Introduction and outline of this thesis
Introduction and outline of this thesis

Burns, scars and contractures

Advances in burn care have led to an increased survival of patients with extensive burns. As a consequence, an increased number of patients have to live with extensive disfiguring and disabling scars. For this reason, greater attention is being paid to the improvement of the quality of scars. Although scar treatment has improved significantly over the past decades, scars resulting from deep burns still result in considerable functional problems in daily life. These functional problems are often caused by the contraction of scar tissue. When the functional result of contracted tissue causes loss of range of motion (ROM) in joint areas, it is called ‘contracture’. Figure 1 shows two examples of burn scar contractures. Because burn scars are often widespread and cover large areas, their treatment remains a considerable challenge in reconstructive surgery. Research in the field of burn scar reconstruction is therefore important and necessary.

By means of the studies that are presented in this thesis, we aim to increase the current knowledge and thereby improve the treatment of burn scar contractures. In order to do so, we will first assess the clinimetric properties of a measurement tool to measure surface area and volume of scars. Secondly, we will review the current literature on the surgical treatment of burn scar contractures to obtain a clear picture of the current state of the art. With this knowledge and the acquired clinimetric knowledge on scar evaluation tools, we will perform two clinical trials that investigate the effect of the use of perforator based interposition flaps for the treatment of burn scar contractures.
Part I Clinimetric studies on scar surface area and volume

Evidence based medicine has become the cornerstone of today’s medical practice. Evidence comes from clinical trials in which treatment techniques are compared. To be able to compare treatment techniques adequately, there is a need for clear outcome descriptions. In reconstructive surgery outcomes are often not a matter of life or death, sick or cured. We must register changes in functional and cosmetic outcome, from the viewpoint of the patient as well as the clinician. Tools to objectify these kind of outcome parameters are not readily available and have to be tested. The discipline of clinimetrics focuses on testing the quality of these tools in medical science and health care. The basic clinimetric properties are reliability and validity. Reliability refers to the degree a measurement is free from measurement error. Validity refers to the degree to which a measurement tool is able to measure what it is supposed to measure. These clinimetric properties are the core of many chapters in this thesis. For some 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. Scar surface area is an important scar feature to measure because it enables quantifying the percentage of scar surface area that becomes hypertrophic and the extent of scar contraction. Scar volume is an important outcome parameter in the treatment of problematic scars such as hypertrophic scars and keloids. Since the available techniques to measure scar surface area and volume have not been proven to be reliable and valid, and are at best cumbersome or not feasible, there is a need for a new measurement method. In Chapter 2 and Chapter 3 we explore the clinimetric properties of 3D stereophotogrammetry for measuring scar surface area and volume respectively.

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

Reconstructive surgery forms the foundation on which the treatment of functional disabling scar contractures is based. Although the first descriptions of reconstructive techniques date from more than 2000 years ago, it was not until the First World War that various surgical reconstructive techniques were developed. At that time the field of reconstructive surgery was rapidly emerging due to the high incidence of burns and injuries to the head and neck. Many young soldiers suffered from large facial defects and scar contractures were often treated before they reintegrated into society. It was during that period, that doctors like Gillies and Esser, originally ear nose and throat specialist and general practitioner (and dentist) respectively, specialized in the reconstruction of facial defects. They created the fundamentals of modern reconstructive surgery. Esser described all types of flaps of which some are still being used today. Figure 2 shows Esser surrounded by his patients.

At the same time, burns were rarely treated surgically and the treatment of acute burns with the use of skin grafts was still in its infancy. Although Thiersch stated already in 1886 that autografts could be used for the treatment of burns, also to cover larger wound areas, their use in burn surgery was not implemented in burn surgery for decades. This changed during the Second World War when the pioneering plastic surgeon Archibald McIndoe introduced revolutionary methods for burn treatment including the use of skin grafting. Many of the reconstructive techniques used today in patients with burn injury and hand surgery are highly influenced by his work. Nowadays, plastic and reconstructive surgery has evolved and established itself as an individual specialism. Over the years, many studies on reconstructive surgical procedures for scar contractures have been performed. Studies on the effectiveness of the treatment of these scar contractures present new techniques or adaptations of previously established techniques. However, examining the current literature does not provide us with recommendations on the appropriate reconstructive procedure or clear algorithms for their treatment. Therefore, Chapter 4 presents a systematic review on the effectiveness of the available reconstructive techniques for burn scar contracture release.
The goal of surgically treating burn scar contractures is improving the functional limitations that patients are experiencing in daily life. Scar contracture release is performed by incising the scar in such a way that it allows optimal mobility. Tissue is used to ‘fill up’ the defect that was created by incising the scar, which we refer to as ‘interposition’ in this thesis. Narrow contracture bands are mostly corrected by use of local plasties, such as Z-plasties. Scar contractures resulting from burn wounds though, are often wide and cover large body areas. This thesis focuses on these wide contractures. Their treatment represents a greater challenge because when a release is performed it is often required to create a large defect.

