exacerbate the tissue damage. In the most unfavorable case, this can lead to the feared complication of shock loss with partial permanent loss of native hair. The risk of shock loss from the FUE method when carefully performed is significantly less compared with conventional extraction techniques and approaches 0%. Nonetheless, this severe complication with respect to anesthesia in combination with the extraction process cannot be excluded.

My recommendation is this: Depending on the number of grafts required, the donor area can be sufficiently anesthetized with 30–50 mL of 1% lidocaine (1 mL of injection solution contains 10 mg of lidocaine hydrochloride) and the addition of epinephrine (1:100,000 and 1:200,000) (Fig. 4.32).

4.9.1.2 Anesthesia of the Recipient Area

The situation is different in the recipient area. Due to the narrow space between the skin and the vault of the cranium, the skin here is less mobile. Even small volumes of space-occupying anesthetic lead to increased interstitial pressure. This in turn results in reduced perfusion of the skin and hair follicles and can lead to insufficient

Fig. 4.32 The patient is positioned prone for diffuse infiltration anesthesia of the occipital portion of the donor area

arterial supply to the recipient area due to compression, thus impairing the microvasculature and increasing vascular permeability. This can lead to exudation of fluid from the blood vessels, which itself can increase interstitial pressure. The risk of effluvium or shock loss increases accordingly.

Another trigger or multiplier of shock loss is the tissue damage (injuries to skin and neurovascular structures) caused by making the recipient incisions. This can lead to insufficient supply of the hair follicles, increased fluid exudation with high interstitial pressure, and the release of inflammatory mediators.

Additionally, the newly implanted grafts without vascular supply will be supplied with less oxygen and nutrients in the severely inflamed skin region. As a result, the survival rate of the grafts decreases and with it the number of surviving hairs.

To avoid complications such as shock loss and low graft survival rates, one should avoid infiltration with large volumes of local anesthetic in the recipient area.

4.9.1.3 Tumescent Local Anesthesia

Tumescent local anesthesia represents a variation of infiltration anesthesia that is widely used in hair restoration surgery. In this type of anesthesia, extremely large volumes of anesthetic mixed with epinephrine and diluted in saline solution are injected into the skin. Whereas this has the advantage of prolonging the anesthetic effect, it is also associated with a very high rate of shock loss.

Other disadvantages of tumescent local anesthesia compared with classic infiltration anesthesia in the frontal region of the recipient area include postoperative swelling of the forehead, eye region, and face caused by drainage of anesthetic and lymph due to gravity. This extremely unpleasant condition reaches its high-point on about postoperative day 3 and greatly impairs patients in their daily life.

In contrast, classic infiltration anesthesia causes slight to medium swelling in the frontal region and face in only about 5% of treated patients. The persons affected are either endurance athletes or persons with a slender build and only slight amounts of body fat in the scalp.

My recommendation is this: For the recipient area, I specifically recommend a ring-shaped area of infiltration of smaller volumes with significantly decreasing amounts of solution injected toward the center. I also recommend maintaining a margin of 1 cm around the anesthetized area. Depending on the number of grafts required, the recipient area can be sufficiently anesthetized with 20 mL of 0.5% bupivacaine (1 mL of injection solution contains 5 mg of anhydrous bupivacaine hydrochloride) and the addition of epinephrine (1:100,000 and 1:200,000).

My conclusion: In light of the possible severe complications for the skin and hair follicles (especially in the recipient area), the use of tumescent local anesthesia should be weighed carefully or, better, simply avoided.

As classic infiltration anesthesia is associated with less severe side effects than tumescent local anesthesia, it should be preferred.

The following items should be considered when using lidocaine and bupivacaine:

- Lidocaine and bupivacaine are amide-type local anesthetics and rarely cause allergic reactions.

- Bupivacaine is about four times as toxic as lidocaine.
- Central nervous system side effects can usually occur secondary to inadvertent intravascular injection. Slight intoxication can manifest itself as tingling and numbness in the mouth, vomiting including disorientation, tremor, and epileptic seizure. Symptoms of severe intoxication can include respiratory depression including respiratory failure and coma.
- Cardiovascular side effects in slight intoxication include tachycardia and hypertension. Symptoms of severe intoxication can include ventricular fibrillation, heart failure, and asystole (Fig. 4.33a–c).

Practical Tip
During the injection process, interstitial pressure increases, requiring correspondingly higher injection pressure. The increased pressure can cause the needle to suddenly separate from the syringe. This mishap often occurs in the recipient area of the frontal region as a result of the decreased mobility of the skin and the narrow space between the skin and the cranial vault. It occurs less often in the donor area. To avoid this, one should ideally use Luer-Lok syringes with 24 to 26 gauge needles.

4.9.2 Surgical Removal of the Donor Hairs

4.9.2.1 Patient Positioning

To harvest the donor hairs from the various donor regions of the hair fringe, the patient is successively placed in the following positions:

- Prone with his face in the head aperture facing down

About 25% of the donor hair to be removed is easily accessible for extraction with the patient prone (Figs. 4.34 and 4.35).

- In the right lateral position (Fig. 4.36)
- In the left lateral position (Fig. 4.37)

The remaining 75% of the donor hair can be harvested with the patient placed in the right and left lateral positions. After every extraction period, the punch wounds are temporarily bandaged with sterile compresses.

4.9.2.2 The IFUE Method with Coordinated Sequences of Procedures

In the classic FUE method, all of the donor hairs are harvested from all donor areas in a single step.

However, my practical experience has shown that this procedure can be further optimized by subdividing the transplantation procedure into several shorter extraction and insertion sessions. I have optimized the FUE method as the IFUE (intermittent follicular unit extraction) method by adding an incision and insertion step immediately after each extraction step. The procedure thus involves a series of short, periodically repeatable phases of extraction, incision, and insertion.

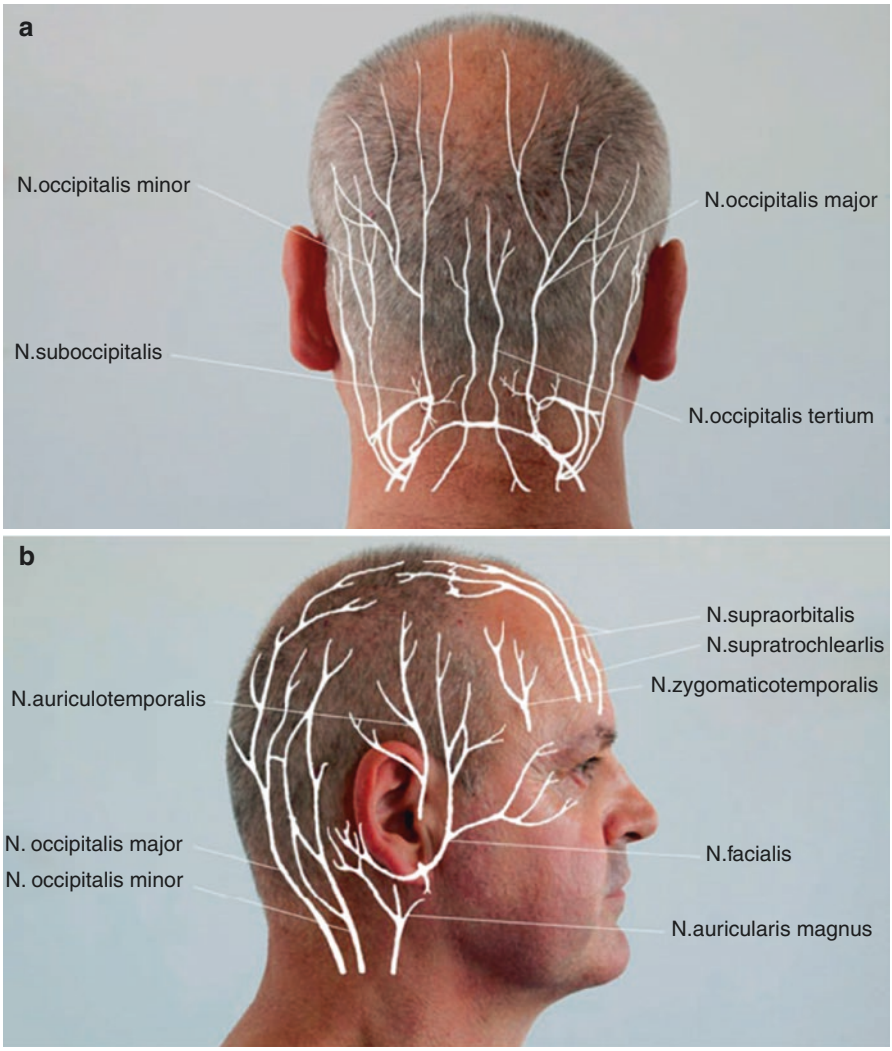

Fig. 4.33 (**a**) Inferosuperior courses of the nerves of the scalp along the back of the head which innervate the occipital and occipitoparietal regions of the donor area and portions of the vertex region in the recipient area. (**b**) Courses of the nerves of the lateral scalp which innervate the temporoparietal regions of the donor area and portions of the vertex and frontal regions of the recipient area; courses of the nerves of the frontal scalp which innervate the frontal region of the recipient area. (**c**) Inferosuperior courses of the cutaneous nerves which innervate the frontal region and portions of the vertex region of the recipient area

Specifically I recommend an extraction phase to harvest about 150–200 follicular units (this takes about 30 min), immediately followed by an incision phase to make the incisions required for the quantity of FUs harvested (about 5–10 min), and in turn followed by an insertion phase (again about 30 min). These alternating phases are repeated until the transplantation goal is achieved.

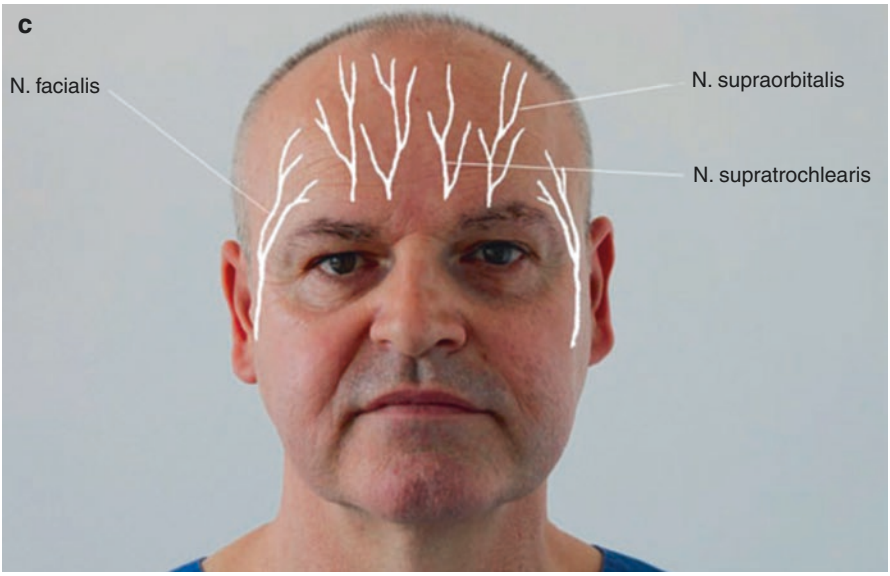

Fig. 4.33 (continued)

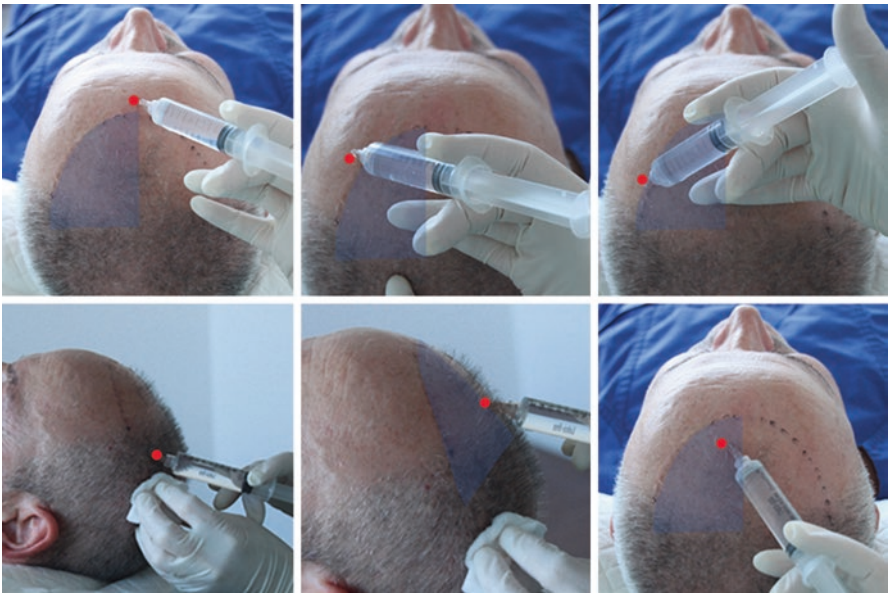

Fig. 4.34 Ring-shaped infiltration anesthesia in the subcutaneous tissue of the recipient area with decreasing amounts of solution injected toward the center

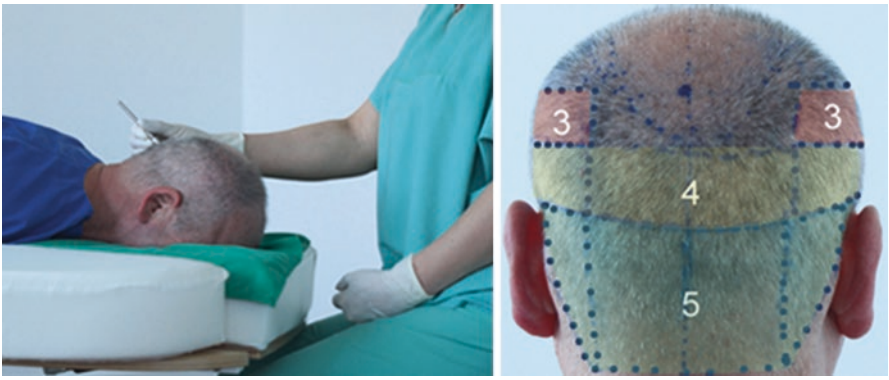

Fig. 4.35 Surgical approach to the occipitoparietal and occipital areas (fields 4 and 5) with the patient prone

Fig. 4.36 Surgical approach to the occipitoparietal and occipital areas (fields 4 and 5) and the temporoparietal and parietal areas (fields 1 and 3) on the left side of the head

Fig. 4.37 Surgical approach to the parts of the occipitoparietal and occipital areas (fields 4 and 5) and the temporoparietal and parietal areas (fields 2 and 3) on the right side of the head

4.9.2.3 Manual Extraction

As the extraction procedure represents the essential difference between the different hair transplantation methods and also greatly influences the transplantation result, I will describe this procedure in great detail in the following section.

In the classic manual extraction technique, the surgeon holds the extraction needle with a needle holder like a pen between the thumb, index finger, and middle finger (a three-point grip). The surgeon aligns the needle with the exit angle or longitudinal axis of the hair and slides it over the hair of the FU (previously trimmed to 1 mm). In an FU containing several hairs in a bundle, the cannulated needle is slid over all of the hairs of the FU (Fig. 4.38).

As the needle is advanced toward the skin and its tip makes contact with the surface of the skin, the surgeon should first stop the needle before penetrating the skin.

If the needle is not precisely sharpened (which is almost always the case due to the manufacturing process), failure to stop the needle would cause local deformation and displacement of the skin before of the forces acting on it. This could cause a relative displacement between the distal and proximal portions of the hair follicle which would also be reflected in a higher transection rate (Fig. 4.39).

Severe local deformation of the skin during the punch process can be avoided by:

Using sharp extraction needles.

Replacing the extraction needle after the cutting edge has been worn down by multiple extractions.

Focused, gradually increasing application of force to the extraction needle.

In this procedure, the sensation in the fingertips is crucial as the physician must "think with the needle," initially aligning it exactly along the hair's axis of growth and then stopping the cannulated needle as it touches the skin before advancing the needle into the skin in a precise motion with measured, gradually increasing

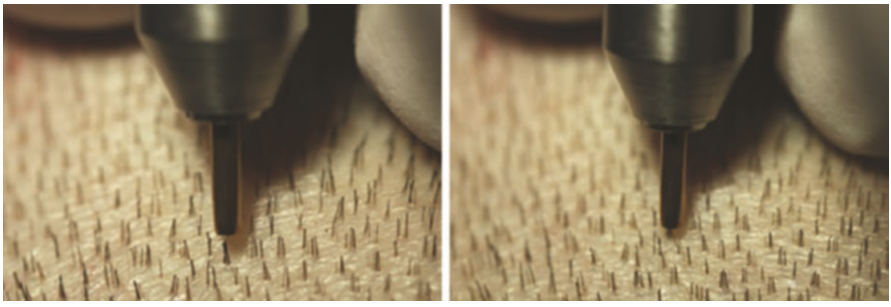

Fig. 4.38 The extraction needle is aligned along the longitudinal axis of the hair and then slid over the hair or hairs of the FU to be extracted

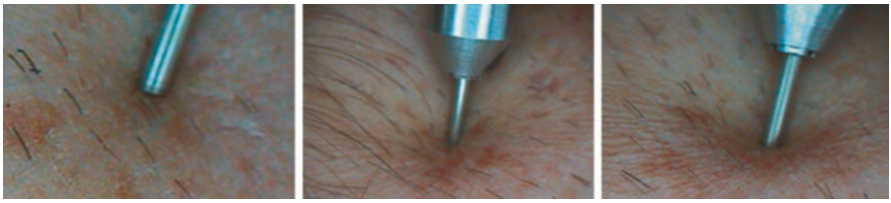

Fig. 4.39 Local deformation and displacement of the skin due to the high force acting on an imprecisely sharpened extraction needle

Fig. 4.40 Extraction procedure: Once the FU has been successfully mobilized by the punch procedure, the epidermal portion of the graft is grasped with the extraction forceps, and the graft is extracted from the punch wound

pressure. This is done by slowly advancing the needle with an oscillating axial motion that overcomes the resistance of the skin and carries the needle into the skin to a depth of 3–8 mm, depending on the length of the follicle. Then the cannulated needle is withdrawn from the skin and removed. When the cannulated needle has been removed from the skin tissue, this punch procedure will be seen to have caused a punch wound around the follicular unit. My experience has shown that it is best to punch 20–25 FUs in this manner and then extract them together later. The FUs are then extracted from the skin tissue with the extraction forceps. Here, it is important to extract the FU without applying excessive force; if there is resistance, then the punch depth was insufficient. The cannulated needle must then be slid over the FU again before punching deeper around the FU (Fig. 4.40).

The extracted FUs are stored with the surrounding skin tissue in a cooled physiologic saline solution in a petri dish. After every extraction phase, the punch wounds are temporarily bandaged with sterile compresses before the insertion phase, which follows immediately afterward (Fig. 4.41).

In an initial treatment, the scope of the extraction should not exceed 2000–2500 FUs due to the risk of trauma-induced acute effluvium with irreversible thinning of the donor area. Here it is helpful to use the term "extraction quota" as the percentage follicular units per cm^2 to be extracted. An extraction quota of 20–25%, meaning every fourth or fifth hair, should never be exceeded as otherwise iatrogenic effluvium could result with permanent loss of some of the FUs. Usually we plan and perform the extraction and insertion of 1000 to at most 1500 grafts per day. In the

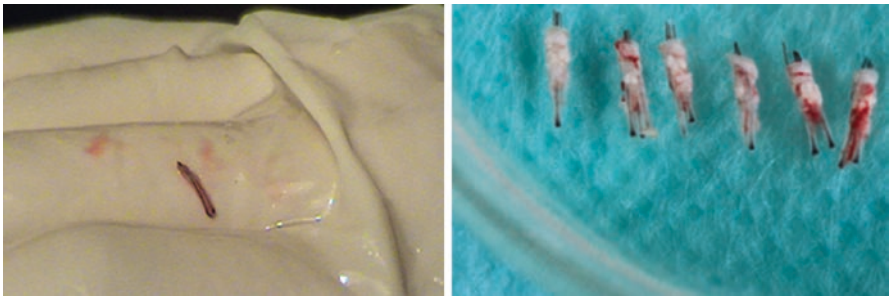

Fig. 4.41 Left: A 2-hair FU on the surgical glove. Right: The grafts are stored in a physiologic saline solution

Fig. 4.42 Irreversible traumatic thinning of the hair fringe and donor area resulting from a single extraction of more than 2500 FUs in two different patients. In both cases, there are no visible extraction scars. This means that the traumatic thinning was not caused by oversize needles but by excessively high extraction quotas. It should be emphasized that extraction of more than 2500 FUs can lead to tissue damage resulting in the irreversible loss of the adjacent native FUs. An irreversible loss of FUs can also occur with a lesser number of grafts when there is additional trauma, for example, from using oversize extraction needles with an outside diameter larger than 1.1 mm

interest of protecting the patient and achieving a good result, it is best not to exceed this quantity either (Fig. 4.42).

4.9.2.4 Advantages of Manual Extraction According to the IFUE Method

The time the sensitive grafts spend outside the body can be kept very short. This minimizes damage to the grafts and consequently allows them to heal and integrate better, which is reflected in a higher survival rate.

The patient is not forced to remain in a certain position so long, which is more comfortable for him and causes fewer subsequent problems.

Taking a break after every extraction and insertion phase is more pleasant for the patient, and it helps the physician maintain concentration while working.

Short extraction phases in which 150–200 FUs are harvested make it easier to sort the grafts according to the length and number of hairs. Consequently, the physician can more easily adjust the number of incisions of the respective depth, width, and angle.

4.9.2.5 Manual Versus Motorized Extraction

As the extraction of donor hairs is a very painstaking and time-consuming process, attempts have been made in past years to speed up this process. Consequently, there has been an observable trend toward motorized extraction methods. Motorized methods use micromotors to advance the cannulated needle into the skin in a rapid rotating motion. When using micromotors, in contrast to manual extraction, the extraction instrument is held in a four-point grip or fist grip.

The difference to manual extraction is that the needle enters the skin in several rotations. However, this does not provide any significant advantages. These rotations are even more likely to cause undesirable side effects. These include strangulation of the FU due to rotation around its own axis in an incomplete punch process. The punch process can also cause thermal injury to the skin and increased bleeding that can impair the surgeon's view of the surgical site.

In the classic manual extraction method described above, the surgeon holds the extraction needle in a needle holder like a pen between the thumb, index finger, and middle finger (a three-point grip) and slides it over the FU until the tip of the needle touches the skin without pressure (Fig. 4.43).

Contrary to popular opinion, the motorized needle cannot accelerate the speed of the extraction phase. This is because the most time-consuming steps in the extraction procedure are achieving perfect axial alignment of the needle with the hair shaft, then stopping the needle upon skin contact, and then slowly punching. Improper or imprecise alignment of the needle with the axis of the hair unavoidably leads to complete or partial transection of the FU (Fig. 4.44).

The extraction procedure requires not only sensitivity in the fingertips but also a very fine motion sequence that can only be performed with the fine motor control of the fingers. The micromotors' size and weight require a four-point grip or fist grip, rendering smooth hand and arm motions and isolated finger coordination impossible. The micromotors are guided with the whole hand or arm. The gross motions of the arm and/or wrist lead to large gross motion patterns. The decisive fine sensation and coordination are lacking.

