



Rehabilitation and Scar Management

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9.1 Introduction

Survival was once the key parameter of success in managing serious burns, but due to improvements concerning burn care this has changed tremendously. Today, however, the aim of all treatment activities is the return of burn patients back into their private and social life under conditions, which allow independence and social sovereignty. This goal has extended the traditional role of the burn care team beyond wound closure.

Three broad aspects are involved in this effort: rehabilitation, reconstruction, and reintegration. Modern burn care may be divided into the following four general phases [1]:

- The first phase, initial evaluation and resuscitation, occurs on days 1–3 and requires an accurate fluid resuscitation and thorough evaluation for other injuries and co-morbid conditions.
- The second phase, initial wound excision and biologic closure, includes the manoeuvre that changes the natural history of the disease. This is accomplished typically by a series of staged operations that are completed during the first few days after injury.
- The third phase, definitive wound closure, involves replacement of temporary wound covers with a definitive cover; there is also closure and acute reconstruction of areas with small surface area but high complexity, such as the face and hands.

- The final stage of care is rehabilitation, reconstruction, and reintegration. Although this begins during the resuscitation period, it becomes time-consuming and involved toward the end of the acute hospital stay.

9.2 Rehabilitation in the Critically Ill Burn Patient

Burn rehabilitation is undeniably difficult and time-consuming, but the time spent is worthwhile [2–6]. For every member of the burn team, rehabilitation must start from the time of injury on, but the final obtainable treatment goals and strategies can vary, depending on the patient's injury, age, and co-morbidities.

In critically ill patients, the primary goals of rehabilitation are:

- Limitation of the loss of range of motion (ROM)
- Oedema reduction
- Prevention of predictable contractures

If a body part is left immobile for a prolonged period of time, capsular contraction and shortening of tendon and muscle groups (which cross the joints) occur. Contractures often develop, if wounds are not closed promptly and adequately.

Several predictable contractures that occur in patients with burns can be prevented by a proper ROM, positioning, and splinting programmes [1].

- Passive ROM is best performed twice daily, with the therapist taking all joints through a full ROM (Fig. 9.1). The therapist must be sensitive to the patient's pain, anxiety, wound status, extremity perfusion, and security of the patient's airway and vascular access.
- These procedures should be performed in coordination with the ICU staff. Attention to the security of endotracheal tubes, nasogastric tubes, and arterial and central

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Fig. 9.1 Passive mobilization

venous catheters is paramount, as an unexpected loss can contribute to morbidity and mortality.

- Proper antideformity positioning minimizes shortening of tendons, collateral ligaments, and joint capsules; moreover, it reduces oedema formation.
- Inspect all splints at least daily for evidence of poor fitting or pressure injury.

Oedema reduction should be encouraged from admission on. The only body system that can actively remove excess fluid and debris from the interstitium is the lymphatic system. The principles of oedema reduction should be performed:

- Compression
- Movement
- Elevation or positioning of limbs
- Maximization of lymphatic function

Beside the factors range of motion (ROM), oedema reduction, and prevention of predictable contractures, a long-term relationship has to be established with the patient and family members to ensure compliance with therapy goals and to increase the patient's morale for recovery. Moreover, adequate pain control is important for long-term compliance of the patient. The factors compliance and pain control will become even more important in the later phase of rehabilitation.

9.3 Rehabilitation in the Recovering Burn Patient

As critical illness abates and wounds progressively close, the roles of the physical and occupational therapists (as well as the demands on the patient) expand and become more diffi-



Fig. 9.2 ADL training

cult. Patients become more aware of what has happened to them, and they can become fearful of the therapist and the associated potentially uncomfortable procedures.

- The principal components of burn therapy [2–6] that characterize this period include the following:
 - Continued passive ROM
 - Increasing active ROM and strengthening
 - Minimizing oedema
 - ADL training (activities of daily living) (Fig. 9.2)
 - Scar management
 - Preparing for work or play or school

Long-term favourable outcome requires hard work during this period, but it is important for the therapist not to push too hard. An early programme of passive ROM greatly facilitates successful retention of normal ROM during this period. Intraoperative ROM also can be useful; in coordination with the operating room team, passive ROM can be performed between induction of anaesthesia and preparation of the surgical site. Other manoeuvres that can be used to increase the patient's tolerance for passive ROM are the timing of the ROM session at the end of the dressing changes performed under pain medication.