In clinical practice full thickness skin grafts (FTSGs) are regularly used to treat wide scar contractures. FTSGs are preferred over split thickness skin grafts (STSGs), as STSGs are known to have a considerable risk of future scar contraction. Remarkably, the extent of contraction of FTSGs has never been objectified for burn patients. Moreover, the available studies on the contraction rate of FTSGs in other patient groups use a relatively short follow-up period and use non validated surface area measurement techniques. Therefore, in Chapter 5 we assess the long-term contraction rate of FTSGs by using 3D stereophotogrammetry. This chapter gives insight in the potential predictive factors that influence the surface area of FTSGs over time.

Besides FTSGs, local flaps are an alternative in the treatment of scar contractures. Local flaps derive from adjacent tissue and are brought to the defect by advancement or rotation. As they contain local (healthy) tissue including the subdermal fat layer, they are of a superior quality. A disadvantage is that they are supposed to have a restricted length-to-width ratio. Ratios ranging from 1:1 for the extremities to 2:1 for the trunk, and even greater ratios for the face are described. When the length-to-width ratio is exceeded, these random flaps may encounter vascular limitations.

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

Perforator-based flaps are flaps where the blood supply of the flap is based on perforators. Perforators are the vessels in the subcutical tissue that ‘perforate’ different layers (fascia or muscle and subcutis) providing the blood supply to the skin. By including a perforator in the design of the flap the vascularization of the flap is improved and larger flaps could be raised with less restrictions concerning length-to-width ratios. Figure 3 visualizes a perforator and its course to the skin. In the early nineteen eighties, tissue (including fascia and/or muscle) was transferred based on cutaneous branches of large arteries such as the ulnar, radial and humeral arteries. Extensive basic research on the vascular anatomy resulted in the concept of angiosomes and their source arteries (the perforators). We know now that the body contains a few hundred perforators with a diameter of > 0.5 mm. Their discovery was an important breakthrough in the utilization of flaps and the term perforator flap was first used by Koshima and Soeda in 1989. During the past decades, many perforator locations have been identified and proven suitable to base a flap on, such as the deep inferior epigastric artery perforator flap (DIEAP), the superior gluteal artery perforator flap (SGAP), the lateral circumflex femoral artery perforator (LCFAP) flap and the thoraco-dorsal artery perforator flap (TDAP).

A new development is the use of ad hoc perforator-based interposition flaps. These flaps are established on any perforator capable of an adequate blood supply that is situated adjacent to the location where the release is needed. Thus, any skin surface of the body can be considered as a potential perforator flap donor site. This type of perforator-based interposition flap is not yet routinely applied for burn scar reconstructions. The application of perforator-based interposition flaps augments the armamentarium for the reconstructive surgeon considerably because it offers a solution for scar contractures, irrespective of the anatomical location. Two small cohort studies have described their safe, reliable and sustainable use. Perforator flaps can be designed as an islanded or a non-islanded flap. The latter implies that the skin base of the flap is left intact, hereby...
The location of perforators varies significantly between patients. Perforators can easily be located by Doppler sonography prior to surgery, which facilitates the planning and safety of the flap design. We anticipated finding sufficient evidence to support the use of the hand held Doppler device to locate perforators. However, literature showed a lack of clinimetric studies adequately testing the reliability. The available studies focus mainly on the validity of this technique, and yield conflicting results. Since the Doppler device is regularly used in the upcoming field of perforator flaps, Chapter 8 focuses on both the reliability and validity of the hand held Doppler for the detection of perforators.

References


