



Specific Attention Areas in Scar Management: Specific Scar Management Depending on Anatomical Features (Face, Hair, Breast, Hand, Joints, Foot)

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Background

Scarring can have a variety of different detrimental effects on the affected patients. While small scars are often little more than an aesthetically displeasing blemish, scarring has the potential to drastically affect patients' lives.

Ultimately, not only the scar type but also the dimension of the affected areas and their location play a large role regarding the impairments they might cause.

Different aspects come into play when certain areas of the body are affected by severe scarring, and they should be taken into consideration when planning the treatment.

Severe facial scarring causes a multitude of issues. It is incredibly stigmatizing for affected patients and will likely cause significant psychological suffering. This oftentimes has detrimental effects on the patients' social life leading to isolation and thus further psychological problems. Facial scarring can have a variety of functional impairments, too. It can cause impaired closure of the eyelids leading to lagophthalmos or leading to ectropium or entropium, all of which can endanger the patients' vision and result in pain and unease.

Microstomia is another common consequence of facial scarring, leading to a reduction of the mouth opening, thus greatly impairing the intake of food and beverages as well as hindering speech or oral hygiene all the while causing significant discomfort.

On the head, scarring can lead to hair loss or cicatricial alopecia which, while problematic in men, too, can be downright devastating in women, where hair loss and baldness remain stigmatizing.

The chest is another aesthetically important area where scarring can lead to a significant psychosocial burden, especially in women.

While scarring of the hands can be aesthetically displeasing, too, its most problematic consequence is the functional impairment it can cause. Especially in burn patients, the functional consequences of the scarring can be so severe that not only the patients' ability to work but to maintain their self-reliance throughout their daily lives is also at risk. Even with immediate physiotherapy and occupational therapy after surgical treatment, functional impairments often remain and are exacerbated by the incipient process of scarring thus leading to a lasting need for further treatment.

Similar problems arise with scarring on the feet. Since walking around throughout the day places a great load on the scars which are often less durable than healthy skin, instable scarring is a common prob-

lem around the feet. Scars can lead to deformities of the toes, too, like mallet, hammer, or claw toes which can lead to progressive joint damage and painful clawing.

In general, scarring around functionally important areas of the body like the hands, feet, and joints can cause dire impairments throughout the demands of the patient's everyday life. Problematically, if left untreated, joint damage, a permanent reduction of one's range of movement, and thus progressive worsening of the patient's condition long after the initial trauma are potential consequences.

Therefore, physicians need to make sure that their proposed treatment not only improves the scarring but that it is also suitable to reduce the risk of secondary damage.

In this chapter, we aim to provide an overview of therapeutical options for the treatment of scarring in different anatomical localizations.

42.1 Scar Treatment Options for Different Anatomical Localizations

42.1.1 Face

When planning treatment for facial scars, physicians need to take all the aspects of the scarring into consideration. If functional impairments like impaired opening or closure of the eyes and mouth are present, the initiation and success of suitable therapeutic options are required more promptly than it would be with merely aesthetic impairments so that permanent damage beyond the scarring itself can be avoided.

If swift therapeutic success is required, surgical intervention remains the gold standard. Common indications for surgical intervention in facial scarring include microstomia, which is often the result of facial burns, acid attacks, or the ingestion of caustic fluids. It hinders sustenance and oral hygiene and impairs speech. Techniques for commissuroplasty to widen the oral opening through the advancement of mucosal flaps after scar excision have been published as early as 1831 by Dieffenbach and have since been modified and refined by Converse in 1959, Friedlander in 1974, and others (■ Fig. 42.1). Often, commissuroplasty is aided postoperatively by splinting to avoid fresh scar contractures.

Lagophthalmos is another indication for swift surgical intervention. It, too, is often caused by thermal or chemical injuries. If left untreated, corneal ulcers, infections, and pain are common ailments associated with this affliction, and permanent damage to the patient's vision is a large risk.



Fig. 42.1 A 7-year-old child with severe microstomia due to burn scarring. Scar revision was performed with bilateral commissuroplasty (Converse plasty). Images were taken before **a**,

intraoperatively **b**, and 4 weeks after surgery **c**. As a result of the surgery, the teeth are visible again, when the mouth is opened, thus facilitating dental hygiene

Ensuring sufficient closure of the eye is therefore a priority. Consulting an ophthalmologist is important in determining if surgical intervention is necessary and when it is best performed as well as to assess the extent to which reconstructive surgery is necessary.