Fig. 4.43 The extraction needle is held and guided in a three-point grip, crucially preserving the sensation in the fingertips that allows the surgeon to "think with the needle"

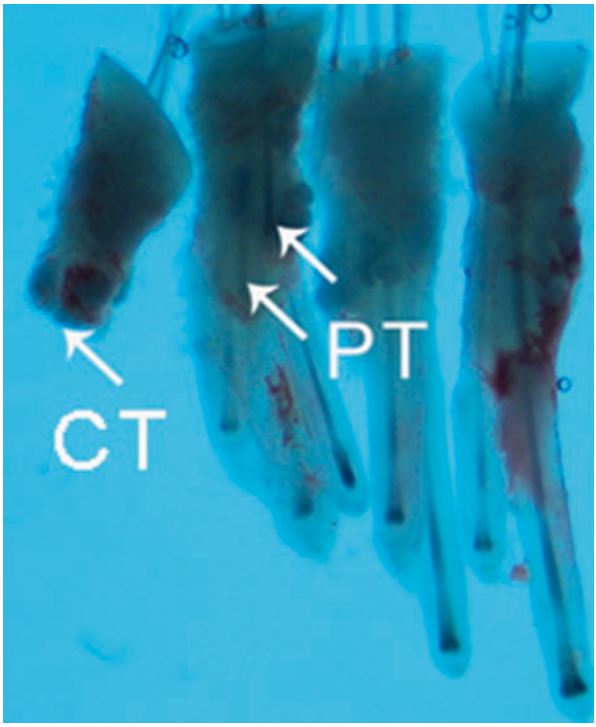

Fig. 4.44 Extraction injury to the FU caused by imprecise alignment of the extraction needle with the longitudinal axis of the hair shaft. CT: Complete transection of the FU at the level of the sebaceous gland. PT: Partial transection of 2-hair follicles within a 4-hair FU

One argument emphasized by proponents of motorized extraction is the higher speed of the extraction and the time it saves. However, precise motorized extraction is no faster than precise manual extraction. This is because the most time-consuming step of extraction is achieving precise axial alignment of the cannulated needle with the hair shaft and performing the slow oscillating punch motion through the skin. Whether it is motorized or manual force that then advances the extraction needle in a few millimeters into the skin is immaterial.

4.9.2.6 Comparison of the Results of Manual and Motorized Extraction

In a given time frame, a larger number of grafts can in fact be harvested with the aid of a micromotor than is possible by manual extraction. Micromotors clearly have the advantage of higher quantity per unit of time.

Yet if we examine the quality of grafts harvested in addition to quantity, then we see that the advantage clearly lies with manual extraction. This is because the rate of transections and injuries caused by micromotors is several times higher than with manual extraction. It comes down to the question of quantity versus quality.

In the final analysis, the time saved by harvesting a higher quantity of grafts using micromotors is achieved at the cost of sacrificing a precisely performed punch procedure (correct alignment, proper pressure, optimum depth) and compromising graft quality. The timesaving argument is thus not really valid.

Fig. 4.45 Thinning of the donor area in the setting of partial irreversible shock loss (in two patients) caused by: Extraction of an excessive number of FUs using micromotors. Extraction of an excessive number of FUs (overly high extraction quota)

Fig. 4.46 Thinning of the donor area in the setting of partial irreversible shock loss caused by: Using micromotors with large extraction needles. Extracting a large number of grafts from an excessively small donor area (extracting every second or third FU, an extraction quota of 33%). This "overharvesting" of an excessively small donor area located only a few centimeters below the posterior hairline is usually due to performing the extraction with the patient in a sitting position as opposed to prone. This means that the inferior occipital region is covered by the headrest and is not available for use as a donor area. The great disadvantage of this sitting position is that the grafts are not harvested in a uniformly distributed pattern from the entire occiput but are obtained in greater numbers from a few smaller available regions

Many users of micromotors attempt to compensate for the lack of precision in needle alignment with the hair and the high transection rate. In doing so they willingly accept unaesthetic scarring, especially confluent scars and iatrogenic thinning in the donor area (Figs. 4.45, 4.46, and 4.47).

Consequences of the motorized extraction technique:

- The suboptimal extraction of the grafts damages many hair roots and leads to a high transection rate.

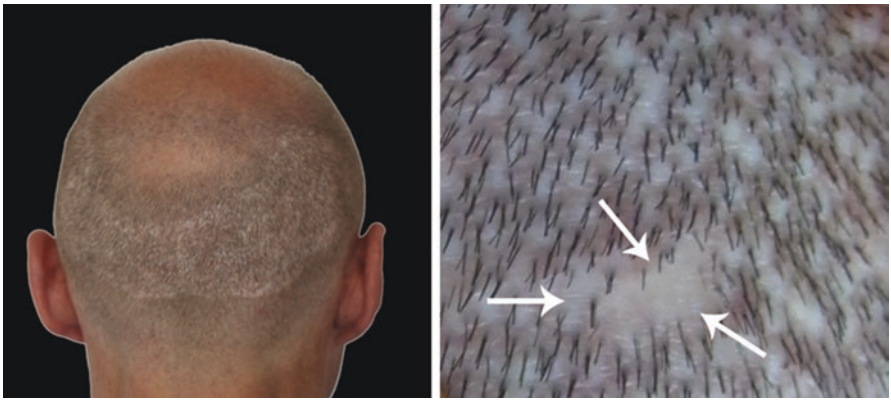

Fig. 4.47 Thinning of the donor area in the setting of partial irreversible shock loss caused by: Extracting an excessively large number of grafts (approximately 2000 FUs) from an excessively small donor area (extracting every second FU, an extraction quota of 50%). Using micromotors with large extraction needles. "Blind punching" due to increased bleeding during the extraction process leads confluent scarring (see right figure)

- Severe, usually irreversible thinning, shock loss, or acute effluvium as a result of "blind punching" and an excessively high extraction quota.
- Confluent scarring from "blind punching" with an impaired view of the surgical site due to increased bleeding.
- Large scars from using excessively large cannulated needles.
- Increased bleeding.
- The traumatization of the donor area by micromotors means that many patients are left with no remaining treatment options at an early age; further hair transplants are no longer possible.
- Excessive harvesting of donor hair: In combination with motorized technique, often too many follicular units are extracted or destroyed. The donor area is "overharvested" and permanently damaged.

4.9.2.7 Robot-Assisted Hair Restoration Surgery

Apart from the motorized removal of donor hairs described, there have also been attempts to utilize robots in hair restoration surgery.

In the beginning of robot surgery, various systems such as the CASPAR and ROBODOC were introduced which could autonomously perform individual steps in the operation. Suppliers had high hopes for these systems because of the anticipated advertising appeal of robots doing precision work. Yet the initial euphoria among physicians soon faded as severe system errors and injuries to patients repeatedly occurred.

In contrast to these systems, the DA VINCI system dispensed with performing individual steps in the operation autonomously. Instead an intelligent robot system was created, which is continuously controlled and guided by the physician. Only by integrating an experienced physician can one achieve a synergy effect, effectively turning the robot into a precision tool.

However, an experienced FUE hair restoration surgeon knows that every patient exhibits very specific characteristics with respect to skin and hair follicle texture and that no two patients are the same. The hair restoration surgeon must be appropriately flexible and make allowances for each individual patient's specific situation. Thus, it is often necessary to use needles of different designs and sizes and to vary the speed of extraction and the needle pressure accordingly. The surgeon who works by hand can be far more flexible and focused in performing these tasks. For this reason many FUE surgeons prefer not to use such inflexible tools as a robot.

Apart from removing grafts intact, the decisive criterion for the FUE specialist is ultimately to preserve the donor area as much as possible by using the smallest possible extraction needle. However, the only robot system currently available for hair restoration surgery, the ARTAS system, employs a concentric two-needle system for extracting follicular units. The inherent lack of human sensorimotor feedback in this system reduces the robot, in my opinion, to a rigid, inflexible tool. Unfortunately, there is no official information available as to the actual size of the robot system's extraction needles (inside and outside diameter).

Moreover, I find there are no independent studies available for the ARTAS system which discuss the errors of the individual technical components, the algorithms used in the system, and the actual transection rate during extraction. Therefore, it would be extremely important for experienced hair restoration surgeons to be able acquire a firsthand impression of this system. Unfortunately, the German distributor did not allow me the opportunity to observe a treatment with this system live in the operating room. Because of this I was unable to personally evaluate the manufacturer's claims regarding the precision of the system, the actual transection rate achieved, and the needle sizes. Once again, the respective questions remain unanswered.

The practice in Germany has repeatedly shown that the system represents an interesting entry-level instrument suitable particularly for inexperienced physicians desiring to begin with FUE hair transplantation.

My conclusion: The ARTAS system has not had any particular benefit for the experienced FUE hair restoration surgeon. Removal of body and beard hair is not possible with the robot. Additionally, harvesting donor hair uniformly from the posterior and lateral hair fringe is only possible to a limited extent.

Given the system's currently limited range of applications, I am highly skeptical that the many and various demands placed on the system can be met in the foreseeable future.

4.9.2.8 Selecting the Cannulated Extraction Needle

Avoiding iatrogenic thinning in the donor area requires more than selecting the proper anesthetic, dose, and concentration of added epinephrine. Other important considerations include the number of grafts to be extracted and the size of the cannulated extraction needles used.

The market for hair restoration surgical instruments offers seven wide varieties of cannulated needles. Depending on the manufacturer, their inside diameter can vary between about 0.5 and 1.6 mm. The larger the needle diameter, the greater the tissue damage it will cause. Thus, one would assume that selecting a very small needle would reduce tissue trauma to the extent that no complications need be feared.

However, it is also the case that a certain minimum graft size is required to obtain a vital graft that can thrive. Here, the principle is that the less surrounding tissue a graft has, the less likely it is to become integrated into the recipient tissue and the lower the survival rate will be.

In conclusion, we see there is a trade-off between two conflicting requirements for harvesting grafts. On the one hand, larger, thicker grafts with a broad margin of surrounding tissue are associated with a higher survival rate. On the other hand, the use of excessively large needles increases the risk of traumatic shock loss and scarring.

This leads us to the question of the optimum needle. An optimum cannulated needle must be large enough to extract a 4-hair FU intact yet also small enough to leave behind no trauma. Very narrowly dissected grafts are known to exhibit significantly lower survival rates than grafts dissected less finely[1]. On the other hand, using a needle with an outside diameter larger than 1.1 mm will cause unintended but unavoidable tissue trauma and consequent scarring.

My experience has shown that using a needle with an inside diameter of 0.95 and 1.05 mm outside diameter can best fulfill the requirements of a cannulated needle in most cases. With this needle one can usually achieve good visual density and a good survival rate. The probability of scarring from the extraction process is also very low. For patients with particularly thick hair shaft diameters, I recommend using an extraction needle with an inside diameter of 1 mm and an outside diameter of 1.1 mm. The disadvantage in this case is that the probability of scarring from the extraction process increases significantly. Extraction needles with an inside diameter smaller than 0.95 mm lead to partial or complete transection of the FU or other injury. Some of the hairs produced by such grafts also have greatly reduced hair shaft diameters compared with native hairs. This is not conducive to achieving good visual density. Transplantation of such donor material is necessarily associated with low survival rates (Figs. 4.48, 4.49, 4.50, and 4.51).

4.9.2.9 Storing the Grafts

The time the grafts are stored outside the body should be kept as short as possible to keep them alive and protect them from dehydration and achieve a high survival rate. The alternating extraction and insertion phases of the IFUE method are conducive

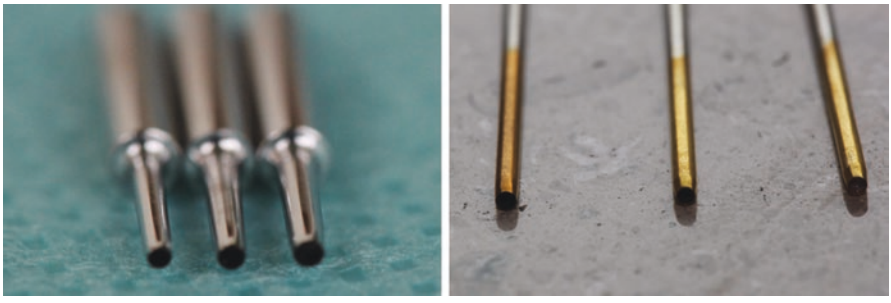

Fig. 4.48 Cannulated extraction needles are available in various sizes between 0.5 and 1.65 mm, depending on the manufacturer

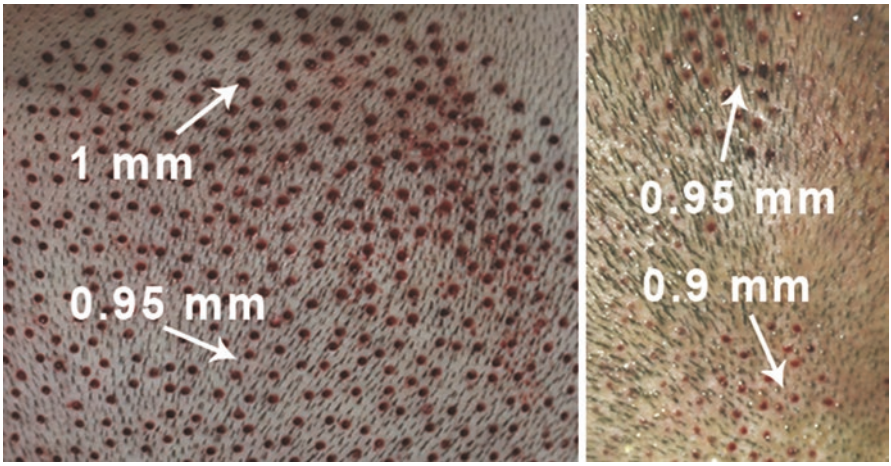

Fig. 4.49 Elliptical punch wounds caused by using different needle sizes from 0.9 to 1 mm

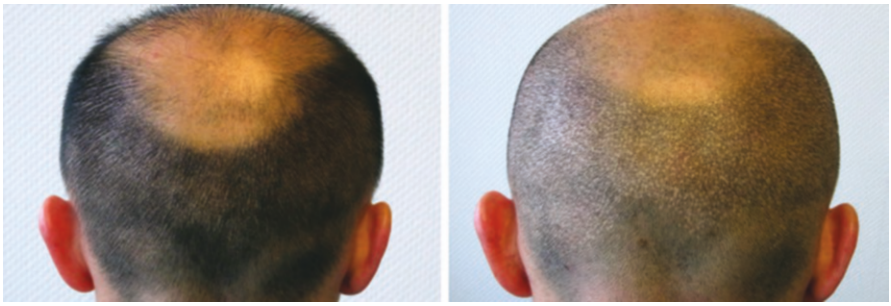

Fig. 4.50 A 35-year-old patient (NW V) after FUE hair transplant with 3500 grafts extracted with a 1 mm extraction needle. Left: Donor area 12 months postoperatively with hair length of 5 mm. Right: Donor area 12 months postoperatively with hair shaved to a length of 1 mm

to such optimally short storage intervals. In one extraction phase, in which 150–200 grafts are harvested, the storage period outside the body averages about 40 to at most 60 min. The grafts are usually stored in a physiologic saline solution in sterile petri dishes. The storage medium is maintained at a maximum temperature of 4 °C with cold packs.

4.9.2.10 Immediate Postoperative Wound Care in the Donor Area

As was mentioned above, between every individual extraction and insertion phase, the punch wounds are temporarily bandaged with sterile compresses and tape. After the intervention has been completed, the temporary bandages are removed, and the treated areas of the head are repeatedly sprayed with saline solution to clean them.

Any residual punctate bleeding is best controlled by compressing the wound region. Should this fail to control the bleeding, then anesthetic with added

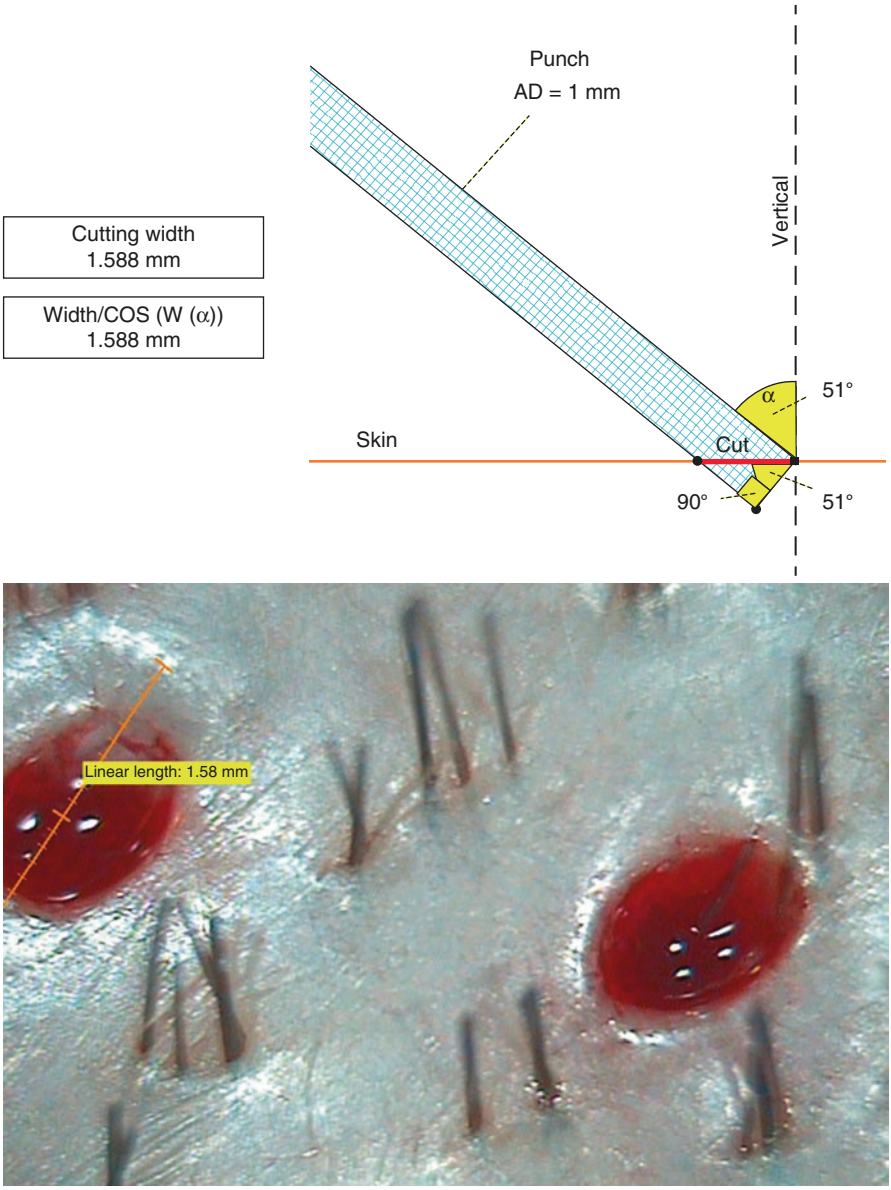

Fig. 4.51 Upper and middle figure: Using extraction needles with an outside diameter of 1.05 mm and inside diameter of 0.95 mm causes an elliptical punch wound with a maximum length of 1.58 mm when the hair is extracted at an exit angle of 39° to the surface of the skin. Lower figure: After only 20 h, the punch wound contacts by as much as 50%. After only 48 h, the wound has closed completely

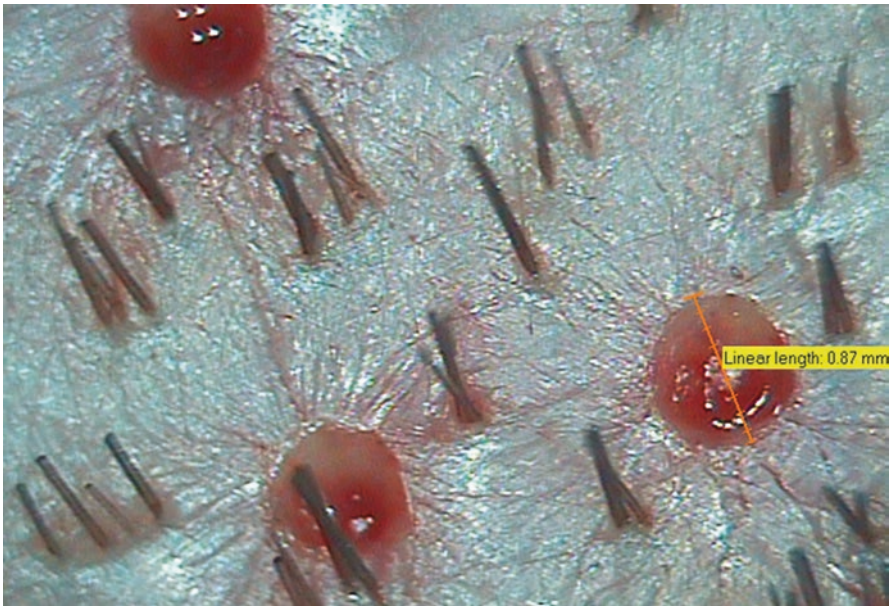

Fig. 4.51 (continued)

epinephrine can be injected deep to the wound. Finally, the treated areas are disinfected with octenisept before they are bandaged with compresses and elastic tape.

The recipient area is cleaned with saline solution. The wound remains undressed; bandaging the recipient area is obsolete and not required (Fig. 4.52).

4.9.3 Creating the Recipient Incisions

4.9.3.1 Angle and Depth of the Incision

The skin incision must be carefully made at precisely the proper angle and depth to achieve optimum results. Where vellus or terminal hairs are present in the recipient area, the surgeon can use their direction of growth as a guide for the incision angle. The incision depth depends on the length of the harvested grafts (Fig. 4.53).

Here, it is important that the hair bulb, which includes the dermal papilla, is later positioned within the subcutaneous tissue when the graft is placed.

Proper positioning of the hair bulb within the subcutaneous tissue will ensure early integration of the grafts with rapid revascularization of the hair follicles and a high survival rate.

Note that the average length of a hair follicle is about 4 mm. However, the length of the hair follicle in harvested grafts is often as long as 6–8 mm. Furthermore, there are also intraindividual differences in hair follicle length due to the different growth phases of the follicles (Fig. 4.54).