- Burned and grafted extremities commonly have oedema that can contribute to joint stiffness. Reducing this oedema facilitates rehabilitation efforts.
 - In the early phase, the use of self-adherent elastic will help to reduce digital oedema. Tubular elastic dressings, elastic wrap dressings, elevation, and retrograde massage also help reduce extremity oedema.
- As definitive wound closure nears and hospital discharge approaches, the focus of rehabilitation efforts becomes

practical. Performance of ADL tasks and the impending return to play/school/work are important considerations.

- Resisted ROM, isometric exercises, active strengthening, and gait training are important objectives.
- When treating children, it is important to use developmentally appropriate play to facilitate rehabilitation goals.
- For many burn patients, the first 18 months after discharge are more difficult than the acute stay. The principal rehabilitation goals at this time include the following:
 - Progressive ROM and strengthening
 - Evaluation of evolving problem areas
 - Specific postoperative therapy after reconstructive operations
 - Scar management

Unfortunately, it is not uncommon for ROM and strength to be lost during the first months after discharge. The burn unit team should monitor the quality of outpatient rehabilitation services during routine clinic visits at the burn unit. If the patient is losing substantial ROM and strength due to inadequate therapy, readmission for focused rehabilitation efforts is appropriate and recommended.

9.4 Non-surgical Scar Management

The treatment of scars is a big challenging process and important part in the rehabilitation programme. Scars can lead to emotional conflicts and psychosocial problems, but beside these aesthetic and emotional problems scars can cause also important functional restrictions and impairments. Due to the fact that the process of the hypertrophic scarring begins often after discharge and may last for several month and years, a need for special aftercare especially during the first 12–24 months is needed.

Although the process of the scar maturation is not fully understood yet, several approaches are propagated for non-surgical scar management.

9.4.1 Compression Therapy

As early as possible compression therapy should be performed by use of special customized compression garments (Figs. 9.3 and 9.4). Compression therapy helps to provide functionally and aesthetically satisfying scars and reduces the need for surgical scar revisions. By use of compression, good and satisfactory results can be achieved in 85% of the patients suffering from hypertrophic scars [7, 8], because as long as the scars are active, they can be influenced by compression. The exact mechanism of action is not cleared yet, but there is clear evidence that continuous pressure reduces the blood flow within the scar and



Fig. 9.3 Custom-made compression garments



Fig. 9.4 Special compression gloves plus additional pressure for the web spaces

thereby its activity. The metabolism of the scar is reduced and local ischemia and hypoxia is resulting in a reduced proliferation and activity of the fibroblasts and thereby of the collagen synthesis [9]. Thereby excessive scarring is decreased [10].

Wounds which heal within 14–21 days have a lower chance to develop hypertrophic scars, but if wound healing takes longer than 21 days, there is a higher chance to develop hypertrophic scars and a compression therapy is an absolute must [10] for a period of several months (in children often also more than 2 years until the scars are mature) and should be worn 24 h daily.

The optimum compression pressure, which should be exerted onto the scar, is discussed still controversially [11–14]. A pressure of 10 mmHg is probably enough to reduce scars and a pressure more than 40 mmHg is possibly not good for the skin and can cause nerve irritations and pain. The compression pressure, which is generated with compression clothes, amounts approx. 24–28 mmHg; this is more or less identical with the capillary pressure, which amounts around 25 mmHg.

9.4.2 Pressure Pads

Problems concerning compression therapy can occur in unfavourable localizations, above all in concave surfaces, as for example in the area of the sternum and the face. These are only hardly accessible to a suitable compression treatment. Mostly, a combination with special pads (pelotte), which can exert additional pressure, is useful. Pressure pads are made from different materials as for example from silicone gel, elastomeric and different plastic materials. The used material should be chosen depending on scar maturation and on the skin status of the patient. In general, one begins with a soft, thin and elastic pad and exchanges this with the time for harder and stronger pressure-exercising pads.

9.4.3 Hydration and Silicone

Silicone has been used with great success in order to reduce hypertrophic scars; hydration or the silicone related prevention of wound desiccation appears to be the contributing mechanism. Hydration seems to inhibit the fibroblast related production of collagen and glycosaminoglycans. Silicone gel sheets can be worn 24 h daily. Beside gel sheets [8], there are also silicone gels [7] available; they are normally applied twice a day after suture removal. Both silicone sheets and gels seem to have positive influence on scar size and erythema reduction. The use is not limited to prophylactic scar treatment, but also for improving pre-existing hypertrophic scars. The advantages of this kind of the scar treatment are the easy use and the quick improvement of the clinical symptoms.