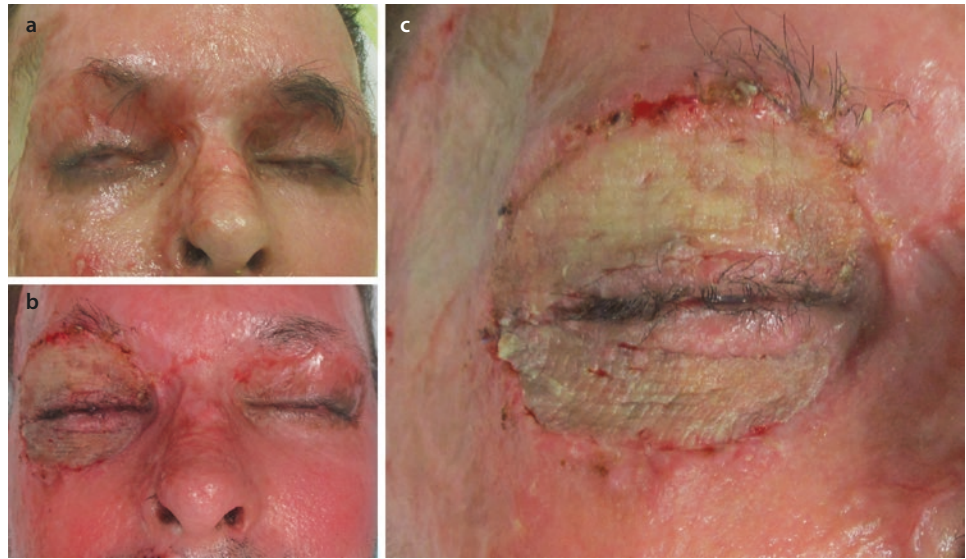
A variety of treatment options exist for the reconstruction of the eyelids. Where full-thickness defects that affect both the anterior and posterior lamella of the eyelids can require complex reconstructions based on local flaps, oftentimes, only the anterior lamella is affected. Here, reconstruction with full-thickness skin grafts remains the standard (■ Fig. 42.2). In lower eyelid reconstruction, lateral canthopexy is routinely performed to avoid sagging of the lateral corner of the eye, thus leading to ectropion. This technique often results in good function and cosmesis.

Lasers, too, play a vital role in the treatment of facial scarring. Ablative laser treatment has been used for years to treat atrophic acne scars and has proven reliable and effective. Since the advent of fractional lasers, side effects and after-treatment downtimes have been reduced significantly while maintaining a good treatment efficacy. In the treatment of acne scars, the fractional CO₂

laser has proven more effective than its Er:YAG counterpart [1]. Through the radiance of heat into the surrounding tissue, the CO₂ laser stimulates heat shock proteins which trigger a cascade of molecular pathways leading to increased levels of scar remodeling factors like transforming growth factor beta 3 (TGF-β3) and matrix metalloproteases. Since treatment with the Er:YAG laser results in almost no heat transfer to the surrounding tissue, those effects are less pronounced.

Widespread hypertrophic scarring as the result of burns, scalds, or chemical agents is becoming a frequent indication for the use of fractional ablative lasers, too. Through its ability to penetrate deep into the scar tissue to stimulate remodeling within the deep dermis all the while being an effective tool for superficial ablation of the irregular, ropelike and tuberosc scars that often result from the aforementioned trauma, the CO₂ laser has become an oft-used and reliable tool for facial scar revision. While studies have shown significant improvement of scar texture and firmness after just one session [2], commonly, repeated treatments are necessary to achieve satisfactory results. Furthermore, the scar remodeling stimulated through the treatment continues

Fig. 42.2 A patient with pronounced facial scarring and lagophthalmos after sustaining burn injuries. Recurring conjunctivitis and a corneal ulcer led to the indication for surgical revision of the lagophthalmos. The scars were released, and the anterior lamella of the upper and lower eyelid were reconstructed using a full-thickness skin graft from the upper arm of the patient. Image **a** shows the preoperative site, while **b** and **c** show the postoperative results where full closure of the eyelids can be achieved



for months so that final results can only be expected after 6–9 months. Thus, while able to loosen contractures and greatly improve facial scarring, other tools should be chosen where immediate scar relief is required.