Fig. 4.52 (**a–c**) The extraction wounds are cleaned, disinfected, and bandaged after the treatment has been completed

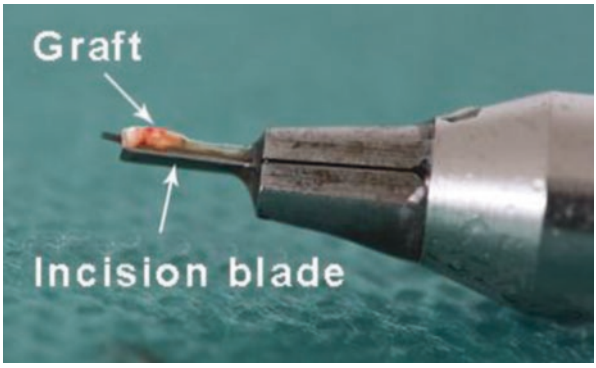

Fig. 4.53 The incision depth is determined by the length of the projecting blade, which is adjusted in the blade holder to match the length of the hair follicle

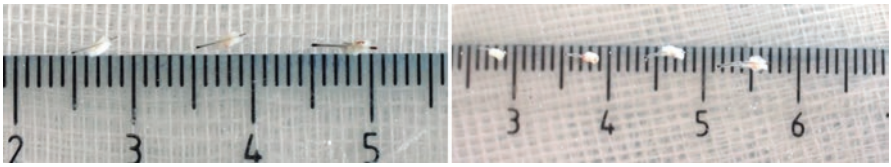

Fig. 4.54 Intraindividual differences in the length of hair follicles from the occipital region of two different patients

The thickness of the skin of the scalp including the subcutaneous tissue is about 5.8 mm [5]. Because shorter hair follicles measuring less than 4 mm may not reach the subcutaneous tissue if placed at too acute an angle, the angle of the incision should be altered accordingly. In this manner, the proximal portion of the hair bulb can be positioned within the subcutaneous tissue even in the case of short grafts. With longer follicles measuring more than 6 mm, the incision angle should be decreased accordingly. To achieve a high survival rate with a homogeneous direction of growth of the hairs in the frontal hairline, an effort should be made to implant hairs of uniform length.

For this reason, it is best not to make all the incisions in a single extensive step but to make recipient incisions with appropriate angles and depths after every extraction phase. After every extraction phase, the incision angles should be adapted to the specific hair follicle length in the individual patient.

Important: This important part in the procedure decisively determines the result. Because the steps of making the recipient incisions and subsequently placing the grafts are so interdependent, optimal results require both to be performed by the same person.

4.9.3.2 Incision Density and Transplanted Follicular Density

Incision density refers to the number of recipient incisions per cm^2. In contrast, transplanted follicular density refers to the number of transplanted follicular units per cm^2.

The goal of the hair transplant is usually to achieve natural visual hair density or, respectively, to restore the maximum possible hair density in the individual patient's bald patches without permanently damaging the donor area.

Two important factors decisively influence the planning of a hair transplant. First, the scope of the extraction should not exceed 2000–2500 FUs per treatment due to the increased risk of iatrogenic thinning in the donor area. Second, the vascular system of the recipient area must not be damaged or destroyed by too many incisions in too small an area. Otherwise the vascular injuries could lead to ischemia in the skin tissue, compromising the supply of blood and nutrients to the grafts.

Accordingly, one should not exceed an incision density or TFD of 20–25 follicular units per cm^2 [6]. This corresponds to a distance of at least 1 mm between recipient incisions.

As a general rule, even a single treatment will be able to achieve good visual density in most patients with NW I–III hair loss. However, a single treatment will not be sufficient if the goal of transplantation in these patients is to restore "natural

hair density." Insofar as sufficient donor hair is available, one should transplant a maximum of 20–25 FUs per cm^2 per operation to gradually increase the hair density up to a maximum transplanted follicular density of 60 FUs per cm^2. This corresponds to a natural hair density. Each additional transplant beyond this also involves massive tissue and vascular destruction and is indirectly associated with loss of grafts and a greatly diminished survival rate.

In patients with hair loss of NW IV or higher, "good visual density" over the entire bald area cannot usually be restored in a single treatment. In such cases, the therapy should be divided into at least two operations. The logical solution is to treat the frontal region and vertex region in two separate operations.

Note, however, that it is practically impossible to restore "natural hair density" in these patients. Given the progressive hair loss usually present in these patients, there will not be enough donor hair to restore natural hair density even with multiple treatments. These patients must accept a compromise with respect to hair density (Fig. 4.55a, b).

The maximum number of incisions per cm^2 is determined by the size and angle of incidence of the incision instrument and by the distance and arrangement of the recipient incisions relative to one another. Changing only the angle of incidence while using the same incision instrument alters the shape of the recipient incision. Whereas an angle of incidence of 90° creates a round recipient incision, reducing the angle of incidence creates an elliptical recipient incision (Fig. 4.56a–d).

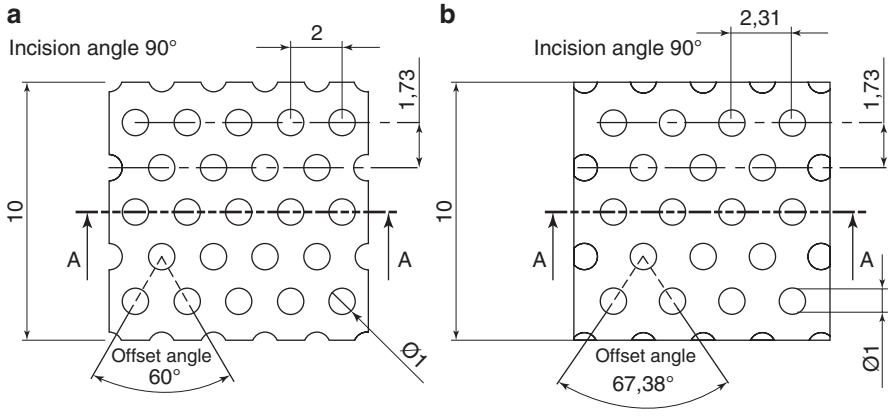

Fig. 4.55 By making the recipient incisions, we create openings in the skin (shown in the figures as round or elliptical incisions) to receive cylindrical grafts. In the incision shown, the opening in the skin is round with an incision angle of 90° (**a**). Reducing the incision angle gives the skin opening an elliptical shape (**b**). In both examples, the incision created a skin opening of 1 mm in diameter. The distance between the recipient incisions is 1 mm. Only the angle of incidence was changed. (**a**) With an incision diameter of 1 mm and an angle of incidence of the incision instrument of 90° in the skin, there is space for 23 recipient incisions per cm^2. (**b**) Changing the angle of incidence from 90° to 60° creates elliptical recipient incisions with a longitudinal axis of 1.15 mm. Accordingly, there is space for 18 complete recipient incisions per cm^2

Fig. 4.56 (**a**) Excessively dense hair transplantation in the frontotemporal corners in a 25-year-old patient (NW III) with 48 FUs per cm². Left: Immediate postoperative view of the hair transplant in the right frontotemporal corner with 48 FUs per cm². Right: View 1 month postoperatively. (**b**) Left: View 2 months postoperatively with persistent erythema and loss of transplanted hair. Right: View 3 months postoperatively with persistent erythema and readily apparent pitting of the skin. (**c**) Left: View 4 months postoperatively with isolated hair growth. Right: View 6 months postoperatively with increased hair growth. (**d**) Final result of the hair transplant 12 months postoperatively with patchy growth as a result of making incisions too close together and an excessively high TFD

Example with an incision density of over 30 recipient incisions per cm^2:

With an optimal graft diameter of 0.95–1 mm, a maximum of 20–25 incisions can be made per cm^2 (with sufficient distance between grafts).

Achieving a higher graft density would require making the incisions closer together (with a distance of less than 1 mm) or making them smaller in size so that more grafts could be placed. Consequently, both smaller incisions and smaller grafts would be required. This would require very fine extraction needles less than 9.95 mm or fine dissection. However, this would damage the grafts and reduce the

survival rate. Additionally, there would be significantly delayed growth of hair with only narrow hair shaft diameters.

Making the incisions closer together would destroy the skin and the capillaries within it. This would lead to an insufficient supply of oxygen and nutrients to the skin which in turn would be reflected in a lower graft survival rate. The transplantation result would be patchy with a graft survival rate of less than 50%. This represents a graft loss of over 50%. Thus, the same result could have been achieved with significantly fewer incisions and thus fewer grafts as well by maintaining twice as large a distance between the recipient incisions.

The figures show the postoperative course of a recipient area implanted too densely with a TFD of 48 FUs per cm^2 in one patient.

My conclusion: In summary we can say that the higher the incision density, the greater the damage to the tissue and capillary bed within it. The reduced distance between the individual incisions (less than 1 mm) in the damaged skin tissue does not offer ideal conditions for graft integration. As adequate revascularization of the grafts only occurs between postoperative days 7 and 14, the plasmatic imbibition occurring in the first few days postoperatively is not sufficient to ensure supply to the grafts.

4.9.3.3 Incision Techniques Using Different Incision Instruments

In addition to the choice and quantity of anesthetic and the dose of added epinephrine, an atraumatic incision process including the correct selection of the proper type and size of incision instrument is a crucial factor in treating the donor area as gently as possible, minimizing iatrogenic injury, and thus maximizing the graft survival rate. The most commonly used incision instruments are scalpels, injection needles, and specially designed fine incision blades. These instruments can be divided into three groups:

- *Severely traumatizing incision instruments* include conventional scalpels, which make straight cuts in the skin. They can be associated with increased scarring and irreversible pitting of the skin. In some cases the tissue damage and inflammation can even lead to scarring alopecia of the scalp [7] (Figs. 4.57, 4.58, and 4.59)

Unfortunately, the scalpel is still used relatively often to create recipient incisions because of its ready availability.

The drill (dental drill bit), which was used in the past for classic punctate incisions, can be categorized in this group due to the high degree of tissue trauma it causes. Today it is regarded as obsolete and is rarely used.

Because of their oversize dimensions, scalpels and drills are associated with tissue trauma and secondary inflammation, scarring, and shock loss or effluvium in the recipient area.

- *Moderately traumatizing incision instruments* include injection needles, which create sickle-shaped cuts in the skin. Especially with a high density of incisions, this results in increased and delayed skin erythema, which can persist for several weeks.

- *Tissue-sparing incision instruments* include specially designed incision blades, which create small slit-shaped incisions. The specially designed blades with a standardized thickness of 0.1 mm and a variable width of 0.6–1.5 mm should be preferred to cannulated needles because of their tissue-sparing qualities (Figs. 4.60 and 4.61).

Fig. 4.57 The use of conventional scalpels for making the recipient incisions causes scarring and visible pitting of the skin in the recipient area

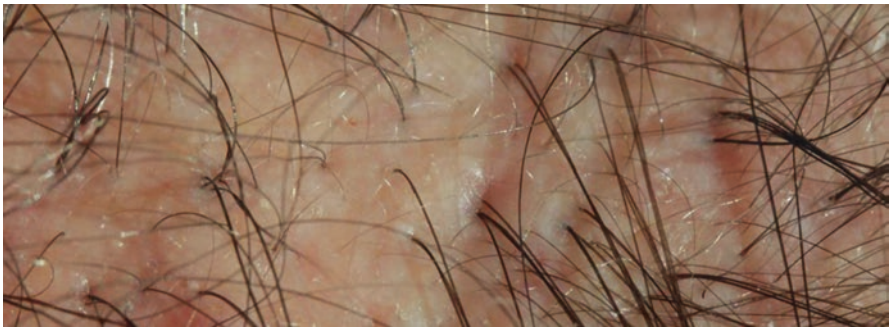

Fig. 4.58 Scarring alopecia of the recipient area after a hair transplant. The use of traumatizing instruments such as scalpels and dental drills can lead to scarring alopecia in extreme cases

Fig. 4.59 Phlegmonous dermatitis in a 26-year-old male patient after a hair transplant with 1500 grafts using the strip method. Left: Severe phlegmonous dermatitis of the left frontotemporal corner. The grafts in the frontotemporal corner were placed by non-physician practitioners using improper technique. Right: View 10 months postoperatively showing status post antibiotic therapy and wound revision with massive scarring and lack of growth of the grafts as a result of an unsuccessful hair transplant. This has rendered further hair transplants very difficult or even impossible

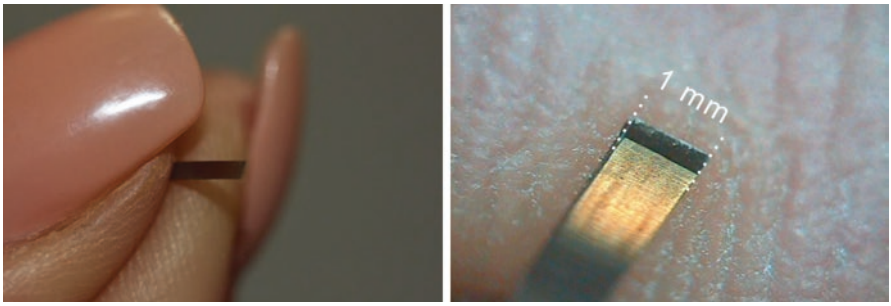

Fig. 4.60 Specially designed incision blade with a width of 1 mm and a thickness of 0.1 mm

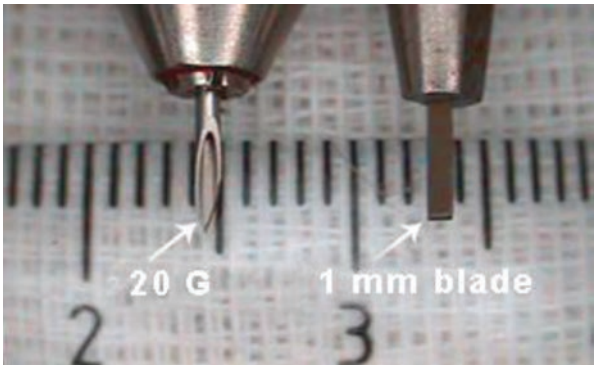

Fig. 4.61 Comparison of 20 G cannulated needle with an outside diameter of 0.9 and 1 mm blade

In the following section, we will describe the slit incision technique using special fine blades which we favor.

4.9.3.4 The Slit Incision

The slit technique involves the use of specially designed blades with a standardized thickness of 0.1 mm and a variable width of 0.6–1.5 mm.

The blade width of the incision instrument should be 0.05 mm larger than the diameter of the graft. Thus, with respect to the size of the optimal extraction needle with an inside diameter of 0.95 mm, the blade width should measure 1 mm. This rule of thumb applies only to 1- and 2-hair follicular units. For easy insertion of 3- and 4-hair FUs, the blade width should be 0.1 mm larger.

The slit incision can be made in either a sagittal or vertical direction. It is more difficult to place multi-hair follicular units in vertical slits than in sagittal slits, and this can result in the damage to the grafts. Therefore, I recommend placing only the hairline grafts in vertical slits. Sagittal slit incisions can be used for placing the grafts in the rest of the recipient area. However, a few hair restoration surgeons recommend using vertical slit incisions exclusively. Yet conventional blades with a thickness of 0.1 mm are not suitable for this.

After the hairline has been drawn, the patient shaved, anesthesia administered, and the first extraction phase has been completed, the patient is placed in an elevated supine position at an angle of about 30° to horizontal. Here, it is best to stabilize the patient's head and neck with a special neck cushion. The surgeon is positioned immediately behind the patient's head.

During the incision procedure, the patient's eyes should be covered with a compress to shield them from the bright operating room lights and to protect them from anesthetic that might flow down over the face (Fig. 4.62a–c).

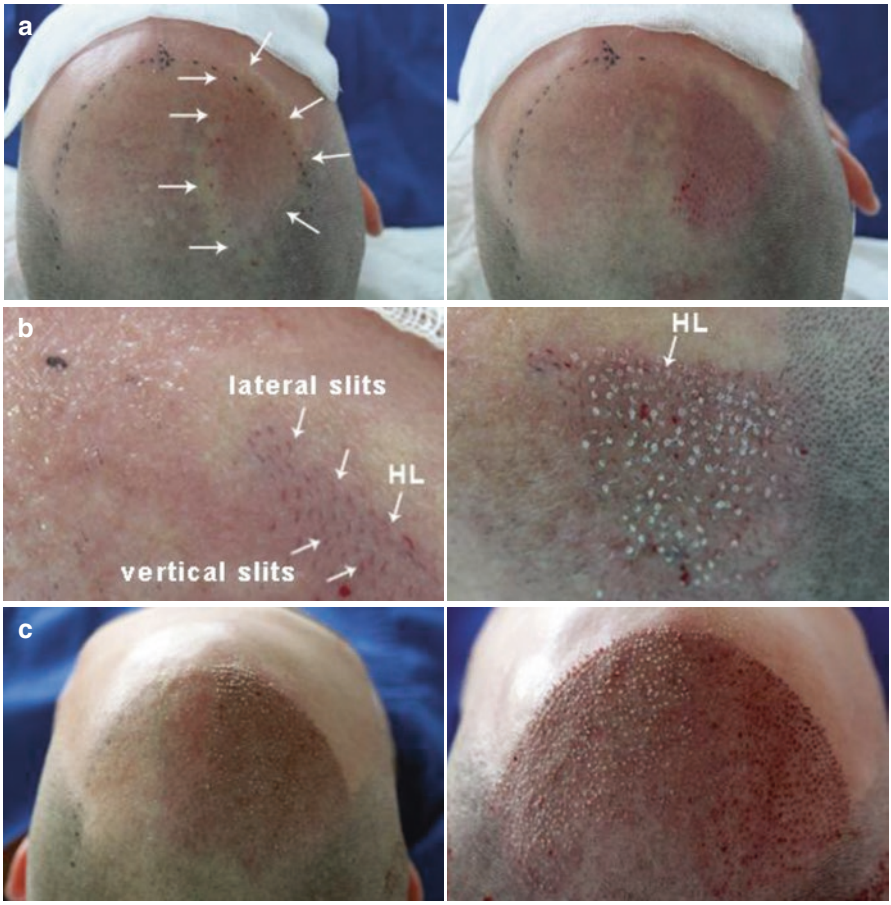

Fig. 4.62 (**a**) Left: Ring-shaped infiltration anesthesia in the subcutaneous tissue of the right frontal region with decreasing amounts of solution injected toward the center. Right: Incisions in the hairline and right frontotemporal corner. (**b**) Left: Lateral slit incisions in the hairline and vertical slit incisions in the adjacent anterior border of the hair. Right: Placing the grafts in the recipient incisions. (**c**) Left: Placement of 1100 grafts in the right half of the frontal region on the first day of treatment. Right: Placement of 1050 grafts in the left half of the frontal region on the second day of treatment

4.9.4 Graft Placement

4.9.4.1 Special Considerations for Design and Graft Placement in the Frontal Hairline

No other region influences the overall aesthetic result as decisively as the hairline. Because of the enormous importance of the hairline, I will again discuss it briefly.

As was mentioned, the frontal hairline is about 5 mm wide and should be reconstructed exclusively with 1-hair follicular units. Behind the frontal hairline of 1-hair FUs, there is an irregular geometric arrangement of 2-hair FUs and then 3- and 4-hair FUs immediately posterior to it.

When reconstructing the frontal hairline in patients with progressive hair loss, one should always avoid an excessively high transplanted hair density. This is because progressive miniaturization and thinning of the existing hair would lead to a very unnatural and unaesthetic hair pattern as time passes.

> The frontal hairline is 5 mm wide at maximum and should be reconstructed exclusively with 1-hair follicular units. Behind it should be an irregular geometric arrangement of 2-hair FUs with 3- and 4-hair FUs immediately posterior to that. This arrangement will produce a result with a natural appearance.

The natural hairline is characterized by the following features:

- Maximum width of 5 mm
- Consists exclusively of 1-hair follicular units
- Laterally bounded by the canthus lines
- Slightly asymmetrical course
- Wavelike and/or sawtooth arrangement

4.9.4.2 The Insertion Procedure

When placing the grafts in the slit incisions, always take care to insert the grafts without applying excessive force. In order to make placing the fine grafts as easy as possible, we have our patients begin applying fatty panthenol ointment to the recipient area 5 days preoperatively to make the skin more supple. This pretreatment makes the skin soft and pliable, greatly facilitating graft placement.

The grafts stored in cool saline solution in petri dishes are grasped directly at the distal portion of the hair bulb and immediately inserted into the recipient incisions. Behind the frontal hairline of 1-hair FUs, there is an irregular geometric arrangement of 2-hair FUs and then 3- and 4-hair FUs immediately posterior to it. When placing the graft in the recipient incision, always take care to avoid compressing or crushing it (Figs. 4.63a, b and 4.64).

> The follicular unit is grasped immediately above the hair bulb and placed in the recipient incision without applying excessive force.

When the grafts have been inserted, only the epidermal portion of the hair follicle remains above the recipient incision. Within half an hour, the tiny epidermal

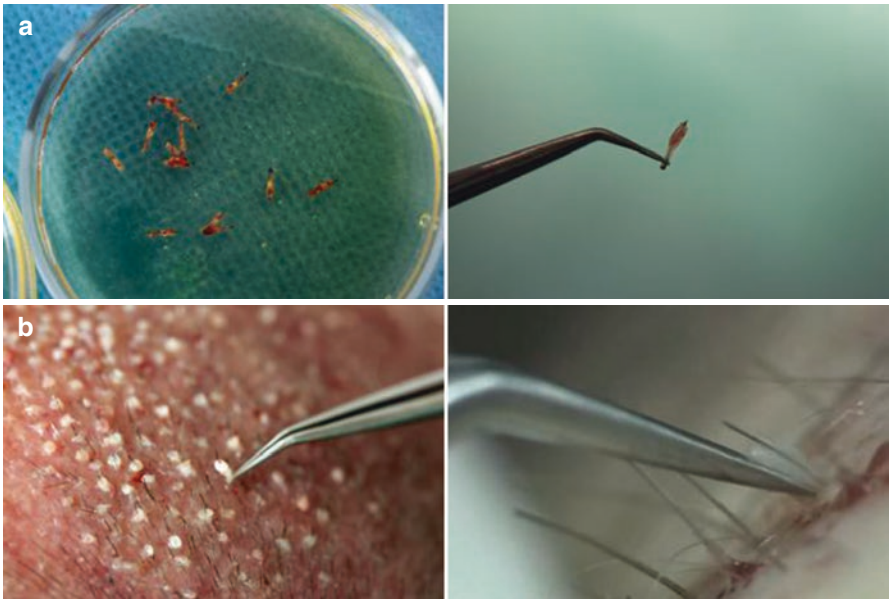

Fig. 4.63 (**a**) Left: The grafts are stored in a physiologic saline solution. Right: The graft is grasped directly at the distal portion of the hair bulb for insertion. (**b**) The graft is placed in the recipient incision

Fig. 4.64 Left: Avoid placing the jaws of the forceps at the level of the dermal papilla when grasping the graft. Right: Gently grasp the graft above the hair bulb as otherwise the graft could be crushed or injured

portions, which initially appear as white pearls, change into brown scabs that only fall off completely after postoperative day 10–13.

After placement of the grafts, the entire recipient area is sprayed with saline solution from a spray bottle and cleaned. A bandage is neither necessary nor advisable as the slit incisions contract, thus ensuring sufficient fixation of the grafts in the skin of the scalp.

