Tissue Expansion: Comparative Analysis of Complications and Risk Factors

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Abstract

Objective: This study is planned to evaluate the relationship between the complications that have occurred in our clinic after tissue expander application and patient age, sex, etiology, expander placement site, tissue expander volume, final expander volume, perioperative inflation volume, and tissue expander inflation duration.

Materials and Methods: Seventy-eight tissue expanders of different sizes were placed in patients. Patients’ age, sex, etiology, tissue expander site, tissue expander volume, preoperative final expander volume, tissue expander inflation duration, and complications were retrospectively documented. The Number Cruncher Statistical System 2007 and Power Analysis and Sample Size 2008 statistical software (Utah, USA) programs were used for statistical analysis.

Results: No relationships between complication rates and patient age, sex, tissue expander volume, perioperative inflation volume, preoperative final expander volume, overexpansion, and inflation duration were observed. Complication rates in the lower extremity and burn scar group were markedly higher than the trunk, head-neck, and trauma scar groups.

Conclusion: Adhering to the basic principles of tissue expansion is important for minimizing complication rates in lower extremity and burn scar reconstruction where complication rates are higher.

Keywords: Lower extremity, tissue expansion, expander complication, burn scar, expander

INTRODUCTION

The application of tissue expanders and their use in reconstructing tissue defects was first reported by Newmann in 1957.1 In 1982, Radovan reported a breast reconstruction procedure using a silicone tissue expander he developed; in the same year, Austad reported his experience with a self-inflating silicone prosthesis and the histologic effects of the expanding tissue.2,4 Since these initial studies, the use of tissue expanders has gradually increased, and many studies have reported the histology and physiology of tissue expansion. More recent studies have described the combined uses of osmotic or conventional tissue expanders and fat grafting techniques in tissues where tissue expansion poses anatomic difficulties, such as congenital palate or nose anomalies or tissues exposed to radiotherapy.5,6

Tissue expansion offers many benefits. One of the key benefits is the ability to expand the soft tissue to close the defect, enabling the generation of new tissue on the defect area that is consistent with and similar in color and thickness to the surrounding tissue. Another benefit is the satisfactory sensory level achieved in the advanced flap subsequent to the reconstruction. Donor site morbidity is minimal because this area is closed using the immediate surrounding tissues. An additional advantage is that another expanded flap can be safely advanced to accommodate a capsule with considerably enhanced vascularization.
However, despite all these benefits, tissue expansion can also carry some risks. The rate of complications reported in the literature ranges from 10% to 80%.\textsuperscript{9,10} Complications such as damage to the expander or the port, exposition, flap necrosis, infection, hematoma, pain, seroma, and rescarring can occur following the placement of the tissue expander.

In this study, we aimed to assess the impact of a range of factors on the development of complications following tissue expanding procedures performed in our clinic. To that end, the following factors were documented: age, gender, etiology, tissue expander placement site, tissue expander volume, perioperative inflation volume, over-inflation, preoperative final tissue expander volume, and tissue expander inflation duration.

**MATERIALS AND METHODS**

The study was conducted in compliance with the Helsinki Declaration and after informed consent was obtained from every patient. The study included 53 patients whose defects were reconstructed using tissue expanders between January 2013 and January 2016. Cases in which tissue expanders were used for the purposes of breast reconstruction subsequent to mastectomy were excluded. A total of 78 tissue expanders of varying anatomic sizes were placed; depending on the type of the defect, multiple tissue expanders were placed in 9 of the patients.

The surgical technique involved an incision over the junction of the scar and the intact tissue, followed by placement of the tissue expander in the pocket created in the region adjacent to the scar site, either in the subgaleal or in the subcutaneous plane depending on the location. The port of the tissue expander was placed in a separate pocket. The site was examined for fluid leaks or distortion during the operation. The incision was sutured following hemostasis, and the tissue expander was inflated up to 10% of its total volume. Expansion was continued on postoperative day 14 using 0.9% isotonic solution stained with sterile methylene blue. The amount of fluid to be inserted at each expansion session was determined according to the patient’s pain level, flap rigidity, and level of circulation to the covering skin.