Medical needling is another option that aims to improve scarring through percutaneous collagen induction. It has been shown to significantly improve acne and burn scars in connection with a low-risk profile and minimal side effects [3]. Satisfactory scar treatment, however, often requires multiple sessions, and thus far, clinical studies have often relied solely on subjective means of evaluation thus leading to a continued demand for evidence.

Ultimately, it seems best to combine different therapeutic paths. While surgical intervention is paramount for the treatment of severe functional impairments, it is rarely able to improve pliability and texture of scars thus normalizing the look and feel of scarred skin. Here, the combination of surgical intervention with fractional ablative laser treatment might provide a more holistic approach to the treatment of severe facial scarring resulting in improved overall results and lasting patient comfort and satisfaction.

42.1.2 Hair

Scarring in areas of hairy skin will often result in hair loss. This is particularly problematic in widespread scarring. While small scars can easily be excised even on the immobile parts of the scalp, larger scars resulting in pronounced hair loss are often difficult to treat.

On the scalp, the scarred, hairless tissue is excised and replaced by healthy surrounding skin. Ideally, local flaps from the scalp can cover the wound defect after excision; sometimes though, pre-expansion through

skin expanders is necessary to provide the required tissue. Side effects of this course of treatment are frequent and include expander malfunction, infection, and dehiscence or “breaking” of the skin over the expanders. If successful, however, the scarred tissue can be excised completely, and permanent hair loss of the scarred areas can be revised.

If neither local flaps, skin grafting, nor tissue expansion are an option after scar excision, free-flap reconstruction can be considered. Here, fasciocutaneous flaps should be considered since the healthy skin architecture seems preferable for receiving a hair transplant as opposed to muscle flaps that have been covered with split-thickness skin grafts. After successful reconstruction and consolidation, fasciocutaneous flaps can easily be thinned to provide a natural contour and integrate well into the surrounding tissue, and consequently, hair transplantation can be attempted to restore a natural appearance. Hair transplantation can also be performed on scars or skin grafts; however, this will require both sufficient thickness of the subcutaneous tissue and adequate tissue perfusion so that the hair grafts are likely to take.

Hair transplantation is the standard therapy for alopecia of the eyebrows or eyelashes, too. While surgical techniques for reconstruction of the eyebrows are available, too, local flaps or composite grafts from the scalp will look different than natural eyebrows. Furthermore, in composite grafts, less so in pedicled flaps, the risk of reduced perfusion might lead to renewed hair loss, thus compromising results. Overall, for this indication, hair transplantation might lead to more natural results.

If hair transplantation is considered, patients should be aware that multiple sessions are required to achieve a satisfactory hair density. Furthermore, it is paramount that sufficient donor sites are available [4].

42.1.3 Hands

Normalizing function in scarred hands is paramount to avoid lasting impairments. Scarring of the hands is common in burns and scalds and often leads to widespread scarring, either through the trauma itself or through the resultant surgical treatment and skin grafting. Oftentimes such scarring will lead to contractures of the web spaces, thus greatly affecting thumb or finger abduction and diminishing grip strength. Closure of the fist is commonly impaired, too, as contractures of the dorsum of the hand and fingers inhibit full flexion.

Such problems are often addressed surgically to allow for swift improvement of the functional impairments and to allow for early mobilization through physiotherapy and occupational therapy.

Loosening of contractures of the web spaces has been described through many different techniques such as single or multiple Z-plasty, butterfly, or jumping man flaps as described by Shaw or Trident flap plasty according to Glicenstein or Hirshowitz (■ Fig. 42.3). Many other techniques have been described as well, but their common goal is to loosen the contracted linear scar and deepen the affected web space.

It is important when planning web space scar revision that adjacent web spaces are never treated at the same time, to avoid perfusion problems to the finger in between, should one of the neurovascular bundles get damaged during surgery. Therefore, when planning to operate on multiple web spaces on one hand, pairings of web space 1 and 3, 2 and 4, or 1 and 4 are possible, while other combinations should be avoided.