4.9.4.3 Graft Placement in the Vertex Region

In the vertex region, the focus is on reconstruction of a natural cowlick or cowlicks. As was mentioned in Sect. 4.6.2, we differentiate between two different variants of

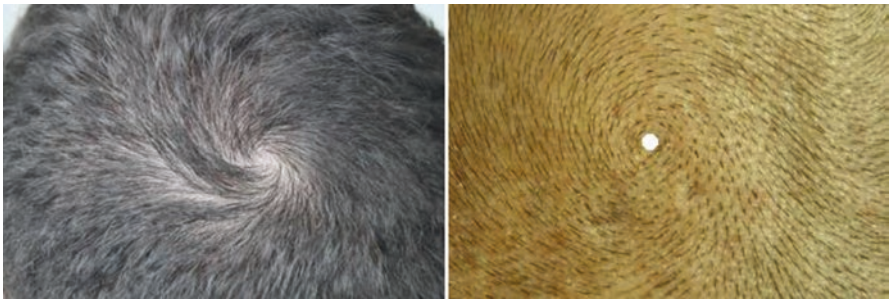

Fig. 4.65 Cowlick. Left: Intact clockwise cowlick. Right: Onset of thinning and miniaturization of the cowlick in a male patient

the androgenetic hair loss pattern in the vertex region. Whereas in variant I the inferior vertex region below the level of the cowlick is well preserved, in variant II there is partial or complete hair loss in the vertex region including the cowlick, depending on severity (Fig. 4.65).

4.9.5 Results of Treatment

4.9.5.1 Results of Treatment in the Vertex Region

The treatment results in the vertex region are shown in the following illustrations. Figures 4.66, 4.67, and 4.68.

4.9.5.2 Treatment Results in Patients with NW I–III Hair Loss

In patients with NW I–III hair loss, a single treatment will usually be able to achieve very good visual density (Fig. 4.69a, b and 4.70a–c).

4.9.5.3 Hair Transplantation in Patients with NW IV Hair Loss

The goal of "good visual density" in patients with NW IV or higher hair loss should be performed as two separate tissue-sparing operations at least 6 months apart.

One should allow a regeneration phase of 4–6 months to ensure that the donor area heals completely. The first transplant can be performed either in the frontal region or in the vertex region, depending on the patient's wishes (Figs. 4.71a–d and 4.72).

4.9.6 Adjuvant Therapy to Hair Transplantation

4.9.6.1 Preoperative Treatment

In order to ensure optimal treatment with the best possible results, we educate our patients at early stage about their options and duty to assist by behaving properly with respect to preparatory preoperative treatment and appropriate postoperative aftercare.

Fig. 4.66 Treatment of the vertex region with 800 FUs. Left: Preoperative view. Middle: View immediately postoperatively. Right: Result 12 months postoperatively

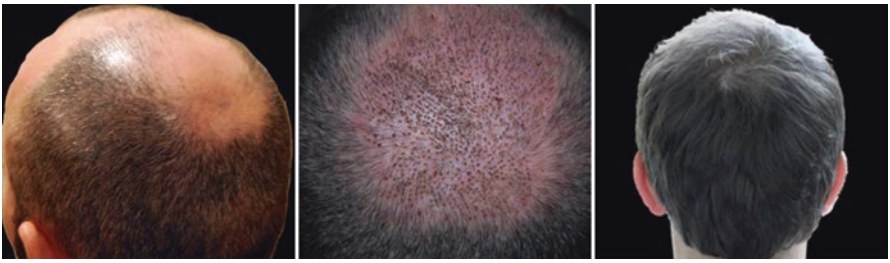

Fig. 4.67 Treatment of the vertex region with 2000 FUs

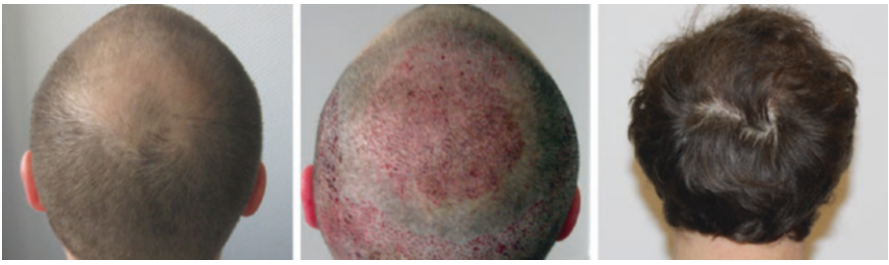

Fig. 4.68 Treatment of the vertex region with 2200 FUs. Left: Preoperative view. Middle: View immediately postoperatively. Right: Result 12 months postoperatively

Therefore, our patients receive an informative flyer that minutely describes the preoperative and postoperative procedure so that the patients can prepare themselves accordingly.

Prior to treatment, we recommend that our patients procure the following preparations:

- A tube of fatty panthenol ointment
- One or two tubes of Bepanthen scar gel
- A large spray bottle of thermal water spray (by Avène) for the postoperative phase
- A mild baby shampoo

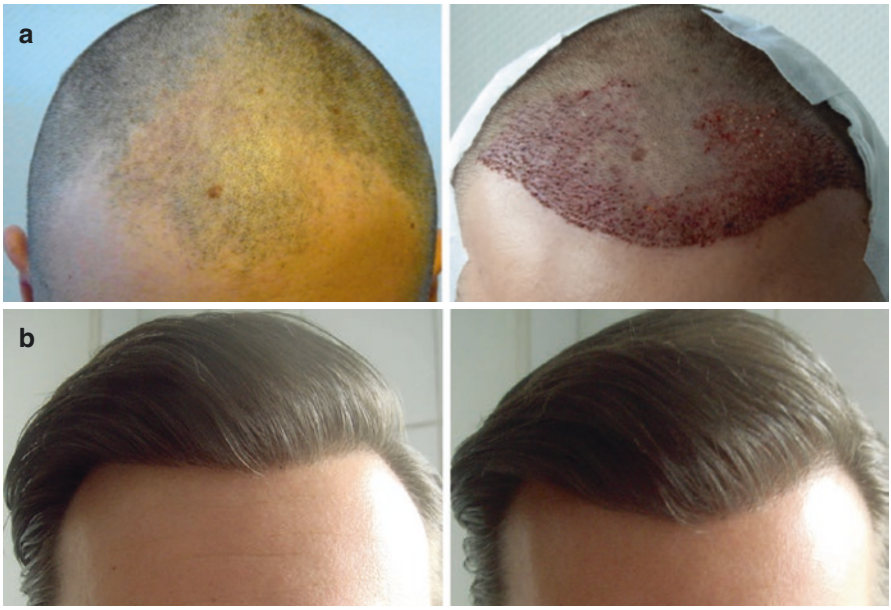

Fig. 4.69 (**a**) A 27-year-old AGA patient with NW III hair loss. The hair transplant was performed with a TFD of 20–25 FUs per cm². Left: Preoperative view. Right: Immediate postoperative view of the hair transplant with 1800 FUs (320 3-hair FUs, 840 2-hair FUs, 640 1-hair FUs). (**b**) View of the same patient 12 months postoperatively

4.9.6.2 Aftercare

A minimally invasive hair transplant usually requires no postoperative examination or aftercare on the part of the physician. Insofar as there are no specific complaints or complications, the patient can perform the aftercare himself. Careful cooperation on the part of the patient is crucial, as it can greatly influence the success of the treatment.

Usually no pain is to be expected. An anti-inflammatory treatment is initiated on the day of surgery. Here, we recommend beginning with 600 mg of ibuprofen three times a day on the morning of the day of treatment and continuing with this dose through postoperative day 3.

Some patients develop nighttime skin sensations such as itching, tingling, and pain in the donor area on postoperative day 4. This can be managed with 600 mg of ibuprofen where indicated. For this reason, one should supply the patient with additional tablets or write a prescription for ibuprofen 600 mg.

Before the patient leaves the operating room, he should again be advised that the grafts are initially very sensitive and can easily be avulsed from their new position by performing actions such as dressing or undressing carelessly.

On postoperative day 1 (16–20 h after surgery), the patient should carefully moisten the bandage or bandages until they are easily removed. Then the donor area is washed with a mild baby shampoo and carefully padded dry before Bepanthen scar gel is gently massaged into the site (Fig. 4.73a–f).

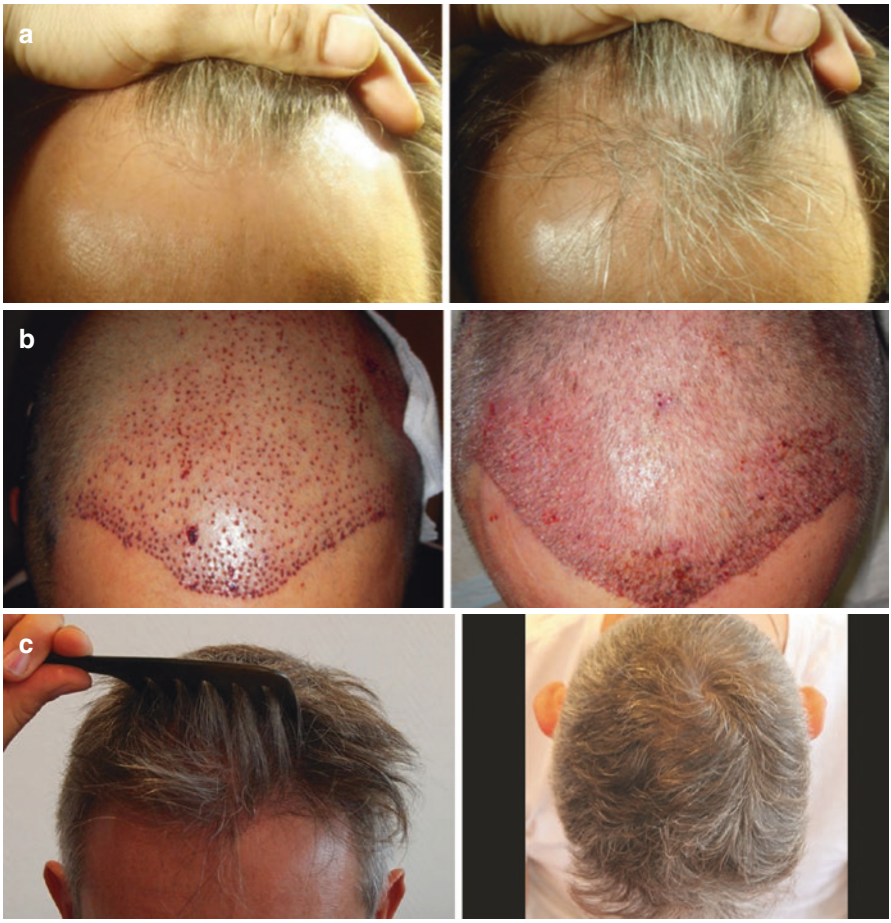

Fig. 4.70 (**a**) A 45-year-old AGA patient with NW III hair loss. Preoperative view. (**b**) The treatment was performed in two separate operations 1 year apart. Left: Immediate postoperative view after the first hair transplant with 1000 FUs. Right: Immediate postoperative view after the second hair transplant with an additional 1500 FUs. (**c**) Postoperative view 12 months after the second hair transplant

The patient should continue to apply Bepanthen scar gel in the morning and evening for at least 1 week. Additionally, panthenol ointment should be applied to this same area at noon or in the afternoon every day.

No ointments should be used in the recipient area. This includes wound care and healing ointments.

This area should be carefully rinsed with thermal water 8–10 times daily beginning after treatment and continuing for about 6 further days. On postoperative day 7, the transplanted area can be shampooed with baby shampoo while applying gentle pressure in a circular motion and then rinsed.

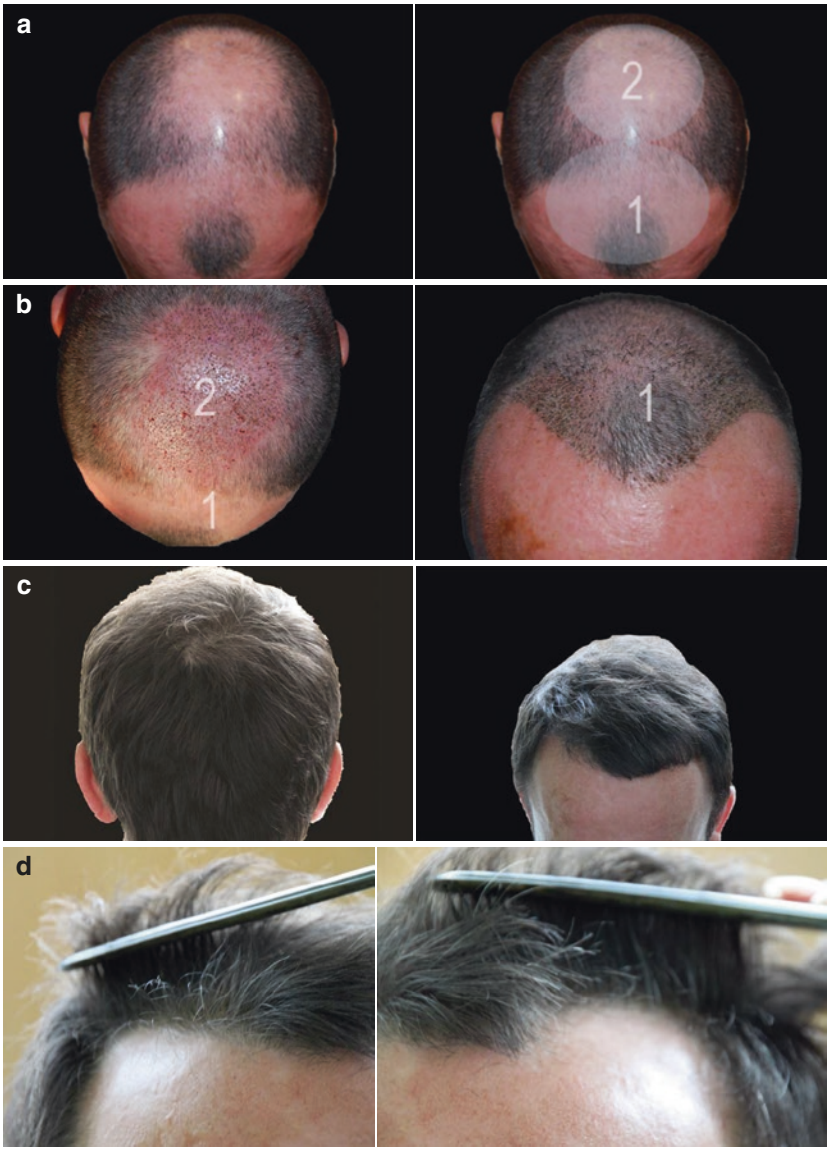

Fig. 4.71 (**a**) A 52-year-old AGA patient with NW IV hair loss. The bald area to be treated is divided into two regions: the frontal region (1) and the vertex region (2). (**b**) The hair transplant was performed with a TFD of 20–25 FUs per cm². Left: The first hair transplant was performed in the vertex region (2) with 2000 FUs (948 3-hair FUs, 752 2-hair FUs, 300 1-hair FUs). Right: The second hair transplant was performed 9 months later in the frontal region (1) with 1500 FUs (634 3-hair FUs, 466 2-hair FUs, 400 1-hair FUs). View of the frontal region 3 days postoperatively. (**b**) The hair transplant was performed with a TFD of 20–25 FUs per cm². Left: The first hair transplant was performed in the vertex region (2) with 2000 FUs (948 3-hair FUs, 752 2-hair FUs, 300 1-hair FUs). Right: The second hair transplant was performed 9 months later in the frontal region (1) with 1500 FUs (634 3-hair FUs, 466 2-hair FUs, 400 1-hair FUs). View of the frontal region 3 days postoperatively. (**c**) Result 12 months postoperatively. Left: View of the vertex region. Right: View of the frontal region. (**d**) Result 12 months postoperatively. Left: View of the right frontotemporal corner. Right: View of the left frontotemporal corner

Fig. 4.72 Loss of seven grafts on the top of the head immediately postoperatively due to carelessly putting on a T-shirt

Here, a few scabs and possibly even a few transplanted hairs may separate from the skin and fall off. However, this is normal and no cause for alarm as the hair roots remain within the skin (Fig. 4.74).

Usually, the scabs fall off completely between postoperative days 10 and 13. Sports activities may be resumed with about 30–40% of normal intensity as of postoperative day 7 and then gradually increased. The patient should refrain from visiting a sauna or solarium for at least 3–4 weeks.

It is particularly important for the patient not to lie on the transplanted area when sleeping or to otherwise come in contact with it during the first week postoperatively. To ensure this protection while sleeping, we recommend that patients use a special neck pillow or a small, firm neck cushion. However, patients are allowed to lie in the donor area.

4.9.6.3 Taking Medications During Hair Transplantation

Patients who were taking finasteride prior to the hair transplant can continue to do so without interruption during and after treatment.

Minoxidil therapy should be temporarily discontinued on the day of treatment and only resumed after the wounds have healed and the erythema has completed resolved. Here, we recommend preferring the foam form to the liquid form.

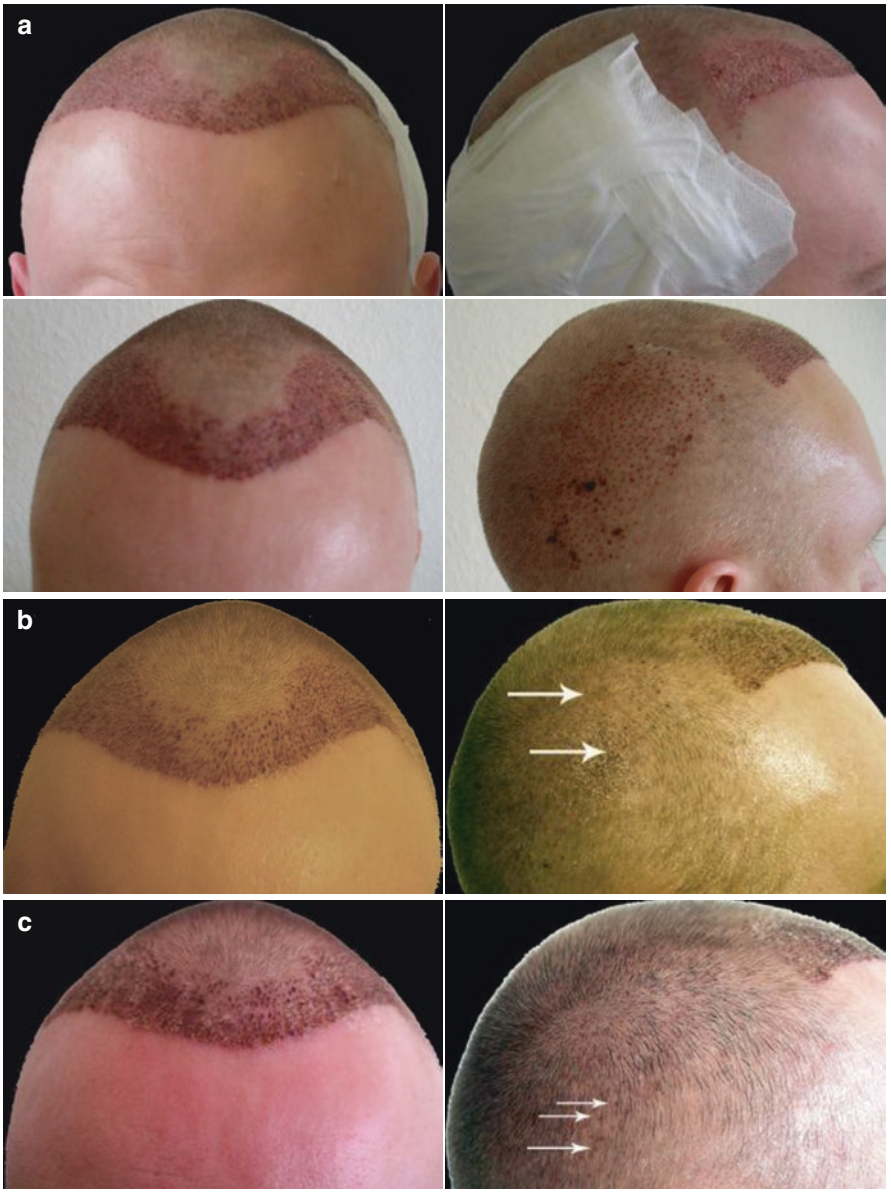

Fig. 4.73 (**a**) On postoperative day 1, the bandage is removed from the donor area, and the site is washed and treated with ointments. The recipient area is rinsed with thermal water. (**b**) Postoperative day 3. Left: Frontal view. Right: Right lateral view with visible donor wounds. (**c**) Postoperative day 6. Left: Frontal view. Right: Right lateral view. A few donor wounds are still visible (see arrows). (**d**) Recipient area after the first shampoo after the procedure on postoperative day 7. (**e**) Recipient area after the second shampoo on postoperative day 8 (left). Nearly all of the scabs have fallen off, and the recipient area has completely healed (right). (**f**) View 13 days postoperatively with partial loss of transplanted hair

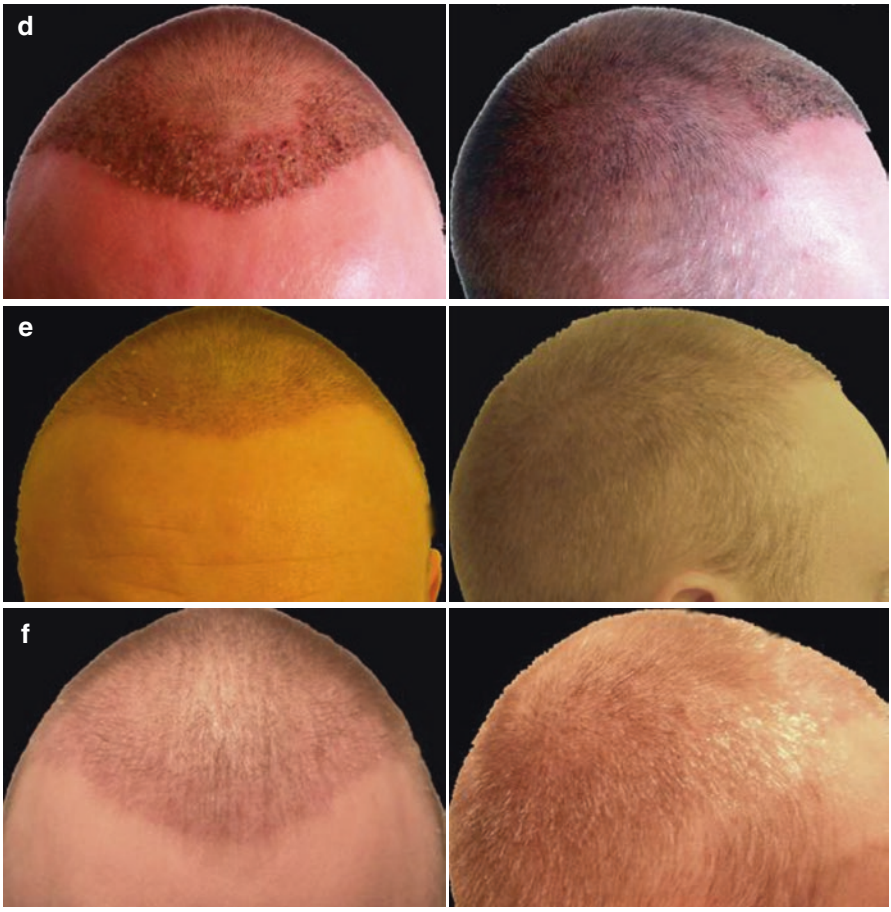

Fig. 4.73 (continued)

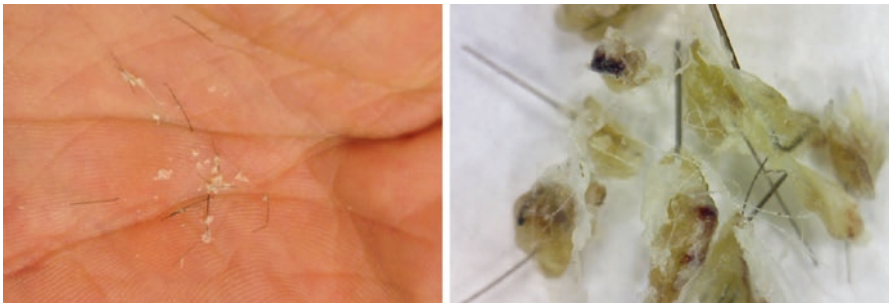

Fig. 4.74 When the recipient area is first washed on postoperative day 7, scabs will increasingly be shed including the hairs contained within them. In spite of being advised in advance by the physician about the unavoidable postoperative loss of transplanted hairs, patients generally find this distressing. Left: Loss of a few transplanted hairs after the first shampoo of the recipient area. Right: Magnified view of the scabs under a digital microscope

4.9.6.4 Taking Medications Against Hair Loss

Although it has been mentioned already (see Sect. 2.3.3), we again draw the reader's attention to the fact that especially with younger patients who may expect further hair loss, one should always consider medical therapy as an adjuvant therapy to hair transplantation. This is because the combination of minimally invasive hair restoration surgery and medical therapy offers the patient the best chances of success.