Patient data were retrospectively reviewed and documented based on age, gender, etiology, tissue expander placement site, tissue expander volume, perioperative inflation volume, over-inflation, preoperative final tissue expander volume, tissue expander inflation duration, and complications. Parametric data were statistically analyzed using the Number Cruncher Statistical System (NCSS) 2007 and Power Analysis and Sample Size (PASS) 2008 statistical software (Utah, USA). Descriptive statistics methods (average, standard deviation, median, frequency, ratio, minimum, maximum) were used to represent the study data. The Mann-Whitney U test was used to compare the development of complications and other quantitative data; qualitative data were compared using Yates's Chi-square test, the goodness of fit test, and the Fisher-Freeman-Halton test. Significance was determined within the limits of \(p<0.01\) and \(p<0.05\).

**RESULTS**

A total of 78 tissue expanders were placed in 53 patients, of which 26 (49%) were female and 27 (51%) were male. The ages of the patients ranged from 4 to 52, with a mean of 17.46 years. The median follow-up period was 13 (4 to 18) years. The cases were grouped by age, with 23 patients in the 4 to 16 age group and 30 patients in the 17 to 52 age group. No statistically significant differences were identified between the two age groups with respect to complications and failure development (\(p>0.05\)).

Review of the diagnoses showed that 70.5% (n: 55) of the tissue expanders were placed for burn scarring, 16.7% (n: 13) for trauma scarring, 11.4% (n: 9) for congenital melanocytic nevus, and 1.3% (n: 1) for reconstruction due to atrophy. Statistically significant differences were identified between

| Table I. Complication rates and distribution of tissue expanders by region |

<table>
<thead>
<tr>
<th>Complications</th>
<th>Total n (%)</th>
<th>No n (%)</th>
<th>Yes n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnosis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn scarring</td>
<td>55 (70.5)</td>
<td>46 (83.6)</td>
<td>9 (16.4)**</td>
</tr>
<tr>
<td>Trauma</td>
<td>13 (16.7)</td>
<td>9 (69.2)</td>
<td>4 (30.8)</td>
</tr>
<tr>
<td>CMN</td>
<td>9 (11.4)</td>
<td>9 (84.6)</td>
<td>2 (15.4)</td>
</tr>
<tr>
<td>Atrophy</td>
<td>1 (1.3)</td>
<td>1 (1.6)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td><strong>Expander placement site</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head and neck</td>
<td>51 (65.4)</td>
<td>42 (82.4)</td>
<td>9 (17.6)</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>12 (15.4)</td>
<td>6 (50.0)</td>
<td>6 (50.0)**</td>
</tr>
<tr>
<td>Torso</td>
<td>15 (19.2)</td>
<td>15 (50.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

\(^{*}\text{Chi-square test (single cell)}\ ^{**}p<0.01\ ^{***}p<0.001\ ^{++}p<0.003\ ^{*\*}CMN: congenital melanocytic nevus
the complication rates based on diagnosis, with significantly higher rates in the burn scar group (p<0.003).

Anatomically, the tissue expanders were placed in the head and neck region of 51 (65.4%) patients, in the lower extremities of 12 (15.4%) patients, and in the torso of 15 (19.2%) patients. A review of the relationship between the placement site of the tissue expander and the presence of complications showed the complication rates to be higher in the lower extremity group vs. other anatomic regions (p<0.001). Findings on the anatomic region of the tissue expander and the diagnoses are summarized in Table I.

While complications were seen to develop in 19.2% (n: 15) of the tissue expanders, the rate of reconstruction failures associated with major complications (perforation, exposition, necrosis) was found to be 12.8% (n: 10). Of the tissue expander complications, 6.4% (n: 5) were perforation, 5.1% (n: 4) were exposition, 2.6% (n: 2) were hematoma, 2.6% (n: 2) were infection, 1.3% (n: 1) were partial necrosis, and 1.3% (n: 1) were seroma.

The average tissue expander inflation time was 46.17±14.49 days. Expanders were over-inflated in 55 (70.5%) of the cases. No statistically significant differences were observed in the presence of complications with respect to patient age and gender, perioperative inflation volume, preoperative final tissue expander volume, over-inflation, and inflation duration (Table II) (p>0.05).

