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Tissue expansion for correction of scars due to burn and other causes: A retrospective comparative study of various complications

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ARTICLE INFO

Article history:

Accepted 23 October 2012

Keywords:

Tissue expander

Scar correction

Burn

Pediatric burn patient

ABSTRACT

Background: Tissue expansion is associated with a relatively high complication rate. The aim of this study was to quantify the complication risk of burn scar patients who underwent tissue expansion in comparison to patients with other indications such as skin tumors. Furthermore it was attempted to compare the complication rates in children and adults.

Methods: A retrospective analysis was performed on 148 expanders implanted in 73 patients during the years 1994–2011. Two patient cohorts (*burn scar cohort* $n = 31$ and *other indication cohort* $n = 42$) were identified and analyzed.

Results: 27 male and 46 female patients with a median age of 21 years were included. No statistically significant difference for complication risk between the burn and other indication cohorts could be found ($p = 0.1412$). Statistical analyses revealed a higher complication rate (52%) in the lower limb compared to all other anatomic sites (29%) ($p = 0.1746$). In addition, statistical analyses revealed a significantly higher total complication rate in children younger than 10 years ($p = 0.0043$). Moreover a greater TBSA was accompanied by a higher complication rate ($p = 0.0258$).

Conclusion: This set of data suggests that the burn scar patient is at no greater risk to suffer complications from tissue expansion. Other factors like age, TBSA and anatomical site have far more influence on the expander complication rate than the initial indication for tissue expansion.

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1. Introduction

In 1957 Neumann first attempted ear reconstruction by implanting a rubber balloon under the skin of a patient in the postauricular area and expanding it [1,2]. Radovan took up where Neumann had left off and his method won general acceptance. Since then skin expansion has been a useful routine procedure [1].

Tissue expansion has become indispensable for burn scar reconstruction and many other indications. The biological basis of tissue expansion is an increase in skin surface area due to generation of new tissue and not only the stretching of existing skin [3,4]. The surgeon consequently provides tissue expansion with donor tissue of similar texture and color to resurface a defect. Tissue expansion is associated with a relatively high complication rate. In literature the complication rate was found to range from 10% [5] to 80% [6]. In

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<http://dx.doi.org/10.1016/j.burns.2012.10.020>

particular it was suggested that burn patients have a higher risk of complications undergoing tissue expansion [7,8].

Studies that compare the risk of burn patients to that of patients with other indications are rare. This is why the intension of this study was to assess if the burn scar patient is at greater risk to suffer complications from tissue expansion than the patient with other indications for tissue expansion.

2. Patients and methods

A retrospective analysis was performed of all cases in which tissue expansion was used for reconstruction from 1994 to 2011. The medical records and operative reports of all patients were reviewed focusing on age, gender, diagnosis, expander size, valve location (internal/external), number of expanders per patient, age of scars, complications, anatomic site of the expander and the length of time required for tissue expansion. During this time period 148 expanders were placed in 73 patients (min: 1 expander per patient, max: 9 expanders per patient). This series includes 27 male and 46 female patients (male/female ratio 1/1.7) with a median age of 21 years (range: 1.6–84 years). The median length of time required for tissue expansion was 65 days (range: 9–174 days). Cases of post mastectomy reconstruction with a tissue expander were not included in this review.

To investigate if the burn scar patient is at greater risk to suffer complication from tissue expansion than the patient with other indications for tissue expansion, two groups were defined: the *burn scar cohort* and the *other indication cohort*.

2.1. The burn scar cohort

80 expanders were placed in 31 patients (min: 1 expander per patient, max: 9 expanders per patient). The *burn scar cohort* includes 10 male and 21 female patients (male/female ratio 1/2.1) with a median age of 21 years (range: 8–44 years). The median expander volume was 300 cc (range: 40–680 cc). The median TBSA (total burn surface area) was 15% (range: 3–58%).

2.2. Other indication cohort

68 expanders were placed in 42 patients (min: 1 expander per patient, max: 7 expanders per patient). The *other indication cohort* includes 17 male and 25 female patients (male/female ratio 1/1.5) with a median age of 20 years (range: 1.6–84 years). The median expander volume was 250 cc (range: 50–1100 cc).

Continuous data were described with median, minimum and maximum. Categorical data are described with absolute and relative frequencies. Occurrences of complications were modeled by generalized linear mixed models with a binomial distribution and logit link function. A compound symmetry variance-covariance matrix was chosen to model repeated expander applications within a patient. Effects are described by odds ratios and corresponding 95% confidence intervals (95% CI). All p -values given are two-sided and $p \leq 0.05$ was considered significant. Statistical analyses were performed by the software package SAS (Version 9.3; SAS Institute Inc., Cary, NC, USA).

Major complications of expansion were defined as infection and expander exposure. Minor complications were defined as erythema, leakage, hematoma, valve dysfunction and wound dehiscence. In case of infection the tissue expander was explanted and the patient was treated with antibiotics. At occurrence of minor complications medical measures such as antibiotic treatment, expander filling pause, operative revision and expander exchange were conducted. The endpoint of therapy was considered as achieved when the expander was left implanted throughout the planned expansion time and the scar or defect was surgically removed and covered with healthy pre-expanded skin. The planned expansion could not be completed when early treatment termination due to complications occurred.

The protocol for expansion was standardized and the same expander system was used over the years (no use of osmotic tissue expanders). All patients underwent general anesthesia and were treated with systemic perioperative antibiotic prophylaxis. After precise preoperative planning the skin incision was made in healthy tissue. The largest expander possible was chosen, placed subcutaneously in a sufficient large pocket and a two-layer wound closure was carried out. At time of insertion 10% of the expander capacity was injected. After a healing process of two to three weeks the sequential filling procedure could be started. Once sufficient expansion had been achieved the expander was surgically removed and a local flap was formed to cover the defect. All patients, included in this study, were operated on either by a senior position specialist in Plastic and Reconstructive Surgery or under his direct supervision. Furthermore the follow up of the patients in our outpatient clinic was carried out by the same senior position or again under his direct supervision.

3. Results

A total number of 148 expanders were placed in 73 patients. Most expanders were implanted into the capillitium ($n = 32$). The distribution of the anatomical expander locations is diagrammed in Fig. 1.

48% of all patients were treated with one expander. Accordingly more than half of all patients were treated with 2 or more expanders throughout the therapy process (see Table 1).

Indications for tissue expansion in the *burn scar cohort* were: combustio ($n = 19$), followed by scald ($n = 7$), electrical burn ($n = 3$) and explosion ($n = 2$). Indications for tissue expansion in the *other indication cohort* were: scar after trauma ($n = 15$), followed by congenital defect such as ear hypoplasia ($n = 12$), malignant skin tumor ($n = 6$), naevus ($n = 4$), pressure ulcer ($n = 3$) and dog bite ($n = 2$).

A total of 49 complications occurred (complication rate of 33%), more precisely 31 major complications and 18 minor complications (see Table 2).

It could not be demonstrated that the burn scar patient is at greater risk of complication from tissue expansion than any other patient undergoing tissue expansion (see Table 5).

Although not statistically significant a higher complication rate (52%) in the lower limb compared to all other anatomic sites (29%) ($p = 0.1746$) could be observed. Accordingly patients

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