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Special Forms of Hair Transplantation

5

5.1 Revision Procedures

Subsequent revision procedures are often needed to correct failed hair transplants. The FUE technique is the only method that allows the entire spectrum of revision procedures. These include:

- Tissue-sparing harvesting of a precisely calculated number of grafts for corrective treatment even of small areas
- Harvesting body hair as donor material for revision treatments
- Transplantation into scar tissue (e.g., strip scars) caused by conventional methods of hair transplantation
- Extraction and removal of individual or multiple improperly selected or improperly placed follicular units in the hairline
- Corrections to the course of the hairline

The most common reasons for revision procedures performed in our practice can be sorted according to frequency into the several groups, which we will discuss in great detail in the following section.

- Low graft survival rate
- Unnatural hairline
- Surgical sequelae of graft harvesting: scarring and traumatic effluvium in the donor area
- Iatrogenic thinning or alopecia of the scalp hair due to improper hair transplantation technique, such as status post shock loss

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5.1.1 Low Graft Survival Rate

Our clinical experience has shown that with a hair transplant performed under the best clinical conditions, a survival rate between 80 and 100% may be expected. Such a survival rate may be regarded as optimal.

Survival rates varying between 50% and 80% can be classified as suboptimal.

Survival rates lower than 50% should be carefully investigated to determine their cause.

Low survival rates are due to the following causes:

- Delegating steps of the procedure to non-physician practitioners with resulting complications such as improper selection of the FUs, incorrect placement in the recipient incision, mechanical alteration of the grafts due to dehydration, and crush injuries
- Extraction methods involving multiple subsequent dissection steps
- Use of traumatizing incision instruments
- Excessively high incision density
- Tumescent anesthesia with the risk of ischemia

Additionally, the following patient-specific factors can also lead to variation in the survival rate:

- The patient's general health
- The tissue quality of the grafts
- The tissue quality in the recipient area
- The process of integration and revascularization of the grafts
- Folliculitis in the setting of an immune reaction with hair follicle infiltration with lymphocytes and macrophages
- Poor patient compliance, for example, nicotine use

Promises and statements about consistently high survival rates around 90% should be regarded with skepticism as such statements do not reflect clinical reality.

The majority of patients who come to our practice in the interest of receiving a body hair transplant have already undergone several hair transplants with survival rates less than 50% and for this reason are now dependent on body hair as donor hair. There are several possible reasons for low survival rates.

Insofar as sufficient donor hair is available, one may consider a revision procedure. As previous treatments have left the patient's skin damaged or even scarred, the survival rate in the revision procedure can vary greatly; one may not expect very high survival rates.

In order to increase the chances of achieving a high survival rate in the revision procedure, we recommend that our patients undergo a series of revision procedures each with a small number of grafts (Figs. 5.1, 5.2, 5.3, 5.4, and 5.5).

Fig. 5.1 A 48-year-old patient (NW V), status post two unsuccessful hair transplants, one with the strip method and one with the FUE method, involving a total of 4000 grafts. The survival rate was about 25%

Fig. 5.2 A 50-year-old patient (NW IV), status post two treatments with the strip method with 3400 grafts. The survival rate was about 50%

Fig. 5.3 A 32-year-old patient (NW III), status post one treatment with the strip method with 1200 grafts. The survival rate was about 25%

Fig. 5.4 A 52-year-old patient (NW VI), status post two treatments with the strip method with 4000 grafts. The survival rate was about 35%

Fig. 5.5 A 32-year-old patient (NW V), status post three treatments with the strip method with 1800 minigrafts. The survival rate was about 40%

5.1.2 Unnatural Hairline

In our clinical experience, affected persons with an unnatural and unaesthetic hairline usually suffer greater distress than those with a low survival rate.

A failed, unaesthetic hairline is immediately noticeable due to its exposed position and can only be concealed by wearing a hat, which can be very impractical in daily life.

It is understandable that patients suffer from this situation. This is true especially when friends, relatives, and even strangers mention their appearance following an unsuccessful hair transplant.

For the physician, the surgical correction of a failed hairline represents one of the greatest challenges in hair restoration surgery. Usually this correction can only be achieved entirely after several revision procedures.

5.1.2.1 Causes of a Failed Hairline Following Hair Transplant

Transplantation of Multi-Hair Follicular Units Instead of Single-Hair Units in the Frontal Hairline

Practitioners of modern hair restoration surgery are generally aware of the fact that the natural hairline is comprised of 1-hair follicular units. Nonetheless, incorrectly transplanting multi-hair units (2-, 3-, and 4-hair FUs) in place of the required 1-hair FUs is common practice. This is the most common reason for a failed hairline in hair restoration surgery. The reason for this common error lies in delegating the duties of the physician to non-physician practitioners. This leads to the improper execution of steps in the procedure and introduces sources of error that are no longer traceable and correctable.

Such hairlines can be corrected surgically in one of two ways: the multi-hair units can be extracted from the hairline and replaced with 1-hair FUs and/or 1-hair FUs can be placed directly anterior to the old unaesthetic hairline to create a new, more natural hairline (Fig. 5.6).

Transplantation of Aggregates of Multiple Hairs or Hair-Bearing Skin Grafts Instead of Single-Hair Units in the Frontal Hairline

With improved understanding of the follicular unit as the building block of aesthetic hair restoration surgery, the harvesting of hair-bearing areas of skin using conventional methods and then sorting them by size has increasingly fallen from favor. Nonetheless, the correction of these errors continues to occupy us to this day.

Especially in the hairline, surgical correction of these cases must utilize the FUE extraction technique without exception. Extraction of individual FUs from the hairline creates a natural, irregular hairline. The revision intervention should replace all of the multi-hair units in the hairline with 1-hair FUs. However, this is rarely possible in a single session (Fig. 5.7a–e).

Bristly Appearance of the Transplanted Hairs After Conventional Methods, Especially with the Strip Method

An increase in the hair shaft diameter of transplanted hairs beyond that of native hairs is often due to placing grafts with too much surrounding tissue. This is usually attributable to grossly dissected grafts obtained with the strip method. A process of adaptation takes place over a longer period of time (from 6 months to several years). Yet as in the following example shows, this adaptation process can occasionally be incomplete or even fail to occur (Fig. 5.8a, b).

Transplantation of grafts with too much surrounding tissue is associated with a bristly appearance of the new hairs. This can also occur after hair transplant with the FUE method. In these cases, excessively large extraction needles were used.

5.1.3 Surgical Sequelae of Graft Harvesting: Scarring and Traumatic Effluvium in the Donor Area

The most commonly used hair transplantation method is the strip method. This method traumatizes tissue, leading to certain surgical sequelae and possibly complications. Scarring is an unavoidable consequence of this method. Whereas the length

Fig. 5.6 Partial correction of a failed hairline in status post two hair transplants using the strip method in a 30-year-old male patient. *Top*: Unnatural hairline due to placement of multi-hair units in place of single-hair units. *Middle*: The partial correction was performed by transplanting 200 1-hair FUs to reconstruct a hairline with a natural appearance immediately anterior to the old hairline. The new hairline has a zigzag course with additional thickening of the frontal portion of the right hairline. *Bottom*: View 9 months postoperatively

of the scar corresponds to the length of the strip of skin harvested, the width of the scar varies with surgical technique, the width of the strip, and between individual patients.

Effluvium in the donor area may also occur as a complication. The effluvium induced by the trauma of surgery coupled with the progressive androgenetic hair loss and the age-related decrease in hair shaft diameter will make the strip scar to

Fig. 5.7 (**a**) A 50-year-old male patient with status post three unsuccessful hair transplants with a failed hairline. *Left*: Unnatural hairline created by inserting hair-bearing cylinders of skin with multiple follicular units. *Right*: Scars of three hair transplants performed with the punch and strip methods. (**b**) View of the hairline. (**c**) *Left*: Multi-hair units punched with fine extraction needles (ID, 0.9 mm; OD, 1 mm) in the frontal hairline. *Right*: Removal of punched multi-hair units from the frontal hairline. (**d**) *Left*: Extraction wounds after removal of the multi-hair units from the hairline. *Right*: Transplantation of single-hair units into the hairline and thickening and grafting of the hairline and frontal region. Thickening was achieved in part by utilizing the multi-hair units removed from the hairline. (**e**) View of the correction 12 months postoperatively

Fig. 5.7 (continued)

Fig. 5.8 (**a**) A 28-year-old patient with status post hair transplant in the frontotemporal corners with the strip method (2 years previously) in the presence of progressive hair loss. *Left*: Transplanted hairs exhibit a larger hair shaft diameter than native hairs. *Right*: The hair in the central frontal region was shaved to clearly show the frontotemporal corners. (**b**) *Left*: Clearly visible difference in hair shaft diameter. *Right*: Strip scar

become increasingly visible as time passes. Increasingly visible scarring that is no longer concealable is usually accompanied by a desire on the part of the patient to have hair transplanted into the scar tissue to obscure it and/or allow the patient to wear his hair short.

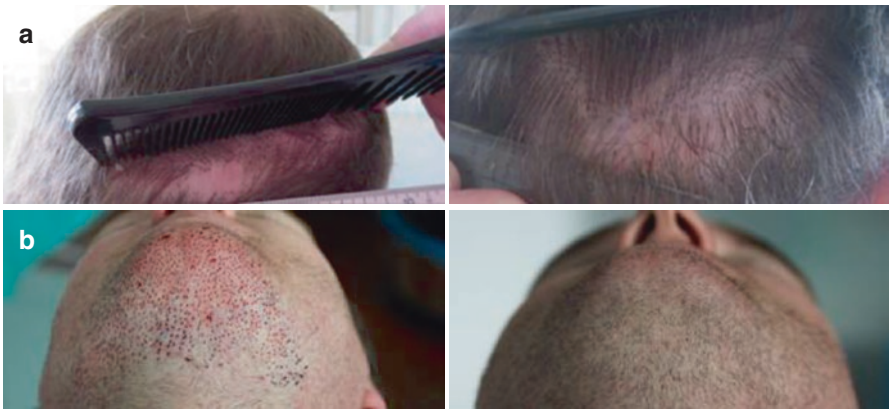

Fig. 5.9 (**a**) A 30-year-old patient with status post hair transplant with the strip method. *Left*: Scar 20 cm long from ear to ear, in places up to 2 cm wide. *Right*: Scar 8 months postoperatively after transplantation of beard hair. (**b**) *Left*: Extraction wounds from removal of beard hair follicles in the chin region. *Right*. Scar-free wound healing in the donor area 7 days postoperatively

Transplanting hair in the scarred area is usually associated with a lower survival rate than in unscarred tissue. Depending on the suture technique, vascular supply, and graft selection, this rate can vary between 30% and 70%.

The lowest survival rates are achieved in scars occurring after use of the trichophytic closure technique. In this technique, the edges of the wound are not approximated as usual but overlapped and sutured or stapled. This results in a thickened scar that not only makes it difficult to make recipient incisions but also severely impairs the integration of the grafts (Fig. 5.9a, b).

5.1.4 Iatrogenic Surgical Sequelae and Complications

Improperly performed hair transplants are associated with an increased rate of sequelae of surgery and complications. These are particularly severe with conventional techniques.

Yet even with a more atraumatic method such as the FUE method, serious complications such as severe scarring and shock loss can occur when the procedure is not performed properly.

Improperly performed hair transplants are usually the result of attempting to obtain a high number of grafts. The number of 2000–2500 FUs per treatment must not be exceeded regardless of the extraction technique. Both harvesting and placing a large number of grafts are invariably associated with increased tissue trauma and vascular injury, which minimally invasive hair restoration surgery seeks to avoid.

Foreign providers in "cut-rate countries" often promise in their advertising to harvest large numbers of grafts (megasession).

Here, responsible physicians have a duty to educate their patients (Fig. 5.10).

5.2 Body Hair Transplantation

In body hair transplantation, body hair is used as donor hair for transplantation primarily to the head. This type of hair transplant should be performed using the FUE method exclusively as the risk of iatrogenic injury caused by the conventional methods far outweighs the benefit (Fig. 5.11).

The various types of body hair provide the physician and patient with new sources of donor hair that can be used for transplantation.

Depending on the individual patient, donor hair can be harvested from chest hair, back hair, axillary hair, abdominal hair, pubic hair, and leg hair.

Fig. 5.10 *Left*: Scarring and iatrogenic effluvium (shock loss) secondary to two hair transplants using the strip method. *Right*: Iatrogenic effluvium (shock loss) in the region of the hair fringe after extraction of 3300 FUs in a single session using the FUE method

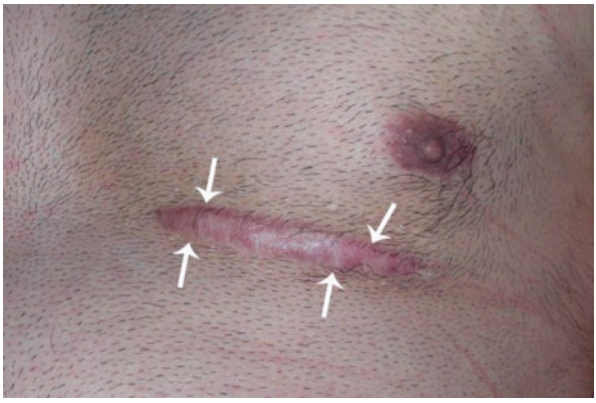

Fig. 5.11 Status post hair transplant with the strip method. A strip of skin was harvested from the chest, yielding 80 chest hair follicles for transplantation to the head and creating a scar 10 cm long and 1.5 cm wide. The damage caused by the strip method far outweighs the benefit

5.2.1 The Patient Group

Transplantation of body hair is particularly suitable for patients who show iatrogenic thinning in the donor area of the hair fringe as a result of having undergone one or more previous hair transplants.

Moreover, transplantation of body hair may be a good idea in young patients with a poor prognosis insofar as their hair loss represents a great emotional burden and they have sufficient donor hair on their bodies.

5.2.2 Beard Hair as Donor Hair

Single-hair units constitute about 90% of beard hair and 2-hair FUs another 10%. Three-hair FUs are extremely rare. As beard hair primarily consists of 1-hair FUs, it will not create the same density as will a comparable number of FUs from the region of the hair fringe.

Example: If one extracts 1000 FUs from the beard region, this will represent about 1150–1200 hairs. Yet if one harvests 1000 FUs from the scalp hair, this will correspond to about 1600–2800 hairs, a larger number of hairs and thus greater hair density and a better visual effect.

The hair shaft diameter of beard hair averages 0.12 mm, which compared with the hair shaft diameter of scalp hair, 0.07 mm, is lightly larger. This also applies to the dermal papilla of the beard hair.

Because of its thickness, beard hair is particularly suitable for treating scar tissue (resulting from traumatic injury or a hair transplant using the strip method).

After transplantation of beard hair to the scalp, miniaturization of the dermal papilla occurs, in turn leading to a decrease in hair shaft diameter of up to 50%. This adaptation process allows beard hair to be used for transplants to restore the scalp hair. Beard hair is also well suited for transplantation into male eyebrows.

I personally prefer and recommend harvesting beard hair from the chin and neck region as it is usually possible to extract about 600 beard hair follicles from this region for use as grafts. Beard hair should be extracted from the chin and neck region using a cannulated needle with an inside diameter of 0.95 mm and an outside diameter of 1.05 mm to avoid scarring.

Even better are the so-called Pro FUE needles, which have an inside diameter of 0.9 mm. These very thin-walled extraction needles are available from Mediquip Surgical in the USA (Fig. 5.12).

In contrast, harvesting beard hair from the cheek is more difficult. Yet in patients with dense beard growth, this region can yield about 1000–1500 beard hair follicles.

Given the exposed position of the beard in the face, patients should be comprehensively informed about the possibility of micro-scarring.

The longitudinal growth of transplanted beard hair is similar to that of scalp hair, although its survival rate in scar tissue is higher than that of transplanted scalp hair follicles (Figs. 5.13, 5.14, and 5.15).

Fig. 5.12 *Left*: Ninety percent of beard hair follicles are 1-hair FUs. *Right*: Scalp hair follicles consist mostly of multi-hair follicular units, whereas about 20–40% are 1-hair FUs

Fig. 5.13 Status post hair transplant with the strip method. A strip of skin was harvested from the chest, yielding 80 chest hair follicles for transplantation to the head and creating a scar 10 cm long and 1.5 cm wide. The damage caused by the strip method far outweighs the benefit

Fig. 5.14 Beard hair transplanted into scar tissue on the scalp in a 58-year-old male patient in status post hair transplant using an advancement flap. *Left*: Preoperative view of the right anterior hairline. *Middle*: Immediate postoperative view after the hair transplant. *Right*: View 8 months postoperatively. The process of adaptation of the transplanted hair to the native scalp hair takes place between the 6th and 18th months postoperatively

Fig. 5.15 Beard hair follicles transplanted to the right temple in a 46-year-old male patient. *Left*: Preoperative view of the right temple. *Middle*: Intraoperative view showing 85 recipient incisions in the right temple. *Right*: View 7 months postoperatively in status post transplantation of 85 beard hair follicles in the right frontotemporal corner

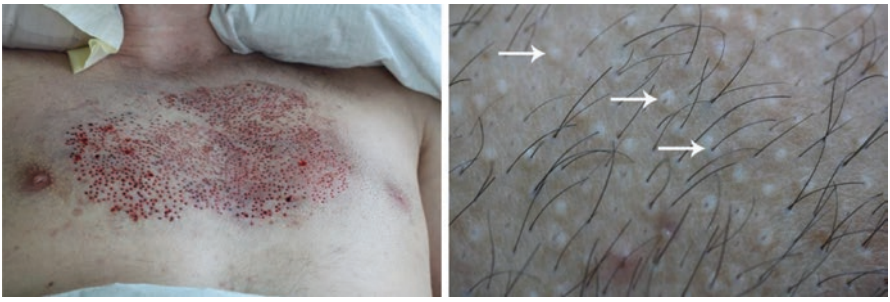

Fig. 5.16 Extraction of chest hair follicles in a 34-year-old male patient. *Left*: Extraction of chest hair follicles with extraction needles (ID, 1 mm; OD, 1.1 mm). *Right*: The chest region heals with micro-scars

5.2.3 Chest and Back Hair as Donor Hair

About 90% of chest and back hair consists of 1-hair follicular units, and about 10% consists of 2-hair FUs, very rarely 3-hair FUs as well. The hair shaft diameter of this hair varies greatly between individual patients.

As longitudinal growth is not genetically determined but is influenced by the surrounding scalp tissue, the longitudinal growth of transplanted chest and back hair adapts to that of the scalp hair. That makes this hair particularly suitable for transplantation to the scalp.

However, chest hair is more difficult to extract than scalp hair even with the optimal extraction needle (inside diameter 0.95 mm and outside diameter 1.05 mm) due to the structure of the skin in the chest region. For this reason we often use the next larger cannulated needle (inside diameter 1 mm and outside diameter 1.1 mm) or larger, although this is associated with greater micro-scarring. Usually, the micro-scars are well covered by the remaining chest hair and other hairs that were in the telogen phase at the time of the transplant (about 70%) and later grow back (Fig. 5.16).

Back hair is usually not as plentiful as chest hair but is very similar in terms of its structure and growth behavior. This hair also consists primarily of 1-hair FUs and, like chest hair, adapts its longitudinal growth to that of the recipient area after transplantation. The skin tissue of the donor area on the back is not as susceptible to scarring from extraction as is the chest skin (Fig. 5.17a–d).

Fig. 5.17 (**a**) Extraction of hair follicles from the back for transplantation to the head in a 38-year-old male patient. *Left*: View of the back after shaving the donor hair 1 mm and then administering infiltration anesthesia. *Middle*: View of the back after extraction of body hair from the left side of the back. *Right*: View of the back after extraction of body hair from both sides of the back on the second day of treatment. (**b**) *Left*: Hair follicles extracted from the back of the patient described above. *Right*: Transplantation of 1800 FUs from the back to the frontal region. (**c**) *Left*: Preoperative view of the frontal region prior to the planned transplantation of donor hair from the back. *Right*: Result of hair transplant with back hair 13 months postoperatively. (**d**) Result of hair transplant with 1800 hairs from the back 13 months postoperatively

5.2.4 Axillary Hair as Donor Hair

The skin tissue in the axillary region is very soft, which makes extraction of the hair follicles difficult. There is also very little axillary hair, and as a result it is rarely used for hair transplants to the scalp.

5.2.5 Hair of the Extremities as Donor Hair

As the follicles of arm and leg hair are usually very short and narrow, they are only suitable for hair transplants to a limited extent.

Because of the acute exit angle of these hairs, extracting them creates large elliptical wounds that remain reddened and inflamed for a long time and are associated with severe scarring (Fig. 5.18).

5.2.6 Abdominal and Public Hair as Donor Hair

The skin in the abdominal and pubic region is highly mobile because of its plentiful subcutaneous fat. Placing the tip of the cannulated needle on the skin with even the slightest force will displace the hair follicle relative to the skin. This means that

Fig. 5.18 View 3 weeks postoperatively. Removal of leg hair follicles using micromotors with large extraction needles in a 27-year-old patient

follicles are easily damaged during extraction, which is reflected in a higher transection rate. The extraction quota of abdominal and pubic hair that can be achieved with currently available extraction needles is generally rather low, which is why this hair is not usually considered as donor hair for hair transplants to the scalp.

5.3 Eyebrow Transplantation

5.3.1 The Patient Group

About 70% of our patients seeking eyebrow transplants are women and about 30% are men. In 90% of our female patients, hair loss in the eyebrows is attributable to excessive plucking of the eyebrows. Only about 10% of all cases involve eyebrow hair loss secondary to trauma, surgery, or disorders such as alopecia areata, ulerythema ophryogenes, or atopic disorders. Thus in the vast majority of cases, the hair loss in the eyebrows is caused by the patients themselves who have excessively plucked their eyebrows (Fig. 5.19).

