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Summary

During the last decades, advances in burn care have led to an increased survival of patients with extensive burns. As a consequence, new challenges arise to improve the treatment of scars. Although scar treatment has already improved, scars resulting from deep burns still result in considerable functional problems in daily life. These functional problems are often represented by contraction of scar tissue resulting in disabling contractures. This dissertation focuses on the improvement of the treatment of burn scar contractures and on measurement tools.

Part I Clinimetric studies on scar surface area and volume

Different scar features may be distinguished that are clinically relevant and contribute to the overall quality of a scar, including color, elasticity, volume and surface area. For some of these scar characteristics (such as color and elasticity), suitable measurement tools are readily available. For the scar characteristics surface area and volume however, reliable and valid measurement tools are lacking. In Chapter 2 and Chapter 3 the reliability of 3D stereophotogrammetry for measuring scar surface area and volume was examined. We showed that 3D stereophotogrammetry is a reliable and valid tool to assess scar surface area and volume for research purposes. For research purposes, measurement errors are much smaller as they are leveled out in groups because the error is divided by the square root of the number of patients included in the study. For the clinical follow-up of patients though, where we are interested in the absolute measurement error of measurements in a single patient, the measurement error was found to be unacceptably large for both surface area and volume measurements. In Chapter 2 and 3 it was furthermore illustrated that relative parameters do not provide an answer to the question how precise a measurement is and to what extent it is free from measurement error. As most previously performed studies only use relative measurement parameters, it is expected that other measurement tools currently in use most certainly are not superior in terms of the measurement error. This means that still no ideal tool is available to register the surface area and volume of scars used for the follow-up of patients in clinical practice.

Part II Burn scar contracture treatment: the current state of the art

Treating burn scar contractures remains challenging for reconstructive surgeons. Because no consensus existed on when to use what kind of technique, a systematic review was performed on the effectiveness of the different surgical techniques after burn scar contracture release (Chapter 4). It was brought to light that the available literature on the
effectiveness of reconstructive techniques for burn scar contracture release is below par in both quantity and quality of the studies performed. Due to the lack of evidence we were not able to provide definitive conclusions on the effectiveness of different techniques or make specific recommendations. This review however did uncover the flaws in the current available scientific literature and thereby provided important lessons for future studies investigating the effectiveness of burn scar contracture release surgery. These lessons include the importance of 1) a comparison intervention, 2) a solid outcome assessment, using reliable and valid measurement techniques, 3) a sufficient sample size and 4) an adequate data presentation and statistical analysis. Only when future studies apply these lessons, evidence on the effectiveness of treatments for burn scar contractures becomes available.

In Chapter 5 we explored the effectiveness of full thickness skin grafts (FTSGs) for treating burn scar contractures. In clinical practice FTSGs are an important tool of the reconstructive surgeon. Although in the past decades a shift has been observed to more advanced techniques such as perforator flaps and dermal substitution, FTSGs are still frequently used for reconstruction of burn scar contractures. The reason is that they are relatively easy to perform and useful in many facets of reconstructive surgery. Especially in the treatment of burn scar contractures it is of paramount importance that the added tissue retains its original surface area. In Chapter 5 however, it was demonstrated that the surface area of FTSGs contracts considerably on the long term. Moreover, the vast majority of the FTSGs showed contraction at final follow-up. Furthermore, we observed that grafts excised from the trunk endure significantly less contraction on the long term than grafts excised from the extremities. This increased knowledge on the contraction pattern allows to take into account the expected contraction and to use another reconstruction technique in cases where re-contraction is least desired, as is the case in scar contracture release. When, however, FTSGs are preferred, it should be recommended to harvest FTSGs with a larger surface area than expected to be needed on the recipient location, taking future contraction into consideration. Furthermore, regarding our finding that grafts excised from the trunk endure significantly less contraction on the long term than grafts excised from the extremities, we advise to, whenever possible, use the trunk as the donor site location of preference.

Part III Progress in burn scar contracture reconstruction by perforator-based interposition flaps

The clinical studies in the last part of this thesis describe the use of local tissue for the treatment of burn scar contractures. In Chapter 6 an algorithm was described that provides a step-wise approach for the surgical treatment of scar contractures. In short, patients with burn scar contractures underwent a release using a perforator-based interposition flap. A non-islanded flap was preferred in case of small angles of rotation because an intact flap base provides extra venous outflow and prevents the necessity for additional scar tissue. However, when the perfusion of the flap was at risk because of a too large angle of rotation, the flap was islanded. By assessing the short-term results, it was found that this concept of perforator-based interposition flaps was a safe and versatile technique for treating burn scar contractures. Furthermore, the long-term results showed its effectiveness: the surface area increased after a mean follow-up period of 7.8 months. The effectiveness of perforator-based interposition flaps was further investigated in Chapter 7 by performing a randomized controlled trial that compared the use of flaps to the conventional treatment of skin grafting. The flaps showed an increase of the original surface area to 123% after 3 months and to 142% after one year, which was in contrast to the substantial decrease in surface area of FTSGs after 3 months and after one year. With regard to the safety of the perforator-based interposition flaps we found a lower percentage of necrosis compared to FTSGs (6% versus 17%). With these clinical studies we provided convincing evidence that interposition flaps lead to better long-term results compared to the current standard of skin grafting. Therefore, we strongly recommend using flaps instead of FTSGS whenever possible in the treatment of burn scar contractures.

For an optimal use of perforator-based interposition flaps, it is essential to locate the origin of perforators precisely. For this purpose the hand held Doppler is often used in clinical practice. In Chapter 8 the clinimetric properties of Doppler for the detection of perforator locations were investigated in healthy volunteers. Subsequently, the perforators within the area were mapped with Duplex to establish the validity by means of the positive predictive value. We discovered however, that the agreement between the observers was poor. In clinical practice this means that when one plastic surgeon locates a certain perforator, another plastic surgeon is not capable of finding the same location. Furthermore, we demonstrated a very low validity of the device. The results in our study showed that Doppler is not suitable as a single diagnostic tool for the detection of perforators.

In Chapter 9, the findings described in this thesis are summarized and discussed in the context of the current practice in burn scar contracture treatments. Conclusions are presented and suggestions for further research are proposed.