**DISCUSSION**

Tissue expanding methods are frequently used in the reconstruction of congenital or acquired tissue defects in children and adults. In the reconstruction of tissue defects, the objectives are to reconstruct the defect site with tissue of similar quality and color and to ensure minimal morbidity on the donor site. Local flaps remain insufficient in cases with larger defects. Therefore, expanded flaps are often preferred for reconstructing larger defects.

In a recent study conducted in Turkey, Demirdöver et al.\(^\text{11}\) reported a rate of 34% for cases in which tissue expanders were used for the reconstruction of burn scars. In our series, 70.5% of the cases were surgically treated for burn scars.

Some studies in the literature report infection to be the most commonly encountered complication.\(^\text{9,12,13}\) However, in our series, perforation and exposition were the most commonly encountered complications. Similar to the findings of our study, in their studies involving 300 tissue expanders, Cunha et al.\(^\text{14}\) reported the overall rate of complications to be 22.2%, with implant exposition and perforation being the most commonly encountered complications. Similarly, in our series, this rate was found to be 19.2%. Demirdöver et al.\(^\text{11}\) reported the overall rate of complications to be 13.5% in their study. In the same study, complications in the head and neck region were observed at a rate of 7.3%. In this study, however, the authors indicated that the complication rates were within lower limits compared to those reported in the literature. We believe the low infection rate seen in our study is due to the attention shown to sterility conditions during both the operation and the inflation process as well as the intimate follow-up in the early postoperative period.

A significant increase was observed in the complication rate of the lower extremity group compared to the torso and head groups (p<0.003). Some earlier studies described the substantial impact of anatomic location on complication and failure rates.\(^\text{9,14-17}\) These studies report higher complication rates in tissue expanders placed in the lower extremities. Having reviewed seven studies in the literature, Pandya et al.\(^\text{18}\) calculated the rate of complications in tissue expanders placed in the lower extremities to be 38% and the expansion failure rate to be 16%. In our study, the rate of complications in tissue expanders placed in the lower extremities was 50% and the expansion failure rate was 20%.

Bozkurt et al.\(^\text{19}\) demonstrated that the size of the tissue expander and the anatomic location where it is placed have significant effects on complications. In their study, the researchers identified significantly higher complication rates in tissue expanders placed in the lower extremities. In the same study, however, parameters such as age, gender, and the shape of the expander were reported to be unassociated with complications. While the findings of our study are in keeping with
these findings, in our study, expander volume was not identified as a risk factor in the development of complications (p>0.05).

While some publications report relatively higher complication rates for case series in which tissue expanders were used to reconstruct burn scars, other publications report no significant differences between complication rates. In a study by Youm et al.15 researchers compared cases in which tissue expanders were used for treating burn scars with those used for treating other indications; they observed that complication rates were significantly higher in the burn scar group. Similarly, after they compared burn scars with other indications in pediatric patients, Friedman et al.16 reported higher complication rates in the burn scar group. In our study, 55 tissue expanders were placed for the treatment of burn scars, and 23 tissue expanders were placed for the treatment of other indications; we found no significant differences in terms of overall complications between the two groups. The complication rate was found to be significantly higher in the group that was treated for burn scars using expanders (p<0.001). Iconomou et al.20, in contrast, reported that they found no significant increases with respect to complication development among the pediatric age group in cases that were treated for burn scars versus cases treated for other indications.

The only study in the literature that has reviewed the association of complications with perioperative inflation volumes and tissue expander sizes is the study by Yeong et al.21 In their study involving tissue expanders, they reported the rate of expansion complications to be 53%. While this study does not address the correlations between complication development and factors such as advancing age, proportional perioperative inflation volume, and tissue expander size, in our study we identified age, perioperative inflation volume, and tissue expander size to be unrelated to complication development (p>0.05).

CONCLUSION

We believe that adequate patient selection and adherence to the essential principles of expansion will be beneficial in maintaining low complication rates in tissue expansion procedures for treating lower extremity defects and burn scars, which demonstrate higher complication rates.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki “Ethical Principles for Medical Research Involving Human Subjects” (amended in October 2013).

Informed Consent: Written informed consent was obtained from the patients for the publication of this study.

Peer-review: Externally peer-reviewed.


Conflict of Interest: No conflicts of interest were declared by the authors.

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