The majority of our patients (about 70%) have already attempted one or more treatments with permanent eyebrow makeup.

The aesthetic advantage of tattooing with permanent makeup is questionable, given the unnatural appearance (bar effect, fading, discoloration). Additionally, the tattooing process damages the skin so severely that with the third permanent makeup treatment at the latest, the skin can no longer absorb the pigment very well. The result is an unaesthetic picture of thinned eyebrows with a faded or unnatural appearance (Fig. 5.20).

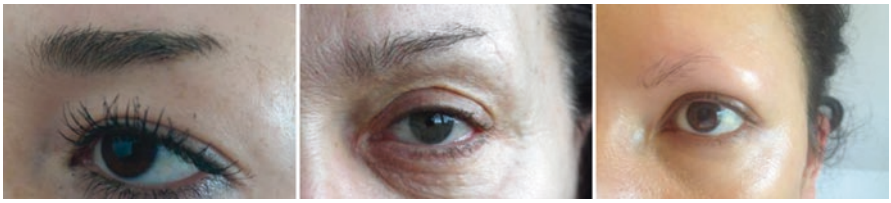

Fig. 5.19 Eyebrow loss due to excessive plucking in three different female patients

Fig. 5.20 Permanent makeup is an unnatural solution to excessive plucking of the eyebrows. In three different female patients, it, respectively, shows a bar effect, fading, discoloration, and/or improper positioning

Fig. 5.21 *Left*: A 26-year-old male patient with ulerythema ophryogenes. *Middle*: A 32-year-old male patient with alopecia areata (partial loss of the eyebrows and eyelashes). *Right*: A 28-year-old male patient with thinning of the lateral eyebrows (Hertoghe's sign) in the setting of atopic disease

In this situation, affected patients initially resort to contouring their eyebrows themselves with an eyebrow pencil, which can be difficult and time-consuming on a daily basis.

Situations in daily life such as sports (sweating) or walking in rain or snow can become very unpleasant when the eyebrow line runs or smears. Seeking a permanent solution to the problem that will work well in daily life and above all be aesthetic, affected persons consider having an eyebrow transplant. The decision to undergo the intervention is based primarily on aesthetic considerations and only secondarily on practical ones.

In about 70% of our male patients, there is no hair loss in the eyebrows. These patients desire a supplementary treatment to augment their existing eyebrows for purely aesthetic reasons. They desire longer and wider eyebrows that would appear more masculine and dominant.

Only about 20% of the male patients have eyebrow hair loss secondary to trauma, surgery, or disorders such as alopecia areata or atopic disorders, and about 10% of male patients have hair loss due to excessive plucking of the eyebrows (Fig. 5.21).

5.3.2 Chances of Success of Eyebrow Transplantation

The rule of thumb is the less treatment the eyebrows have undergone (in the best case, no previous permanent makeup or eyebrow transplant), the higher the graft survival rate and the more satisfactory the result will be. In a patient with intact, undamaged skin, one can expect a survival rate of 70–100%. In patients with permanent makeup or status post laser removal of permanent makeup or previous eyebrow transplant, one may not expect such a favorable result. The survival rate in such cases is usually significantly lower and can vary between 40 and 100% depending on the amount of scarring in the specific patient.

5.3.3 Determining the Shape of the Eyebrows

As a rule, the shape of the eyebrows to be reconstructed is adapted to the shape of the individual patient's face in consultation with the patient and drawn on the skin. In the case of patients with permanent makeup applied, the shape of the eyebrows

has been predetermined and can no longer be significantly altered or adapted to suit the patient's wishes. In certain cases such as permanent makeup with improperly positioned eyebrows, the pigment should first be removed with a laser before performing the transplant.

5.3.4 Selection of Donor Hair and Its Growth Characteristics

With complete loss of the eyebrows, the reconstruction will require about 120–250 grafts per eyebrow, depending on the desired shape. As women usually have little body hair, hair from the scalp will be particularly suitable as donor hair.

The head is partially shaved to facilitate harvesting the donor hair. Depending on the number of grafts required and the patient's hair density and length, we select either one donor site or several small donor sites on the back of the head. Depending on the length of the hair, it should be easy to cover the donor site or sites (Fig. 5.22).

As the majority of native eyebrow hairs occur in 1-hair follicular units or, less often, 2-hair FUs, the surgeon takes care to extract only these FUs as donor follicles. This ensures more natural visual results.

In the case of a complete reconstruction of the eyebrows, I recommend transplanting only 1-hair FUs as they can be used to achieve a very attractive, homogeneous result. Using 1- and 2-hair FUs could create visual contrasts and lead to an inhomogeneous appearance.

In cases in which a good stock of native eyebrow hair is present and the objective is merely to improve density, 2-hair FUs can be used as well, as here the visual contrast between the hairs is not as pronounced.

The important thing is to use only native 1- or 2-hair follicular units for this purpose. Splitting multi-hair units to obtain the required FUs would lead to traumatic folliculitis and a possible autoreactive response, which would result in a lower survival rate.

In contrast to the procedure in women, donor hair in men is primarily harvested from the chest region and secondarily from the beard and the reliable occipital

Fig. 5.22 The hair on the top of the head is bound together in a pigtail to harvest the grafts. Depending on the number or grafts required, a U-shaped strip of hair around the base of the pigtail 1–2 cm wide is trimmed to a length of 1 mm

region. The advantage of chest hair is that the hair characteristics including longitudinal growth are very similar to those of eyebrow hair, and thus this hair will not have to be trimmed as often. Clinical experience has shown that the transplanted hairs must be trimmed about every 2 weeks during the first 2 years postoperatively until they gradually adapt. Then they will need trimming only at much longer intervals.

When scalp hair is used as donor hair, note that the growth characteristics, especially the strong longitudinal growth, of transplanted hair remain unchanged at the new site and only adapt gradually over the next few years. Patients (mostly women) must be advised of this early as they will need to trim their eyebrows continually with eyebrow scissors.

They should also be informed that all or at least most of the transplanted hairs will fall out in the first 2–3 weeks postoperatively.

The long-term growth of the transplanted hair only begins after 3–10 months postoperatively, reaching its maximum growth 5–8 months postoperatively.

Patients should also be informed that transplanted hair (especially scalp hair) will initially exhibit an altered structure. That means that individual hairs can have a spiral shape or bristly appearance but will largely adapt later. However, complete visual adaptation may not be expected. As a result, closer inspection of the eyebrows will usually reveal subtle differences in hair structure. The color of the donor hair remains unchanged.

5.3.5 Patient Positioning

During anesthesia the patient lies in a comfortable horizontal supine position with the head supported by a cushion.

During the incision and graft placement phase, the supine patient should be positioned as close to the lateral edge of the couch as possible near the physician. The physician positions himself or herself contralateral to the side being treated.

5.3.6 The Operation According to the IFUE Method

It is advisable to use the alternating technique of the IFUE method for eyebrow transplants as well. This means that the grafts required for one eyebrow are first harvested in an extraction phase and then implanted before beginning the extraction and insertion phase for the second eyebrow.

5.3.7 Drawing and Positioning the Eyebrows

We use the frontomedian line (FML) as a reference line for positioning and drawing the eyebrows. The FML arises from the glabella and courses proximally over the tip of the nose and the midpoint of the upper lip to the tip of the chin (Fig. 5.23).

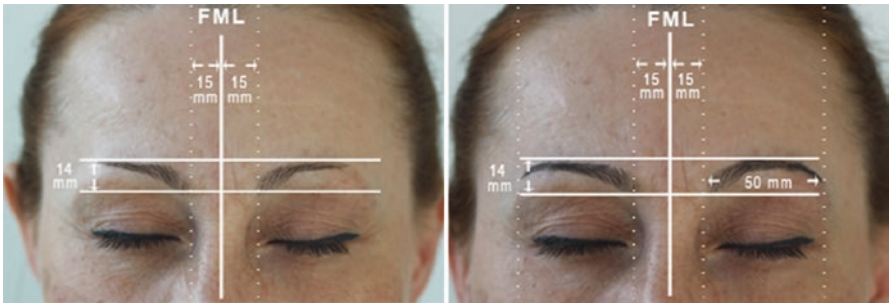

Fig. 5.23 The frontomedian line (FML) and two additional reference lines are drawn to determine the height and facilitate symmetrical positioning of the eyebrows. *Left*: View of the preoperative state without the desired shape of the eyebrows drawn on the skin. *Right*: View of the preoperative state with the desired shape of the eyebrows drawn

Where native eyebrow hairs are still present, the distance between the medial portion of each eyebrow and the FML is measured. Where there is nothing left of the eyebrows, the patient is consulted, and the medial margin of each eyebrow is set at a defined distance from the FML to create symmetrical eyebrows.

We use another reference line that runs perpendicular to the FML and is tangent to the superior margins (the respective highest points) of each eyebrow. Here, we often detect a height difference and asymmetry between the eyebrows, which we then correct. Where there are no more eyebrow hairs present, the superior margin is defined in consultation with the patient.

A second reference line that runs perpendicular to the FML and parallel to the reference line mentioned above is used to determine the inferior margin of the medial portions of the eyebrows. The lateral margin of the eyebrows can be defined symmetrically with a tape measure. The shape of the eyebrow is determined in each individual case in consultation with the patient. Finally, lines connecting the existing coordinate points with each other are drawn on the skin with a fine indelible marker.

5.3.8 Anesthesia

The adjacent skin superior to the eyebrows is now disinfected.

Infiltration anesthesia is applied to this region outside of the eyebrow marking at a distance of about 5 mm. Several injections are made superior to the eyebrow in a superior to inferior direction moving from medial to lateral (Fig. 5.24).

As soon as the anesthesia takes effect, the outlines of the eyebrows are sketched with fine needle stick marks a few millimeters apart. A sterile 27-G cannulated needle can be used for this purpose.

Now the skin of the eyebrow can be disinfected and wiped with colorless codan tincture on a compress to remove the markings.

See Sect. 4.9.1. Skin Disinfection and Infiltration Anesthesia for the composition of the anesthetic.

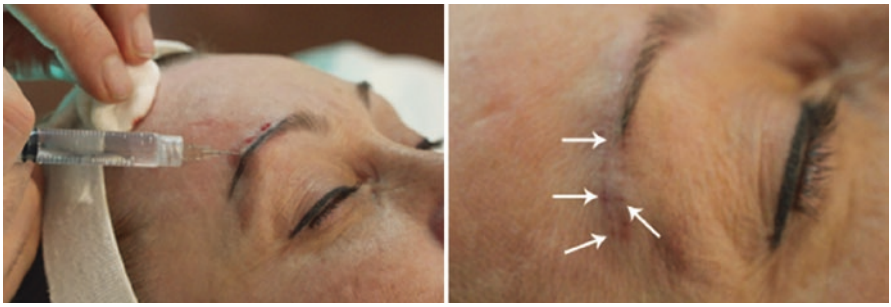

Fig. 5.24 Infiltration anesthesia along the right eyebrow (*left*). The outlines of the eyebrow are marked with fine needle stick marks (*right*)

Fig. 5.25 Incisions in the predefined eyebrow region (*left*). Placing the grafts (*right*)

5.3.9 The Incision and Insertion Procedure

Each incision must be made in such a way as to immobilize the graft within it so that it can neither rotate around its own axis nor become displaced. To achieve this, we recommend using special blades with a width of 0.8–1 mm and a thickness of 0.1 mm.

The recipient incisions are made at an angle of 5–7° to the surface of the skin. The direction of growth of the individual grafts can be aligned with that of the existing native hairs when each graft is placed.

5.3.9.1 Graft Placement

Whereas the donor site is bandaged and treated with a spray dressing, the transplanted area remains unbandaged (Figs. 5.25 and 5.26).

5.3.10 Aftercare

The aftercare does not require the assistance of a physician and can be performed by the patient herself. On postoperative day 1, the donor area is carefully shampooed with a pH-neutral shampoo (a mild baby shampoo) and washed. In the first week

Fig. 5.26 Result in both eyebrows 7 months postoperatively with 100% survival rate

Fig. 5.27 Reconstruction of plucked eyebrows in a 23-year-old female patient by means of an eyebrow transplant with 130 1-hair FUs. *Left*: Preoperative view. *Middle*: View immediately postoperatively. *Right*: Result 8 months postoperatively

Fig. 5.28 Increasing the density of plucked eyebrows in a 26-year-old female patient by means of an eyebrow transplant with 220 1-hair FUs. *Left*: Preoperative view. *Middle*: View immediately postoperatively. *Right*: Result 8 months postoperatively

postoperatively, the wounds are treated with Bepanthen scar gel in the morning and evening and with panthenol ointment during the day.

The recipient areas can be sprayed with thermal water several times a day from postoperative day 1 on. When spraying, the patient should avoid touching the sensitive recipient areas. The area is then gently padded dry. Only after postoperative day 7 can the patient gently wash the eyebrows with gentle circular motions of the fingers. After postoperative day 10–12, the scabs will usually fall off completely.

An anti-inflammatory therapy with ibuprofen 600 should be initiated on the day of surgery and continued three times a day for another 3 days.

The patient should also be informed that in rare cases postoperative hematomas and swelling can occur, which then resolve spontaneously. The patient may sleep on the donor site but should carefully avoid lying on the eyebrows for at least 2 weeks (Figs. 5.27, 5.28, 5.29, and 5.30).

Fig. 5.29 Broadening the eyebrows in a 26-year-old male patient by means of an eyebrow transplant with 130 1-hair FUs and 20 2-hair FUs. *Left*: Preoperative view. *Middle*: View immediately postoperatively. *Right*: View 6 months postoperatively

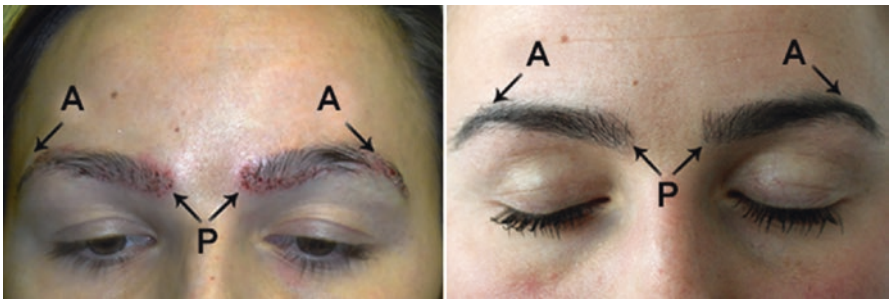

Fig. 5.30 Reconstructing and increasing the density of plucked eyebrows in a 24-year-old female patient by means of an eyebrow transplant with pubic hair follicles (P) and axillary hair follicles (**a**). Preoperative view (*left*) compared with result 7 months postoperatively (*right*)

5.4 Eyelash Transplantation

In our center, eyelash transplants are almost exclusively requested by and performed on women. Male patients are treated only extremely rarely.

In about 70% of the female patients, wearing false eyelashes and especially eyelash extensions is responsible for the loss of the eyelashes.

The process, repeated about every 3–4 weeks, of gluing, pressing, and tearing off false eyelashes subjects the natural lashes to strong mechanical forces that damage their structure.

The tensile force of the eyelashes' own weight and the daily application of mascara place additional stresses on the lashes that damage their structure, especially at the glued spots. The eyelash hairs are increasingly impaired until finally alopecia mechanica occurs with anagen effluvium and decreased longitudinal growth and the eyelash hairs fall out partially or completely (Figs. 5.31, 5.32, and 5.33).

About 20% of patients have normal eyelashes but are not satisfied with their length and desire a longer appearance.

Only about 10% of patients seek intervention because of previous surgery or disease, for example, trauma, removal of an eyelid tumor, or eyelash loss due to alopecia areata or chronic blepharitis.

Fig. 5.31 Eyelash extensions are individual synthetic hairs that are glued to existing eyelashes

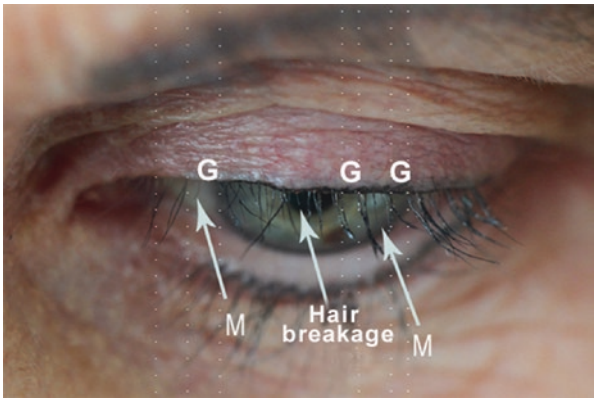

Fig. 5.32 Chronic use of eyelash extensions leads to alopecia mechanica with irreversible loss of the eyelashes. Sequelae of chronic use of eyelash extensions include: Hairless gaps (G) between the eyelashes. Hair fractures at the site where the extensions are glued to the native eyelashes. Increasing miniaturization with decreased longitudinal growth (M) of the eyelashes

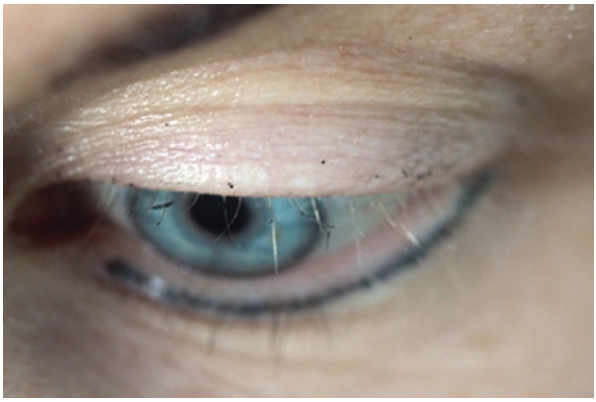

Fig. 5.33 Irreversible sequelae of use of eyelash extensions include miniaturization and loss of eyelashes

5.4.1 Selection of Donor Hair

The scalp hair follicles usually consist of multi-hair units and exhibit long growth which makes them particularly suitable for eyelash transplants.

However, patients must be informed that the growth behavior of the transplanted scalp hairs does not change. This means that they will constantly have to trim the new eyelashes to the desired length.

In rare cases, body hair is desired as donor hair because it does not have to be trimmed as often. The final decision on the selection of donor should be made based on the hair characteristics of the specific patient.

About 80% of eyelash transplants are performed on the upper eyelids and 20% on the lower ones.

As a general rule, only multi-hair units are used for eyelash transplants. In this way a large volume of hair can be produced in a small area with a few grafts. Often the presence of existing eyelash hairs means that there is little space available for creating recipient incisions in the eyelash region.

Where the eyelashes on the upper eyelid are almost completely absent, about 100–150 grafts per eyelid can be placed in a single treatment. Where the eyelashes are thinned, the smaller recipient area means that a maximum of about 20–40 grafts can be placed, depending on the specific situation.

5.4.2 The Operation According to the IFUE Method

As with eyebrow transplantation, eyelash transplantation involves first the complete treatment of one eye (alternating extraction and insertion phases) and then the complete treatment of the other eye.

The patient is positioned supine and the physician is seated behind the patient's head. After the eyelids have been disinfected with octenisept, a special topical anesthetic (proparacaine 0.5% by URSAPHARM) is applied to the conjunctival sac of the eye being treated. Then a protective metal eye shield is placed on the eye being treated. The physician then stands on the side being treated at the level of the patient's head to administer the infiltration anesthesia to the eyelid.

The anesthesia consists of bupivacaine with epinephrine (see Sect. 4.9.1).

The first injection is made into the lateral epicanthal fold. After an interval of about 30 s, another 4–5 injections are made adjacent to the eyelashes in the upper or lower eyelid (Fig. 5.34).

5.4.3 The Incision and Insertion Procedure

The physician stands behind the patient's head to make the incisions in the upper eyelid. He or she holds the eyelid with the index finger of the nondominant hand about 0.5 cm above the edge of the eyelid and pulls the lid superiorly about 1 cm, so

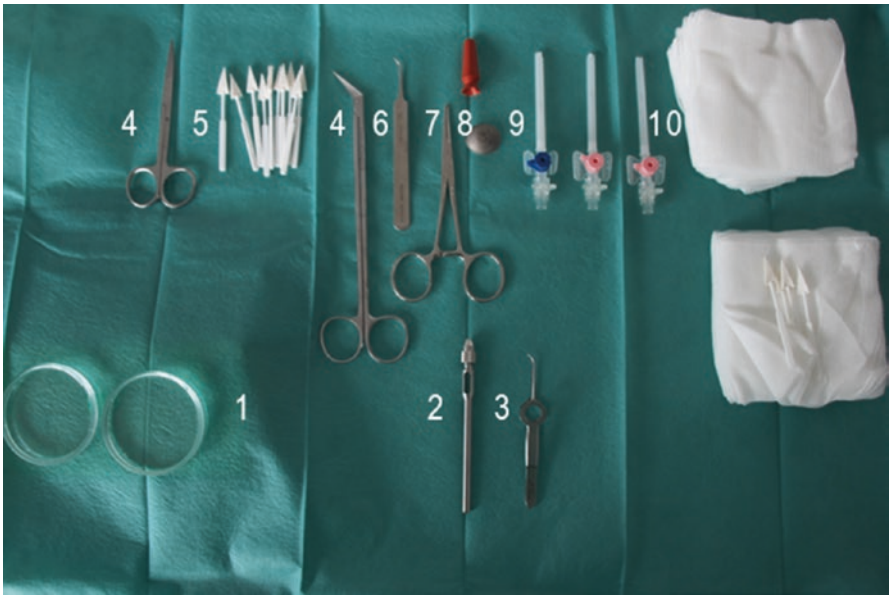

Fig. 5.34 Instrument set for eyelash transplantation: (1) petri dishes for storing grafts, (2) needle holder for extraction needle, (3) extraction forceps, (4) scissors, (5) swab, (6) insertion forceps, (7) clamp, (8) eye shield, (9) 20-G (pink) and 22-G (blue) venous cannulas, (10) compresses

the eyelashes are upright, parallel to the finger. In this position, the eyelid is immobilized with the finger, and the incision needle (venous cannula) is held parallel to the direction of growth of the eyelashes, and the incisions are made in the eyelid. A minimum distance of 1 mm should be maintained between the individual recipient incisions (Figs. 5.35 and 5.36).

In patients with permanently tattooed eyeliner, particular care should be taken when making the incision as the superficially scarred portion of the eyelid adjacent to the lashes can easily tear. This is particularly true for older patients whose eyelids generally have less elasticity.

Transplanting grafts into the lower eyelids is a particular challenge for the attending physician because the incision angle must be carefully chosen on an individual basis. This is important in order to preserve the physiologic closure mechanism of the eyelids without the eyelashes turning inward.