Postoperative regimens vary, but commonly, load-free assisted exercising can be started shortly after surgery. Ideally, compression gloves with silicone spreaders

for the affected web spaces are prescribed for overnight use for a year after surgery.

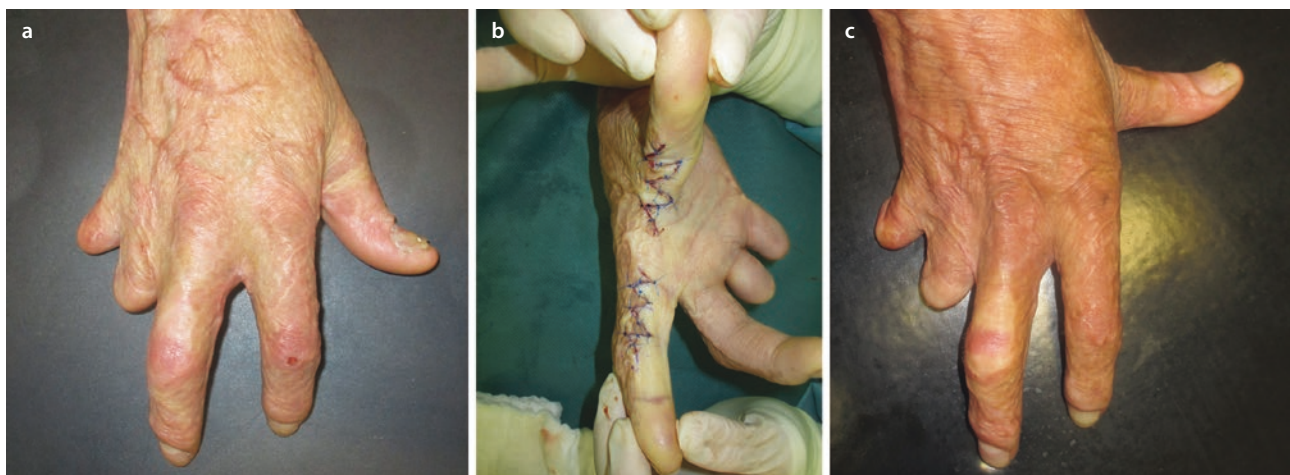
Volar flexion contractures are often treated through multiple Z-pasties, thus lengthening the scar and resolving the contracture.

Especially in widespread dorsal contractures, treatment remains difficult. Ensuring full closure of the fist is central to ensure good hand function; however, scarring is often rigid and restrictive.

To ameliorate these impairments, different techniques should be considered. One option is to replace the scarred tissue. After scar resection, full-thickness skin grafts or dermal substitutes like Integra® in combination with split-thickness skin grafts can be used to create a thicker, more flexible, and pliable skin in commonly stressed areas like the dorsum of the hand. Studies have shown that this might lead to improved pliability and functional results, both in acute and secondary burn reconstruction [5]. This, however, requires adequate coverage of functional structures like neurovascular bundles or tendons so that the grafts will take reliably. Otherwise, local or more likely free-flap coverage will be required. That course of action will, however, likely lead to multiple surgical revisions as flaps are often bulky and require subsequent thinning and contouring.

Laser therapy should be considered when improving the skin quality and rigidity is required. Fractional ablative CO₂ laser treatment has proven effective in releasing contractures and improving scar firmness, and different authors have described swift improvements in range of motion and scar quality in patients with burned hands [6, 7].

After scar revision on the hands, dedicated hand therapy is imperative to achieve lasting improvements regarding hand function and strength. After severe



■ Fig. 42.3 A patient with severe impairment of the abduction of the thumb following burn injuries to the right hand with consecutive scarring of the first web space **a**. After double opposing Z-plasty in

the first web space and serial Z-plasty along the radial side of the index finger **b**, abduction of the thumb is drastically improved **c**

trauma and scarring, patients often require months of therapy to reach satisfactory results and to enable self-reliance throughout their daily lives.

The ideal time for scar revision should be carefully weighed, too. Especially in the pediatric patient population, where scar contractures might inhibit physical and functional development, timely intervention is indicated to avoid lasting damages that can be hard or even impossible to reverse.