9.4.4 Lubricants and Solar Exposition

Due to the functional impairment, special skin care is needed after a burn injury. Hydration protects the skin against dry-

ness. Special oils and creams, which do not irritate the skin, should be applied several times daily.

The patients should be cleared up thoroughly about the fact that the scars in the first year after a burn injury may be put out by no means to the direct sun. The danger of sunburn is very big and the scars will become probably darker in the sun. This discoloration is lasting and makes the scars even more remarkable. Solar cream with a solar protection factor from at least 30 as well as adequate sun protection clothing is strictly recommended [15].

9.4.5 Creams/Salves

There is a great variety of creams for conservative scar management on the market; many of them are used, but few of them enjoy medical acceptance. A lot of these creams are vitamin based or contain herbal extracts. Vitamin E, a lipid soluble antioxidant in skin has been used to reduce oxygen radicals, which alter collagen and glycosaminoglycan production. Topical Vitamin A has been used as a superficial resurfacing agent. Softening and flattening of scars are presented in the literature, but the use is not generally recommended. Other natural sources for scar improvements are on the market, but their efficacy is still under heavy discussion.

9.4.6 Scar Massage

Massage is a very good treatment option in order to improve the mobility of joints in the case of rigid scars. Rigid scar ropes are thereby dissolved and the scar becomes softer, more elastic, and more pliable. In the acute phase, only a local pressure should be applied to the scar. Furthermore, no special massage creams should be used in this early phase. If the skin tolerates friction, the scar can be manipulated by rotary and stroking movements under use of special oils and creams. It is recommended to carry out the massage at least twice daily. An electric massage device can be also used with additional heat application. Heat relaxes the tissue and raises the elasticity, so that the scars can be better mobilized. Here paraffin wax hydrotherapy and ultrasound are used with success. Conscientious scar massage can be effective in limited areas of scarring; it is also convenient, because it can be performed by family members.

9.4.7 Cortisone Treatment

In the non-surgical scar management, cortisone therapy has a firm place [16–18]; it is mainly used for the treatment of hypertrophic scars and keloids. The application of steroids can reduce collagen synthesis up to 60% [16]. Moreover, there is a significant reduction of glycosaminoglycan- and

hyaluronic acid synthesis by use of steroids. This leads to the decrease of the extracellular matrix and thereby to a scar reduction. Intralesional injections are often performed every 4–6 weeks. They can be used alone or as an adjunct to other treatment modalities. It is often used in combination with compression and/or excision and post-surgical radiation [16]. The most frequent side effects are atrophy and hypopigmentation around the injection places [17].

9.4.8 Antimitotic Drugs

A new intralesional scar treatment option is mainly based on antimitotic drugs such as bleomycin and 5-fluorouracil (5-FU).

9.4.9 Verapamil

The intralesional injection of the calcium channel blocker Verapamil seems to be a new promising option for the treatment of hypertrophic scars and keloids. In a recent study, Verapamil was injected into the wound edges directly after the scar and keloid excision [19–21].

9.4.10 Laser

Hypertrophic scars, keloids, and mild to moderate acne scars may benefit from skin resurfacing procedures using the carbon dioxide (CO₂) laser and the Nd YAG laser [22, 23].

9.4.11 Radiotherapy

Nowadays the application of radiotherapy in the conservative scar treatment is critical because of its potential side effects and risks like radiodermatitis, ulceration, and tissue atrophy, but there are also many reports available that this kind of treatment option is still useful and should be taken into account for scar treatment, especially after keloid excision [24].

9.4.12 Soft Tissue Augmentation

Atrophic and depressed scars may also benefit from filling procedures. There are different fillers available on the market. Collagen and collagen with fibroblasts are quite popular. Live cell transfer has been advocated as a long-lasting solution for tissue augmentation. Lipotransfer has become popular for scar treatment, because it seems that fat cell transfer is

not only able to improve volume and contour, but also to improve skin quality [25].

9.5 Conclusions

The ultimate goal of all burn care is the reintegration of the patient into society. A few years ago, the goal of the burn team was survival of the patient and discharge was the measurement of outcome. Ideally, patients return to their families, schoolmates, and communities as if the injury had never occurred. In order to achieve this, rehabilitation and reconstruction of the seriously burned patient became important parts of today's burn care.

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