To make the incisions in the lower lid, the physician stands behind the patient's head. Once local anesthesia has been administered to the lower eyelid, the nondominant thumb immobilizes the lower eyelid close to its edge and pulls the eyelid inferiorly to expose the inferior conjunctival sac. The incision needle is advanced into the lower eyelid anteroposteriorly at an angle of 10° to the

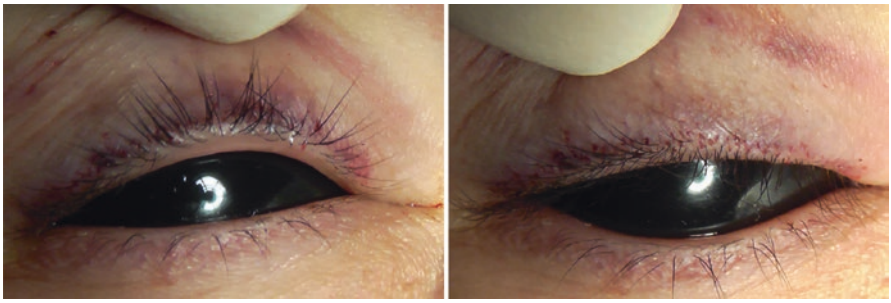

Fig. 5.35 *Left*: After the eye shield has been placed on the eye, the upper lid is immobilized with the finger and pulled superiorly so the eyelashes are upright, parallel to the surgeon's finger. The incision is made parallel to the eyelashes. *Right*: Recipient incisions for the eyelash grafts

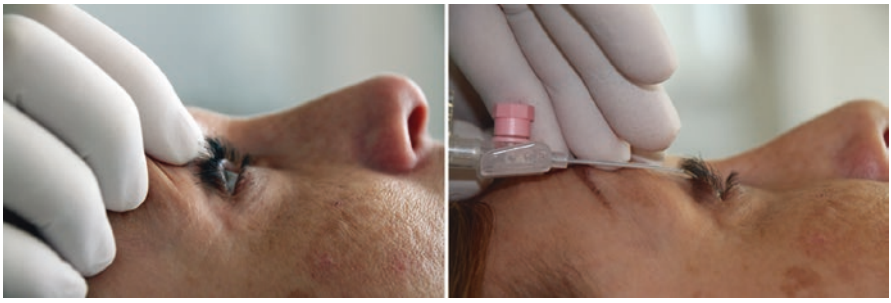

Fig. 5.36 *Left*: To make the incisions, the upper lid is immobilized with the finger and pulled superiorly so the eyelashes are upright, parallel to the surgeon's finger. *Right*: The incision is made with the cannula parallel to the eyelashes

Fig. 5.37 Precise positioning of the incision needles and achieving an exact fit of the grafts prevent the grafts from turning inward. This prevents trichiasis when the eyelids close

surface of the palpebral conjunctiva immediately adjacent to the edge of the lower eyelid. The depth of the incision corresponds to the length of the hair follicles of the grafts. The grafts are placed with an insertion forceps (Figs. 5.37 and 5.38a–e).

Fig. 5.38 (**a**) Partial madarosis in a 24-year-old female patient. (**b**) Eyelash transplant immediately after placement of the grafts. *Left*: With the protective eye shield in place. *Right*: After removal of the eye shield. (**c**) *Left*: View on postoperative day 5 after eyelash transplantation. *Right*: View 4 months postoperatively. (**d**) *Left*: View immediately postoperatively after eyelash transplantation into both upper and lower eyelids with a total of 298 FUs. *Right*: View 4 months postoperatively. (**e**) View 4 months postoperatively

Fig. 5.38 (continued)

5.4.4 Aftercare

The aftercare does not require the assistance of a physician and can be performed by the patient herself. On postoperative day 1, the donor area is carefully shampooed with a pH-neutral shampoo (a mild baby shampoo) and washed. In the first week postoperatively, the wounds are treated with Bepanthen scar gel in the morning and evening and with panthenol ointment during the day.

The recipient areas can be rinsed with water several times a day from postoperative day 1 on. I recommend patients to fill their cupped hand with water and carefully dip the respective eye in it. Here, patients should avoid touching the sensitive recipient areas and then only gently pad them dry. Little scabs form on the eyelashes which after postoperative day 10–12 will usually fall off spontaneously.

An anti-inflammatory therapy with ibuprofen 600 should be initiated on the day of surgery and continued three times a day for another 3 days.

The patient should also be informed that postoperative hematomas and swelling can occur, which then resolve spontaneously.

Patients should sleep on their backs for the first 2 weeks postoperatively.

5.4.5 Growth Behavior and Postoperative Course

On the day of surgery, the hairs of the eyelash grafts are about 1 mm long. The postoperative course can develop slightly differently from this initial situation in different patients. Grafts usually exhibit three different types of growth behavior:

- The eyelash grafts do not fall out and slowly begin to grow.
- Some of the grafts begin to grow immediately but slowly, whereas the other eyelashes fall out. The hairs that have fallen out start to grow back 3 months postoperatively until the final density is reached after about 8 months postoperatively.

- The majority of transplanted hairs fall out between 1 and 3 weeks postoperatively before definitive growth of the eyelashes begins between 3 and 8 weeks postoperatively.

A hair loss rate of about 50–100% can usually be expected. In patients with relatively thin hair, one should plan on at least one additional treatment.

5.5 Beard Transplantation

5.5.1 The Patient Group and Patients' Motivations

Compared with scalp hair, eyelash, and eyebrow transplants where patients of all age groups are represented, the group of patients seeking a beard transplant is far smaller and more homogeneous. About 80% of these patients are young men between the ages of 18 and 30.

The reason for a beard transplant in these patients is almost exclusively incomplete beard growth or total lack of it which these patients would like to counteract for purely cosmetic considerations.

Whereas in other cultures wearing a beard may also be an expression of belonging to a religious community, in our Western culture, it is at present largely a fashion or a means of expressing one's own personality. The beard can take many forms. It can vary from a 3-day beard, a moustache, and chin beard to a full beard with any number of intermediate forms.

The remaining 20% of patients seeking a beard transplant want to conceal the results of trauma or a pathologic condition such as alopecia areata or a harelip.

5.5.2 Prognosis of Beard Transplantation

In patients with little natural beard growth but intact facial skin, the prognosis is very good with a survival rate of 70–100%. When treating scarred skin, a survival rate of 40–70% can be achieved, depending on the selection of donor hair.

5.5.3 Selection of Donor Hair

Insofar as the patient does not suffer from androgenetic alopecia, we recommend extracting scalp hair follicles as they are present in sufficient quantity.

In patients suffering from AGA who require their hair in the reliable donor area for scalp hair transplants, one can use chest hair as donor hair for a beard transplant.

However, in less extensive treatments and in posttraumatic cases with scarring, we recommend extracting beard hair from the neck and lower chin region. Diligent and careful extraction of the hair from this region can yield from 300 to 500 follicular units without leaving behind scars. We also find it expedient to use chest hair.

5.5.4 Determining the Form

The number of grafts varies greatly, depending on the desired type and size of beard. To reconstruct the sideburns, the lateral hair on either side of the face that should extend from the scalp hair over the cheeks to merge with the beard, one should calculate about 150–250 follicular units per side, depending on size.

Whereas about 200–300 FUs are sufficient for a moustache, a moustache and chin beard will require about 500–600 FUs. However, a full beard cannot be reconstructed in a single treatment. Depending on existing conditions (presence or absence of a moustache), this requires a full facial transplant that will have to be performed in several sessions and can require up to several thousand grafts.

5.5.5 Patient Positioning

During anesthesia the patient lies in a comfortable horizontal supine position with the head supported by a cushion. The physician assumes an appropriate position according to the location of the donor site. During the insertion phase, the physician is seated behind the patient's head.

5.5.6 The Operation According to the IFUE Method

It is advisable to use the alternating technique of the IFUE method for beard transplants as well. This means that about 100–150 follicular units should be extracted from the donor area and immediately inserted before any further extraction and insertion phases follow.

5.5.7 Disinfection and Anesthesia

The respective area of skin is disinfected with codan before the bupivacaine anesthetic with epinephrine added is diffusely injected over the entire recipient area. During the treatment, the recipient area should occasionally be rinsed with a saline solution to maintain the surgeon's view of the recipient incisions.

Fig. 5.39 (**a**) Reconstruction of the moustache in a 24-year-old patient with a harelip. *Left*: Preoperative view. *Right*: Immediate postoperative view of the moustache transplant with 100 scalp hair follicles. (**b**) *Right*: View 1 month postoperatively. *Right*: View 2 months postoperatively. (**c**) *Left*: View 3 months postoperatively. *Right*: View 4 months postoperatively. (**d**) *Left*: View 5 months postoperatively. *Right*: View 6 months postoperatively

5.5.8 The Incision and Insertion Procedure

The incisions are made as in a scalp hair transplant. Each incision must be made in such a way as to avoid crushing the graft and so that it can neither rotate around its own axis nor become displaced.

The recommended blade length is 0.8–1 mm with a thickness of 0.1 mm. The recipient incisions are made at an angle of 5–7° to the surface of the skin. The direction of growth of the individual grafts can be aligned with that of the existing native hairs when each graft is placed (Fig. 5.39a–d).

With small donor sites and when extracting grafts from the neck and chin, it is usually sufficient to treat the site with a spray dressing. With extensive donor areas or bleeding, the donor area is bandaged with compresses and elastic tape. The transplanted area remains unbandaged.

5.5.9 Aftercare

As with other hair transplants, the aftercare does not require the assistance of a physician. On postoperative day 1, the donor area is carefully shampooed with a pH-neutral shampoo (a mild baby shampoo) and washed. In the first week postoperatively, the wounds are also treated with Bepanthen scar gel in the morning and evening and with panthenol ointment during the day.

The recipient area can be sprayed with thermal water several times a day from postoperative day 1 on. The area should be padded dry only very gently.

Scabs usually develop on the transplanted beard hairs in the following days. On postoperative day 7, the face including the recipient area can be carefully washed with gentle circular motions of the fingers. Usually the scabs will gradually fall off spontaneously.

I recommend a concomitant anti-inflammatory therapy with ibuprofen 600 beginning on the day of surgery and continuing three times a day for 4 days.

The patient should also be informed that especially in the sensitive facial region, postoperative hematomas and swelling can occur, which then resolve spontaneously.

The patient may sleep on the donor site but should carefully avoid lying on the transplanted facial area for 1–2 weeks to avoid avulsing the grafts.

Further Aspects of Hair Transplantation

6

Reza P. Azar and Ludger Mentrup

6.1 Hair Transplantation Between Business and Ethics

The modern methods of hair transplantation have made it possible to improve the situation of most people suffering from alopecia. So in the last decade, the number of patients has risen greatly. But the increase in patients, doctors, and technologies has also created a very different competitive situation for all parties involved, and this is going far beyond the pure medical factor.

Being part of cosmetic surgery, it is a procedure which is triggered by the wishes and expectations of the patients. We have arrived at a situation where the interests of patients and physicians have to find a common denominator so that an operation can be successfully carried out to the full satisfaction of all parties involved. And this is a situation where patients are willing to travel great distances to bargain on the price of their surgery or to get a special treatment not available within their home area. There is a large flow of patients between countries and continents, which raises many additional practical questions concerning patient communication, travel organization, language, and patient management before and after surgery. Different cultures, desires, and prices collide with legal frameworks for the doctor which are different in each country. This is an area which many doctors are relatively unprepared for, as this is beyond the scope of their medical education as well as the usual work in the hospital or even as an employee in a practice.

For the doctor, it is very important to see how he is able to obtain patients based on a valid strategy covering both medical and financial conditions and to balance out the ethical problems in a competitive market situation.

These questions of the determination of one's own position, the medical and business strategy, but also very concrete questions, how and where patients are recruited for their own practice or clinic, and in what form the communication is handled. These are new topics for many doctors but are very decisive for success.

In fact we have to look at the whole process starting from the strategy with medical, financial, and practical options to see the consequences in managing a hair clinic.

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6.1.1 Marketing Strategy

6.1.1.1 Market and Target Groups

Questions which are almost unknown to doctors from hospitals, currently seeing only patients acquired by other people, are as follows: Who is my potential client? What is my target group? These are questions that did not matter at a time when there were perhaps 10 or 20 doctors worldwide for techniques of modern hair transplantation. But now that there are more than 500 clinics in cities like Istanbul, it is clear that this is a crucial question from the beginning. Every doctor and clinic must consider exactly which customers should be addressed. And here the experiences of the marketing people help, which classify the customers according to a very different number of segmentation criteria beyond the pure medical pattern, and thus enable a selection but also targeted communication (Table 6.1).

Within these criteria it seems very easy to focus on the clearly identifiable and certainly important demographic factors such as the regional target group. Naturally, the location of the clinic, the connection to transport, etc. play a very central role, which target groups maybe of potential interest.

Besides the easy demographics, it is very important to consider that the decision of a patient for a physician is mostly influenced by emotional factors, at least at the point where offers of clinics are technically and price-wise similar. "Trust" becomes an important factor, which is the result of much more complex ideas and decision-making processes than one might suspect. There are many points which flow into the image of the physician and his clinic.

But it is also vice versa: the clinic will always represent an image of the respective physician and owner, who must also identify with his work and his appearance. There is no "good or bad," but the need for a sensible adaptation, which the clinic must give to the outside in accordance with the desired target group.

6.1.1.2 Detailed Competition Analysis

But before you realize your own ideas in—perhaps even in purchasing office space and equipment—it is very helpful to look at other providers and their offers to the patients. This is the best way to recognize where there are still

Table 6.1 Nonmedical segmentation criteria for customers

Demographic	*Psychographic*
Age Income level Education Nationality/national roots *(e.g., Hispanic, Turkish, etc.)* Gender (*male certainly, female??*) Geographic location	Open/closed personality (*how openly personal situation and hair transplant is discussed*) Spontaneity (*decision-making process*) Price sensitivity Lifestyle (*including desired haircut*) Information sources
Behavioral	*Environmental*
Medical history Service preferences Media (especially Internet) usage Time investment Traveling and language flexibility	Location *(travel options)* Family *(travel options)* Political situation *(travel easiness)* Finance and currency *(financial frame)* Languages routinely spoken

gaps on your own profile and in which questions your own abilities could be improved.

So spend your time not only checking the Internet websites but also doing a careful examination how the other clinics around you work and how the patients (customers) see these clinics.

Also it is important to know how much marketing and financial power competitors are able to exercise. Sometimes it will be hard to find out. For example, if a Hispanic doctor is using media in his own language for advertising, you most likely will not see and find this.

6.1.1.3 SWOT Analysis

When starting a new clinic or thinking about the future of an existing franchise, it is important to take a step back from the pure operational aspect and tasks. When deciding about the key strategy, the most realistic possible assessment of the initial situation is decisive for the success of all strategies, and too much optimism and pessimism can be very dangerous.

In the case of any business including a hair clinic, a false assessment of the initial situation may have serious consequences.

The SWOT analysis is one of the world's most widely used methods for assessing the initial situation in practice. It is collection of general (external) opportunities and threats/risks in relation to own (internal) strengths and weaknesses.

It is important to try to include all important items. To make it a bit more practical, an example of "a newcomer clinic in a medium-sized city of the Western world" is used with some fictitious framework of this doctor or clinic (Table 6.2).

Table 6.2 SWOT analysis of a hair clinic (example)

Strengths—internal factors	Weaknesses—internal factors
Long-term working experience in an established hair transplant clinics before starting own clinic Good results, published in many patient forums Newly purchased equipment in good conditions The only doctor around doing manual FUE Two experienced nurses as staff	Starting with "zero" income Money already invested in clinic Patient requests create work but do not result in real surgeries No marketing experience Monthly costs to cover
Opportunities—external factors	**Threats—external factors**
A growing market Wide publicity about hair transplant lowers also psychological barriers FUE now de facto standard Increasing amount of "repair work" New medical options in FUE give more choices to treat patients	Established competitor clinics in the same city Aggressive pan-national advertising campaigns of large hair centers Low-cost offers from foreign clinics putting pressure on prices Not all new medical options are considered effective but required by patients In a world of many disputes of political and even terrorist character, the frame for beauty surgery may change immediately

A SWOT analysis primarily helps one become aware of the basic conditions and prerequisites. It also helps to identify tasks and risks at an early stage, as well as to define further action with them. However, it must also be made clear that a sober and honest analysis is necessary, but in the end always an entrepreneurial decision has to be made.

6.1.1.4 Develop Your Own Profile

Seeing the others should not lead you away from the target to develop your own strong profile. There are many niches, and there is enough space for every doctor willing to create a clear message. Don't copy others—it does not pay off.

With analytical data in hand, you should have a better idea of who you are, who you are not, and who your best audience is. It's time to make a statement about those facts, and this in a clear comparison to the clinics which you consider to be "competition."

Draw a simple table starting with the main points (Table 6.3).

6.1.1.5 Define Your USP

This table already gives you a solid basis for your concept. But think also about your patient and what you can really promise and keep. The questions about credibility and authenticity of your service are a major key for long-term success. So ask yourself some questions:

- What makes our clinic unique?
- What are our particular strengths?
- How can we differentiate from our competitors?
- Where are we better than our competitors?
- Which of the strengths could have the greatest appeal to our customers?
- Which existing and future options (innovations, additional service offers, etc.) can be added?
- What additional benefits can we offer?

Although success depends on many influencing factors, it is essential to look for a factor for one's own success. This search for a competitive advantage is aimed at achieving a certain uniqueness and thus a unique feature—a so-called unique selling proposition (USP).

Table 6.3 Simple competitive analysis sheet for hair transplant clinics

	Clinic A	Clinic B	Clinic C	Clinic D	YOU
Technology (FUT/FUE, manual, robot, etc.)					
Price per graft					
Additional treatments					
"Service"					
Package pricing					
Media strategy					
Other					

The USP is the outstanding and unique feature of your clinic, which makes it easy for your customers to decide for your clinic. Just some examples how this could like:

- The only manual FUE clinic in xyz city
- The most exclusive place to go in xyz city
- Unique treatment package besides surgery included
- All work done by medical doctor
- The unique "weekend option" for busy people

6.1.1.6 Write Down and Visualize Your Profile

The last step to define the desired profile is the textual and graphical implementation in the form of websites, brochures, and other advertising materials.

Many doctors offer lots of information on their websites or vice versa—some nice pictures and that's it. It is very difficult in practice to inform the potential customers on one hand as much as possible but also, on the other hand, to motivate them to make contact with the clinic. At this point it is very advisable not only to involve a graphic artist but also an experienced copywriter and web designer. Also, it must be pointed out that the responsibility for the content is always with the doctor and he should therefore very carefully examine what statements are made on his advertising materials. There is also a legal side to this matter, and only the one who keeps his promises has a secure position in case of a legal conflict.

There is a practical marketing model which we would like to introduce briefly.

6.1.1.7 AIDA Concept

Anyone who has some experience in the advertising and marketing world knows it: the AIDA formula. It is the best-known model for the advertising process and consists of four phases that a possible customer can go through and finally make him a buyer.

All phases are equally significant, but can overlap. Even if it belongs to the self-evident repertoire of every marketer, it makes sense to know and follow it, as many marketing professionals get really lost on their way to create materials fulfilling this need.

AIDA stands for *A*ttention, *I*nterest, *D*esire, and *A*ction.

Attention

The attention of the potential customer has to be gained; he has to start looking and reading. This may be an attractive graphic element or an interesting slogan, just to keep the patient with you. Caution: Getting attention at any cost may become dangerous, especially if this is distracted or even contradicted by the service of the clinic. For example: A red Ferrari as a motif may be very striking and could be related to success and attractiveness, but it can also easily enter into a negative interpretation of "asocial" and "very expensive."

Interest

Now the special interest of the customer has to be addressed. It's very important to tell very early that something special is available. Typically it's the headline of a brochure or advertisement which should lead the reader to further looking inside the offer.

Fig. 6.1 The AIDA concepts leads the viewer to a concrete action

Desire
More and more details should be explained. The desire for the product or service has to grow; there should be clear reasons why this offer is good and interesting. Clear and pragmatic and not too long and too many!

Action
The customer should be led to act himself. Famous and simple slogans like "Call us now" are there to make this step easier (Fig. 6.1).

As stated above, it is often very important to check the materials created by agencies to see if they follow these but very effective sequence:

1. Is my advertising attractive and unusual, so the customers look at it?
2. Does it clearly state what is offered?
3. Are there clearly recognizable advantages that lead to a contact?
4. Is there a simple and easy-to-recognize option for the patient to contact the clinic?

6.1.2 Communication Framework in the Clinic

6.1.2.1 The Nonmedical Workflow

Operations, techniques, and patient examinations form the everyday life of a doctor. However, when you are responsible for the organization of a clinic, there are a number of important organizational issues that need to be clarified and transparent.

Patients and their inquiries need to be answered quickly and correctly, just as patients and customers have to find their way to the clinic and their contacts easily.

Everything is simple in a small office, but the more the number of patients and employees grows, the more it is important to ensure a smooth flow of the patient and clear responsibilities within the staff.

6.1.2.2 Clinic (Location, Size)

It is not the place here to discuss the medical needs or the details of a hair clinic. However, some points are very important, which are self-evident among experienced physicians, but are often neglected as part of a new foundation:

Good accessibility by public transport, especially if the clinic is located in a major city and/or there are no suitable parking facilities nearby.

The clinic must reflect the desired profile; e.g., those who offer a high-price treatment should also provide a sufficient budget for the clinic facilities.

Restrooms and toilets for patients and staff contribute to the image of the clinic as well as the doctors and the operations rooms.

Proper labeling from outside helps to avoid confused visitors and also helps to strengthen your brand.

6.1.2.3 Consultations: Doctor or Hair Consultant?

One of the most important points that must be carefully considered is the question of who is communicating with the patient and how.

While in smaller clinics it is often the task of the doctor, this quickly causes problems: the doctor must consider whether he is devoting his time to the actual hair transplant, the control and training of his staff, his own training, or his daily communication with the patients.

The physician very quickly reaches his personal limits, so in the vast majority of the clinics essential parts of the communication are provided by permanent employees or freelancers of the clinic. A full new profession has developed here—unfortunately still very ill-defined—the "hair consultant."

It is a very wide field with many problems and questions to be considered. The basic question is the exact definition of the job profile. One can try to define the tasks more precisely here.

Assume only the purely technical processing according to the respective specific details of the physician (comparable to a secretary).

Assume the processing of routine requests; in case of special questions, then consult the doctor.

Extensive independent acquisition of customers; the doctor usually receives the patient only on the day of the operation. This model is usually found in foreign representatives who operate here as economically independent companies.

It must be noted very critically that in particular the last model can entail massive economic and ethical problems. The responsibility for the operation lies, after all, with the treating physician. If the consultant has failed to recognize a problem which necessitates major deviations from the planned and promised procedure, then one may expect conflicts with the patient.

From a medical standpoint, one can only make the clear recommendation that the surgeon must obtain a thorough patient history before agreeing to perform an operation and promising certain options.

6.1.2.4 Online Recruiting and Data Management

The technical processing of patient inquiries appears very simple at first glance: Forms on the websites are easily created, and the Internet transports the messages quickly to all parts of the world. Nevertheless, every doctor should be very specific about the processing of such inquiries:

- The number of inquiries is much higher than the actual number of patients, because the ease of electronic communication encourages the patient to make the same request to a larger number of clinics.
- The data volume with images is considerable, even if technically today the hard disks on computers are more than sufficient; retrievability and traceability of the communication must be guaranteed. Changing e-mail addresses, different computers or devices for responding to inquiries, and different languages – there are many reasons why you can have difficulties in documenting all discussions with a single patient later.
- Security of data transmission: a secure and encrypted transmission of the data is still technically problematic today, especially if emails are to be processed with different terminals.
- Data backup: here again the problem arises that with changing processing devices (as, e.g., the mobile phone), a complete data backup of the communication with the patient is not so easy to realize.