In general, if possible, the conservative treatment of scarring through compression gloves, silicone finger spreaders, and hand-therapy should be exhausted, especially throughout the phase of scar maturation to avoid unnecessary surgery or even exacerbation of the scarring through stimulation of the scarring process.

42.1.4 Feet

Severe scarring of the feet can lead to a variety of problems for the affected patients. Common causes of scarring located on the feet include burns and scalds but also complex physical trauma.

Oftentimes such injuries cause contractures of the toes that will lead to painful malposition and toe deformities that can greatly impair walking.

Unstable scarring around the feet is a frequent problem, too, and chronic wounds and tears open under the daily stress those scars are exposed to.

These common problems result in a high urgency for scar therapy regarding the feet. The goal is to provide stable skin that is flexible and resistant to the daily strain the feet are exposed to.

Scars resulting from burns or scalds are commonly located on the dorsum of the foot, and resultant contractures of the toes can often be released through excision and Z-plasty or other local flaps, not unlike contractures on the dorsum of the hand. Similarly, though, more severe scarring or unstable scars might require excision of larger scarred areas and then skin grafts or a combination of a dermal substitute (like Integra® or Matriderm®) and skin grafts. Full-thickness scars that require excision onto the extensor tendons might even require free flaps for successful defect reconstruction.

Severely contracted joints might require capsulotomy for release, and sometimes, temporary Kirschner wire transfixation is indicated to achieve lasting rehabilitation of the affected joints [8].

The data on laser treatment for severe scarring of the feet is scarce. In light of the capabilities of fractional ablative lasers, however, it seems prudent to consider this line of therapy as an adjunct in more severe cases or

as a primary therapy option in mild to moderate cases where its capabilities to loosen contractures and to soften the scarred skin might yield promising results or at least ease subsequent surgery.

Complications of surgery around the foot include hyperkeratosis, which is especially common around the load-bearing areas like the heel or the ball of the foot, where scarring can often result in this cumbersome problem, which is associated with significant pain, thus hindering walking and resulting in severe discomfort. Authors have noted that hyperkeratosis oftentimes forms protectively around a scarred area to minimize pressure on said area. Especially early on during the wound healing phase after local or free flaps to the heel or the sole of the foot, hyperkeratosis can often hinder the healing process by overgrowing the wound margins and thus inhibiting complete fusion of the wound margins. Therefore, after surgical treatment of the foot, medical foot care presents an important adjunct, not only to ensure patient comfort but also to facilitate wound healing and to minimize complications.

As with treating scarred hands, surgical or laser-based interventions should always go along with conservative means like compression garments, scar massages, and physiotherapy to optimize treatment results. This should be continued until the scar activity has subsided.

42.1.5 Joints

Scarring over joints can be particularly cumbersome to deal with. The constant tension that the healing tissue is exposed through the movement of the respective limb will encourage scar hypertrophy after trauma but also after scar revision. This should be taken into consideration when planning the treatment of scars that run over joints.

Plenty of treatment options are available, but ideally, a combination is chosen to avoid recidivism of problematic scarring.

Linear hypertrophic scarring can be released through Z-plasty or other comparable techniques relying on local flaps. While hypertrophic scars commonly show a great tendency for regress without treatment after an initial phase of growth activity and a consecutive constant phase so that invasive treatments are not considered a first-line treatment option, an exception can be made if hypertrophic scars are under constant tension.

As this stress can be considered a major cause of the scar hypertrophy, resolving it through surgery or fractional ablative laser treatment can result in

subsiding hypertrophy and symptoms thus constituting a causal therapy.

Supportive measures that should be considered to avoid renewed hypertrophy include intralesional triamcinolone acetonide or 5-fluorouracil injections, silicone gel or sheets, and pressure therapy.

Widespread scarring can be treated through serial excision. Here, the scar is excised in two to three consecutive operations every 3–4 months. This allows the remaining skin to stretch thus facilitating complete scar removal that would not have been possible in one single step. To avoid stretching of the scar, wound closure should be performed in a layered fashion. The subcutaneous and corium sutures should provide large tensile strength that remains over an extended period. Many studies, most recently by Gupta et al., have shown that superior scar appearance results can be achieved by using intradermal polydioxanone (PDS) sutures when compared to polyglactin 910 (Vicryl) sutures [9].