In addition to the technical question, there is also an organizational problem: inquiries must be answered quickly and at the same time correctly from a professional standpoint, so that there are no discussions with patients about medical or financial questions afterward.

Especially for the doctor who spends a large part of the day in the operating room, this can be a considerable problem if he handles these requests personally in his remaining time. Conversely, an answer by employees with insufficient knowledge is also a possible problem factor in patient relationships.

6.1.2.5 Website, Promotion, and Patient Information Material

In today's world, the website has become the central information place of a clinic and its doctor. A variety of agencies allow professional websites at manageable cost. Again, it must be pointed out here that the medical and legal responsibility for the content always lies with the doctor who should be very well aware of the relevant legal regulations regarding such advertising.

A review by an experienced lawyer for medical Internet advertising is hardly a waste of money but nowadays a sensible investment in legal security. In many countries there are very restrictive regulations, in terms of both medicine and competition law.

For the design of the site, please refer to the comments already made on the marketing strategy, because the website must fit the doctor and his direction.

But one point should be considered in addition: As many webpages look brilliant on the large screen of an advertising agency, it must be taken into consideration that today a significant and increasing number of patients just use the small smartphone to surf on the Internet. It is therefore important to ensure that a so-called responsive design also gives these users the possibility to navigate quickly and safely on the page and, above all, to make appropriate inquiries.

6.1.2.6 Patient Manager

The more a clinic relies on patients from a greater distance, the more important is the care of these patients and customers on site. This has of course also to be seen in the context of the accessibility. A clinic located in the immediate vicinity of a center and/or a central railway station is certainly in a different situation than in a secluded location far away from public transportation.

If patients come from abroad and do not speak the local language, it becomes increasingly important to ensure safe, comfortable, and reliable transportation. This is also in the interest of the clinic, because relaxed patients arriving punctually at the clinic and in the operation create far fewer problems than if there are delays and problems.

Particularly in countries with low wage levels, most of the hair clinics have special staff responsible for the care of the patients on site. In addition to the arrival, this may also include accommodation, food, entertainment, and the simple organization of punctually keeping a medical appointment in the clinic.

These patients should have good language skills in the visitors' languages and have a friendly and balanced personality.

In countries with high personnel costs, it will often not be possible to hire in-house employees for this task. It is very important, however, that the website contains accurate and easily understood information on travel, accommodation, and contact possibilities so that fast and secure communication is possible in case of a problem.

6.1.2.7 Aftercare

Few patients will leave the clinic without advice. And in fact it is crucial that the patient is acutely aware of the behavioral rules for dealing with his sensitive new hair. Another important point is subsequent hair care. Here the advice of the individual clinics differs. Many hospitals also provide the patient with a care kit, so that he does not have to procure corresponding products at home.

Most doctors also know that they should not rely on the spoken word but also provide written instructions. And yet, if the patient is at home, there are still many questions that occupy him. Partially afraid of losing his new hair, but also stressed by returning to the daily workplace, he is faced with questions which require prompt answers from the doctor or an experienced consultant.

There are clinics that have special staff after the operation day in order to explain skin care and behavior in detail. This is certainly an ideal situation, which cannot

always be achieved for personal but also time reasons. That is why it is important that there are contact persons who are also available to the patient in the short term.

6.1.3 Promotion in Forums and Media

The patients have a choice nowadays, so to be successful a clinic requires active promotion and information for the public. In order to choose the best way, the careful analysis of your own strengths and the positioning or marketing strategy is an indispensable foundation. Particularly with regard to the selection of specific media, some guidelines are given here. Whoever is targeting a specific language group will have to deal with the media of the language in question.

Many doctors now find their patients on the Internet. Millions of websites also mean millions of ways to find and contact patients or customers. The range of possibilities is very wide, it is only important to point out very important communication and distribution channels:

- Video (e.g., YouTube)
- Forums
- Online ads (e.g., Google AdSense)
- SEO (search engine optimization)
- Social media (Facebook, Twitter, Instagram, etc.)

As diverse as these media are, just as varied are the advertising possibilities in detail. The doctor or the clinic will hardly manage most of these channels without the advice and the activity of a special agency, which is familiar with these media and presents the clinic accordingly.

It must also be clearly stated that it is hardly helpful to utilize all of these at the same time. It is far more sensible to test individual opportunities and gain experience in a step-by-step manner, especially since the marketing investments in these advertising channels can be very high in some cases and in many cases do not lead to convincing results.

However, we will deal with a very specific path, the forums on the topic of hair transplantation, in a very detailed way, since this is absolutely essential for the largest number of clinics.

6.1.3.1 Classic Media

In view of a typical age group of 20–45 years for hair transplant patients, the classic media like newspapers, radio, and TV have to be judged with care, as many of the probable patients do not use these types of media anymore. But this also depends greatly on social status and educational background.

As these types of media are usually pretty expensive to use (including cost for design), a very careful analysis of possible target groups has to be done. It may be more interesting in the case of a local reference (regional marketing) or very specific target groups (e.g., special languages).

Radio is an unusual communication channel, but there is the well-known radio project in the USA with a new sidekick in the UK "The Bald Truth" by Spencer David Kobren (http://www.thebaldtruth.com/).

On the other hand, reports of beauty operations are much more often found in television broadcasts, and of these, hair transplants are not excluded.

However, all of these media will require a specialized agency with the appropriate experience and background.

In recent years the new media and the many possibilities of the Internet have opened new means of communication.

6.1.3.2 Forums and Their Special Role in Dialog

Forums: Innovation of the Internet

With the expansion of the Internet, the hair loss victims encountered a previously unknown form of communication. With the development of suitable software for the exchange of discussions in connection with the possibility of anonymous participation, it became possible to use the Internet as a platform for the exchange of opinions regarding their own questions, fears, and worries about hair loss.

As a result, the Internet launched an absolutely novel and revolutionary communication on the topic of hair loss, since it was never before possible for those concerned to exchange information on one another in anonymous form and even on an international level.

Through the linking of pictures, reports of personal experience, and discussion contributions, the forums became the central contact point for all questions concerning the topic of hair loss. Many thousands of visitors per day are usual for the big forums, with the most rapidly growing segment currently being the topic of hair transplantation.

The focus of the forums might cover hair loss in general, and the share of hair transplant surgery may vary to a large extent.

6.1.3.3 The Forum Users

The forum users take part in the possibilities of the forum for various reasons and motivations. In terms of content, the discussed questions are divided into:

Personal reports: here the user reports on their own situation and possibly their own experiences after treatment—the individual experience and the individual person are in the foreground. Through pictures it is possible for other participants to see, understand, and take part in the concrete situation of the person concerned.

Technical questions: here are concrete questions, e.g.: "Where can I get the product x?", "How can I treat my hair after surgery?," etc.

Exchange of experience: everyone can participate in discussions about products and suppliers and express their opinions. This can be done with or without personal concern, as a suggestion or as a criticism.

The following motivations lead people to participate actively in the forum.

The patients with personal interests are the following:

- Patients who could not yet find the courage to contact a doctor. This demands a great deal of fortitude of sufferers and is often associated with personal shame and anxiety.
- Affected persons who are new to the topic of hair loss and are looking for information and solutions for their personal problem.
- Formerly affected persons, who are present with tips or moral support for other affected persons.
- Patients who are not adequately perceived, understood, or advised by their doctor and therefore have the need for communication and communication on hair loss.
- Patients who have already been treated and are looking for additional advice for the postoperative phase or a second opinion on hedging. In some cases, they have only experienced inadequate advice from their treating physician, or they are looking for an exchange and comparison with other affected persons and ask questions such as "Is it normal for me to lose all hair a few weeks after the hair transplant?"
- Patients who are not satisfied with their results after a hair transplant. They use the forum as a valve to communicate their disappointment, dismantle frustration, and possibly also announce their displeasure over the doctor.
- Patients who would like to share their joy about a successful hair transplant and encourage others to do so. They share their satisfaction with a treatment, physician, or medication, thus encouraging other users to go similar or same steps. Sometimes the treating physicians have also requested the patient to make such communication or treatment documentation to act as a positive example.
- Patients who have already had multiple hair transplants and are described as "exfoliated" and rejected by many doctors. These patients have often not been adequately advised by their doctors about alternative treatment methods and are desperately looking for further solutions.

In the forum, they collect information and learn about therapeutic approaches which are not quite as common, for example, body hair transplant.

6.1.3.4 Commercial Users and Usage

Doctors or clinics who provide information about their treatments in the form of contributions. Either directly from their point of view as treating physicians or through consultation with a patient who describes his successful treatment from his perspective and reports practically on the treatment of the physician. The forum acts like a multiplier, which can ensure a fast-growing awareness level.

Doctors or clinics who advertise their services using banners and advertisements.

Hair consultants who draw attention to themselves through editorial contributions and advertising in order to advise potential patients about their choice of doctors and clinics and to mediate accordingly.

In addition, experts from the field who provide comprehensive information on studies, scientific background, and current and also international developments.

6.1.3.5 Managing a Forum

The forum moderators monitor the discussions, exercise a control function, and are also a kind of conciliation body and are usually recruited from the circle of users. Whereas a forum was originally a rather free area, there are now clear legal considerations that must be respected. The moderators check the contributions in terms of content and objectivity, issue warnings in the event of a breach of rules, and possibly resolve conflicts between the participants in the forum. They are able to delete posts and to ban users from the forum in case of repeated and/or severe problems.

Meanwhile, many physicians are also aware that online contributions to the forum can have a significant impact on their personal reputation as doctors and their sales. In case of negative feedback, there is usually an immediate response from a lawyer on behalf of the clinic, which has to be handled carefully according to local regulations.

The multiplicity of the participants in the forum and their varied and often contrary opinions are both an opportunity and a risk because only if these different wishes and needs are fulfilled can a lively but constructive discussion emerge, allowing all parties to benefit from using the forum.

6.1.3.6 Small Number of Forums

Both nationally and internationally, particularly forums with a broadly established user base are the most attractive, which offer users a timely exchange of information and opinions. As a result, smaller forums have problems to defend themselves against already successful forums. Similar constellations can be observed in many countries but clearly divided by language. In most countries and languages, there are only one or two forums in which the people concerned exchange on the topic of hair loss and/or hair transplant online. In the European countries, these are mostly general hair loss forums, which also have a corresponding subgroup on hair transplantation. Only in the USA, "hairrestorationnetwork.com" is a provider that specializes almost exclusively in the field of hair transplantation.

Finding objective criteria about the importance of forums is not easy. As the different forums are privately operated, it is unfortunately not possible to report the exact number of visitors to the forums. However, the number of forum contributions is a fairly strong indicator of popularity of a forum. The following chart provides information on the estimated numbers of forum contributions on the subject of hair transplantation in some selected important countries of the Western world (Table 6.4).

6.1.3.7 Video Platforms

YouTube became the new "TV programs" for younger people, and in fact there is extensive coverage of all aspects of hair transplantation found there. Although there are many more similar platforms, there is a clear dominance of YouTube.

Table 6.4 Selected hair forums of western world and their coverage of hair transplant surgery

Forum/country	Estim. posts hair transplant (June 2017)	Other hair loss topics	Remarks
English language			
USA			
http://www.hairrestorationnetwork.com/	400,000	35,000	
http://www.baldtruthtalk.com/	30,000	200,000	
http://www.hairlosstalk.com/	28,000	810,000	
http://www.hairlosshelp.com/forums/	20,000	90,000	
http://www.hairsite.com/	40,000	80,000	Forum software switch in 2016
http://www.heralopecia.com/	800	242,000	Hair transplant in women is an absolute niche!
UK			
http://www.hairlossexperiences.com/	35,000	10,000	
Other languages			
France			
http://www.international-hairlossforum.com/	67,000	36,000	
Germany (Austria, Suisse)			
https://www.alopezie.de	125,000	450,000	
Greece			
http://www.hairlossgr.com/	47,000	130,000	
Italy			
http://bellicapelli.forumfree.it/	235,000	130,000	
http://forum.salusmaster.com/	35,000	475,000	
Netherlands			
http://www.haarweb.nl/	56,000	340,000	
Spain			
http://foro.recuperarelpelo.com/	144,000	370,000	

It is especially the place for many younger people to find out about hair transplantation. However, it must also be made clear that the contributions often have a questionable character. This is based on some dangerous practices:

YouTube does not conduct any content control of the published videos.

YouTube allows anonymous videos and does not require any proof of whether commercial interests are represented here.

As a consequence, there are a large number of publications sponsored by hospitals. However, it must also be stated very critically that the quality of these contributions often has a deterrent effect.

Having one's own YouTube channel is certainly an interesting marketing tool but also requires corresponding consistent preparation and ongoing updating of the contributions.

It is also very difficult to reach a successful position in the hair transplant section and to achieve a sufficient number of visitors. Here, as on the rest of the Internet, certain marketing measures are necessary to optimize the position, requiring a dedicated specialist.

6.1.3.8 Social Media

Facebook, Twitter, Instagram, Pinterest, etc. have had a big impact on Internet communication. Despite this it should be noted that social networks are less important in terms of hair loss. The desired anonymity is not present here, and it is easy to understand that the personal hair problem is omitted from most self-presentations on social networks, usually trying to show the nice side of the people involved.

It may still be helpful to build some kind of presence here comparable to a website, as the number of people who do use these channels is growing.

Especially with regard to Facebook, it may be worthwhile to keep in touch with existing patients and to build new contacts via the existing connections.

6.1.3.9 Online Advertising

Who does not know it—the ads on Google. The company runs a very professional advertising business, and in every country, there are a large number of clinics that are present here with advertising.

Conceptually, the idea is awesome: someone who is looking for the term "hair transplant" on the Internet is most likely a candidate for it and will be interested in offers. And, indeed, a large number of contacts can be generated via corresponding online advertisements.

Customers of Google have the possibility of running several keyword concepts as well as different advertisements, in order to be able to control the display circuit very precisely.

However, the problem lies in the rather high price: Google is paid by every contact (click) by a price which is determined in a kind of auction.

In the field of hair transplantation, there are a large number of clinics, and accordingly, prices are also comparatively high. And there are already some points that make at least a careful review of efficiency important:

- It is known that manipulations (click fraud) occur repeatedly on Google. The temptation to build up a simple page and generate corresponding clicks and visitors and income through a network of friends or through automated systems is high. Even if Google intensively combats this fraud method, it cannot be completely ruled out.
- The interested customer will, of course, look at a wide range of pages. To what extent he really makes at least one specific inquiry is a very different matter. There are systems that provide very accurate information about this and should be implemented when working with Google.
- Interesting headings bring more visitors but not necessarily more customers. It is therefore important to ensure that there is a link between the ad and a real request by checking the relevant queries.

Of course the Internet does not just consist of the search engine Google, and there are numerous ways to build advertising campaigns. Nevertheless, one should be aware that only a relatively small part of the population is interested in a hair transplant. This makes it very difficult to use general Internet offers since at least 95% of the users are not interested in this topic at all.

In addition to Google, there are also other interesting advertising networks that offer certain optimization options. Appropriate professional advice is, however, essential, as otherwise valuable investments in advertisements quickly become wasted.

6.1.3.10 Search Engine Optimization

The high cost of advertising with Google has led many people to improve their position in the search results instead. The so-called search engine optimization (SEO) usually focuses on the respective leading search engine (Google worldwide, but in some countries BING and other providers also have relevant market share).

Whoever uses the term "hair transplant" in a search box on Google will see a very specific result: it depends on the location of the searcher, his language, and his previous searches. Google has set itself the goal of providing each user with an individual optimization.

For example, a patient from New York will see the offer of clinics from this area with a certain priority. But there are more than 200 factors that ultimately determine the search result.

In addition to the geographic location, the page layout also plays a role as well as the content, which is carefully analyzed by Google.

An optimization for search engines therefore usually involves different work steps:

- An optimization of the page, in particular outline, text parts, pictures, and videos. This work is not only helpful for the position in the search engine but often also for the customer, if the information is clearly presented to him with suitable titles.
- Creation of interesting content which leads to other pages linking this content.
- Trying to get some valuable "backlinks" to the own website, being still one of the most important factors.

While website improvements are well accepted by Google as being legitimate, most methods of backlink building are now seen as fraud. However, a whole industry has developed here which tries to improve the position in the search engines by means of illegal methods. This creates the long-term danger that this can lead to complete deletion from search results.

Overall, the topic of search engine optimization is now a very complex matter and is not feasible without a specialized agency. The costs are now considerable; they are often in the four-digit range (euros or dollars) monthly. Control of the

activity is rarely possible, and if after many months of monthly payments still no success is seen, it leads to a great frustration.

There is also another significant risk that must be pointed out: if an agency has successfully achieved a placement, the customer ultimately depends on the agency. If he terminates the contract, he risks the agency reversing the measures taken and that success may be lost.

6.1.4 Conclusion and Outlook

More patients, better techniques, increasing number of doctors, and cheaper prices have built the basis for a very positive development in the number of hair transplants. While a decade ago the number of renowned of hair restoration surgeons was very small, an industry with a four-digit number of clinics in the world has since developed here.

So the individual doctor can and must also deal with how he can structure and build up his medical and business concept. There is unmistakably a trend toward specialization in certain customer groups, whether these are geographic, price-related, or related to the type of applied technologies. In order to successfully offer its services on the market, every clinic should have a clear idea of the offer and the advantages of acquiring new customers. It is very important in this context that, in cooperation with service providers (agencies and consultants), medical supervision is not lost, and thus no unrealistic hopes are created which later cannot be fulfilled by the doctor.

The Internet as a communication platform and especially the forums offer users a variety of services and benefits for the topic of hair loss, and the possibilities of these channels represent a revolution in medical communication. The widespread use of the Internet and the great interest in the subject can be interpreted as a continuing increasing importance.

Looking to the future, however, Internet operators will have to increasingly focus on quality assurance.

This includes on the one hand the assurance of the content quality of individual contributions. Unfortunately, some contributions to the discussion do not have any medical basis and lead to the dissemination of false and scientifically rejectable statements, which leads to false conclusions and possible follow-up therapy recommendations.

Currently it is a very problematic development that in many areas of the Internet, there is essentially no control over content, especially on YouTube. In the long run the question of liability must be clarified. Independently, every doctor must consider whether this is an appropriate environment for his presentation.

On the other hand, providing better information on techniques, treatments, and results offered may be an argument in favor of these channels. Quality assurance is in the fundamental interest of all patients.

6.2 Founding and Development of FUE Europe

As was described in Chap. 1, the new millennium brought with it a decisive technical breakthrough in hair transplantation. Techniques were becoming ever more refined and more efficient, and the time had come for FUE hair transplantation. New at the time, the FUE method was the first to allow direct extraction of individual follicular units. This wonderful possibility aroused my initial interest, an interest which later developed into an absolute passion for hair restoration surgery. I found this type of hair transplant so much more atraumatic, efficient, and sensible than the methods that had previously been used.

I wanted to share my fascination with the FUE method with other like-minded hair restoration surgeons. Eventually this led to Dr. Mentrup, Dr. Heitmann and myself founding FUE Europe. With the founding of FUE Europe, our vision was to bring together experienced specialists in order to create the best possible conditions for defining the highest international standards of quality and thus to ensure internationally the highest quality results for patients undergoing minimally invasive hair transplantation.

Together we have realized this vision. FUE Europe has since become the world's leading association of FUE specialists.

The European Organization of Hair Restoration Professionals (FUE Europe) is today an international, nongovernmental, nonprofit, nonpolitical organization pursuing the goal of defining and ensuring high international standards of quality for the minimally invasive FUE technique and providing competent professional consulting for persons affected by hair loss. Founded in 2010, the organization now has its headquarters in Zürich, Switzerland. FUE Europe's members are primarily physicians who perform hair transplants themselves using the FUE method and who are also interested in maintaining the highest, internationally recognized standards of quality.

Tissue preservation and the natural appearance of the result have top priority in their work. This necessitates a high level of ability and many years of experience on the part of the attending physician.

At the European Organization of Hair Restoration Professionals (FUE Europe), the members made it their goal to contribute to the education and improvement of each and every medical professional that desires to be active in the field of hair transplantation as well as noninvasive techniques. Besides this, their dedicated staff is working toward educating the public and raising awareness among prospects that desire to invest in high-quality, long-lasting results.

6.2.1 Tasks and Goals of FUE Europe

Hair transplantation has become a very effective option for covering the consequences of hair loss. In particular, new techniques such as follicular unit extraction provide the patient with the benefit of the elimination of the linear scar in the donor area. FUE is becoming a widely used standard procedure in hair transplantation.

The goal of FUE Europe is to bring science and practice to one table in order to eventually develop practical solutions based on scientific data and facts. The organization aims to achieve these purposes by organizing annual meetings, additional meetings and seminars, and education programs and events and by publishing printed materials.

New emerging techniques related to FUE raise interesting new questions. Therefore FUE Europe as professional organization aims to:

- Collect, exchange, and supply information about innovative treatments of hair loss and the method of hair transplantation especially
- Exchange and diffuse expertise of methods, possibilities, and opportunities of treatments of hair loss in general with a special focus on FUE hair transplant technology between professionals and for patients
- Advance the knowledge in the scientific disciplines relating to the methods and physiology of hair growth and hair transplantation by conducting its own research, supporting third parties' activities and exchanging findings with other scientists
- Supply services, products, and support to professionals and patients
- Act as a cooperation platform for registered members
- Act as a policy maker for the benefit and in the interest of professionals and patients

6.2.2 Membership

Specialists in research, university, hospitals, and practice are welcome to participate with their academic experience in the hair follicle research and their clinical experience in this working group.

The specialization in Europe as a region should make it possible to establish a regular and close communication among members. Short distances and a pragmatic approach are important to us.

Both licensed MDs and surgical staff such as technicians and assistants may register and become FUE Europe professional members.

On behalf of the Board of the European Organization of Hair Restoration Professionals (FUE Europe), we would like to welcome you in joining and supporting their mission.

For registrations and further details, please visit www.fue-europe.org or contact us by email: office@fue-europe.org

FUE EUROPE - IT´S YOUR ORGANISATION

FUE EUROPE

At the European Organization of Hair Restoration Professionals - FUE Europe, we made our goal to contribute to the education and improvement of each and every medical professional that desires to be active in field of hair transplant, as well as non-invasive techniques.

Besides this, our dedicated staff is working towards educating the public and raising awareness amongst prospects that desire to invest in high quality, long-lasting results.

On behalf of the Board of the European Organization of Hair Restoration Professionals - FUE Europe, we greet you all and we welcome you in joining and supporting our mission.

"Become member of a quickly growing family of professionals dedicated to deliver the highest quality in FUE "

www.fue-europe.org

Correction to: Further Aspects of Hair Transplantation

Correction to: Chapter 6 in: R. P. Azar, *FUE Hair Transplantation*, https://doi.org/10.1007/978-3-319-75901-2_6

This book was inadvertently published without Ludger Mentrup's name as one of the authors in Chapter 6. This has now been amended throughout the book mentioning Ludger Mentrup as a co-author in chapter 6.

The updated online version of the chapter can be found at https://doi.org/10.1007/978-3-319-75901-2_6

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