Alternatively like in other problematic areas, fractional ablative lasers have shown great potential to ameliorate scar contractures and should be considered a treatment option and be discussed with patients [10]. Successful treatment, however, will likely require repeated treatment sessions.

42.2 Conclusion

When treating pathological scarring, taking the anatomic location of the scar into account is imperative when choosing the right form of treatment.

Facial scarring can be extremely disfiguring and beyond the aesthetic implications often results in severe functional impairments like microstomia and lagophthalmos, among others. Treatment should be initiated quickly to avoid secondary damage to the affected organs. Commonly, surgical intervention remains the gold standard. Contractures are loosened through local flaps (e.g., Z-plasty), and skin defects after scar excision can be treated through split- or full-thickness skin grafting. Fractional laser treatment as an adjunct has become an important factor in improving facial scarring as they are able to improve scar firmness and smoothen their irregular surface. Similar effects are sought through the use of medical needling, though objective clinical data on its efficacy are largely lacking. Alopecia is a problem when scars affect the scalp. Often, the healthy skin is expanded through skin expanders

over several weeks so that the scar can then be excised with the expanded skin now covering the defect. However, such treatment is often difficult because of expander malfunction and infections. Other options include free-flap reconstruction after scar excision, followed by hair transplantation. Especially in hair loss of the eyebrows and lashes, hair transplantation remains the gold standard, and achieving a near natural result in the hands of an experienced surgeon is often possible. Scarring of the hands can result in the loss of self-reliance in affected patients. Oftentimes, the web spaces are contracted thus limiting abduction of the thumb or spreading of the fingers. This can be addressed through deepening of the web spaces, for example, through double opposing Z-plasty. Afterward, compression gloves with silicone spreaders are fitted to ensure permanence of the achieved results and to inhibit renewed contractures. If contractures on the dorsum of the hand inhibit closure of the fist, complex reconstructions can become necessary if larger areas of scarred tissues need to be replaced. Laser treatment can assist in improving scar quality. Overall, a combination of treatment options should be considered. Physiotherapy and occupational therapy as well as compression garment therapy should be included into the treatment algorithm to improve functional results and to inhibit renewed pathological scarring. On the feet, scars often lead to toe deformities which impair walking and make wearing regular shoes uncomfortable or impossible. Here, surgical intervention is indicated. Since the feet are exposed to a lot of strain throughout the day, scars are often unstable and repeatedly crack and tear, leading to chronic wounds and strong patient discomfort. Here, excision and skin replacement through skin grafts, often together with dermal substitutes or even free flap reconstruction, can become necessary.

Overall, it is important to remember that scarring is a multifaceted problem. Through their firmness and contraction, they cause functional problems, their irregular appearance and color can be aesthetically displeasing, and all of these effects can put an enormous strain on the quality of life of the affected patients. Treating such scarring, especially in exposed areas or where function is greatly impaired, should therefore address the complexity of this problem. This is oftentimes only possible by combining surgical, laser-based, and conservative treatment paradigms into an individual treatment plan for the affected patients. This ensures not only immediate but also long-term improvements and inhibits renewed scarring.

Take-Home Messages

- Common functional impairments after scarring of the face include microstomia and lagophthalmos that require swift surgical attention to avoid secondary damage to the affected organs.
- While surgery remains the standard for severe functionally impairing scars of the face, fractional lasers have become a staple in improving scar firmness and surface irregularities and should be used in combination with surgery to improve overall results.
- Hair loss in scarred areas can be addressed in a variety of ways. Expanding healthy, surrounding tissue can help create enough tissue so that the scar can be excised in its entirety and the resultant defect can be covered with the expanded skin.
- If this is not possible, the scarred tissue can be replaced by fasciocutaneous free flaps, and these flaps can then be contoured afterward and receive hair transplants.
- Hair transplants are the gold standard for hair loss of the eyebrows and eyelashes.
- Improving function in scarred hands is imperative to maintain self-reliance in affected patients. Contractures of the web spaces can easily be treated through local flaps to deepen the web space, and results are commonly good when assisted by compression garment therapy afterward.
- Scarring of the feet can be severely impairing for affected patients. Contractures that result in toe malposition or deformities should be addressed to ensure that the patients can walk and wear shoes comfortably.

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