Massive Soft Tissue Expansion: Safety Pearls

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ABSTRACT

Overview: Reconstruction of patients suffered from extensive skin deformities is challenging. One of the difficulties is limited donor sites available to reconstruct the nearby deformed skin. Tissue expander overfill is an available option to achieve customized expander dimensions.

Patients and Methods: This descriptive prospective study includes thirteen patients (31 expanders) presented with extensive skin lesions (post burn scars or benign skin lesions). Different sizes and shapes of tissue expanders are inserted in all of them. Expander overfill is done to achieve sufficient skin with good suitable thickness to be used in replacing the deformed tissue. Patients are assessed regarding the rate of complications of massive soft tissue expansion.

Results: One of the thirty one expanders that were inserted showed after a while extrusion (3.2%). While the other thirty expanders with overfill volume reached from 3 to 8 times of the original expander volume without a single complication.

Conclusion: Limited donor site area that is available for expansion in patient with massive skin deformities is a common problem. Tissue expander overfill is a safe procedure provided that proper preoperative, intraoperative, and postoperative precautions are applied.

Key Words: Soft tissue – Massive – Expansion – Burn – Skin lesions – Reconstruction.

INTRODUCTION

Reconstruction by tissue expansion is one of the gold standard options used for management of the cosmetic and functional problems of the extensive skin lesions. The extensive skin lesions may be one of post burn consequences as well as extensive benign tumors such as giant hairy neavi and neurofibromatosis, etc.[1].

It has many advantages, minimizes the donor site morbidity, excellent color and texture match [2].

Manders et al., classified the complications of tissue expanders into either major or minor complications. Expander extrusion, hematoma, infection, and implant failure are major complications.

Presence of seroma, pain, scar widening all are considered to be minor complications [3].

One of the challenges that facing the reconstructive surgeons when dealing with the extensive skin lesions either benign tumors or post burn scars are rarity of the donor site areas. So, using the tissue expander is a useful adjuvant. Although there are diverse shapes, sizes of expanders yet it can’t fit all patients requirements. The availability and the cost is an obstacle to the use of customized expanders. So, overfill of the tissue expanders can be used as an alternative to customize expanders.

In this study we tried to address the clinical safety of expander overfilling in massive skin disfigurement management. And we tried to optimizing the peri-operative conditions to minimize the complications of the tissue expanders and to introduce new steps to get safe high volume expansion.

PATIENTS AND METHODS

This prospective study was conducted on 13 patients (31 expander) with extensive skin disfigurement. The affected areas were; head and neck, trunk, upper and lower limbs. They were operated upon in the period from October 2013 – January 2016.

We are going to introduce three stages (Preoperative, intraoperative, and postoperative) for safe massive tissue expansion resulting in a very wide extra-expanded skin.

Preoperative steps:

- Laboratory results:
  - Hemoglobin % should be above 11gm. %
  - Serum albumin should be above 3.5gm.

- At least one year should be passed between the last previous surgery and trauma (such as grafting, secondary wound closure, post burn healing, etc.).
• Smoking should be stopped at least one month before surgery.
• The donor area was assessed to determine the size, shape, and plan of expander insertion.
• The choice of one or multiple soft tissue expander depends on the length of the deformed area and not its width (that means that length of the expander(s) should be approximately equal to the length of the deformed area) Fig. (1).
• Rectangular expanders are used in most cases due to its higher expandability compared to other shapes.
• At night of surgery:
  o All patients should take a shower using antiseptic soap.
  o If the planned site of expander insertion in close proximity to hairy area it should be epilated (not shaved).
  o One dose of prophylactic antibiotic (third generation ceftriaxone, 1gm, IM).

**Intraoperative steps:**
• Before skin incision:
  o The skin is prepared with Povidone iodine solution and left for half an hour.
  o Another dose of prophylactic third generation cephalosporin 1gm. is given.
  o The pocket area and incision site is infiltrated with adrenaline 1/100,000 and 160gm. gentamycin.
• The pocket is dissected in subfascial plan.
• The pocket area is dissected narrower than the size of the expander base from 2-5mm.
• Meticulous hemostasis is crucial.
• After completion of dissection of the pocket, recheck of hemostasis and washing of the pocket with 500ml. saline and 160gm, gentamycin solution.
• The pocket of port is dissected under the planned area of resection (the deformed skin) and before insertion of the expansion as shown in Fig. (2)
• No need for a separate incision for the pocket of the port.
• The tunnel for the pocket of the port must be very narrow and away by 10-12cm from the expander pocket.
• Insertion of the port in its pocket can be facilitated by a sterilized K-Y-gel.
• Connecting the port tube with the expander tube with interconnecting metal should be supported by two proximal and distal ligatures with three zero needless absorbable polyglactin sutures to avoid accidental expander puncture and disconnection.
• The incision site is disinfected again with Povidone iodine before insertion of the expander.
• The gloves are changed before handling of the expander.
• The expander is washed with gentamycin in saline solution for more disinfection and to assure removal of talc powder particles.
• The expander shouldn’t contact the skin, the Povidone iodine solution, or any instrument soaked with blood.
• After the placement of the expander in its pocket, the incision is closed in three layers, polyglactin 3/0 for closure of the fascia and the subcutaneous tissue, polypropylene 3/0 for skin closure.
• The skin is disinfected again with Povidone iodine and the wound is dressed with sterile dressing.

**Post-operative steps:**
• The patient is discharged in the same day of surgery.
• It is recommended to avoid hot humid climate, the ambient temperature is not higher than 20º.
• Stiches are removed after three weeks.
• First session of expansion is done after six weeks to ensure adequate tensile strength of the wound to allow tissue expansion without fear of wound dehiscence.
• The intervals between the expansion sessions are one week apart.
• Before injection the skin overlying the port must be disinfected by 70% alcohol swabbing.
• Normal saline is injected; approximately 10% of the expander volume is injected.
• Addition of ceftriaxone to the solution of injection is done if needed (if the skin showed early signs of inflammation or the patient had mild fever regardless the etiology for example common cold).
• The session of injection is postponed if the skin exhibits any signs of inflammation, cellulitis or presence of tiny neovascularized capillaries in the expanded skin (it is an indication of relatively ischemic expanded flap), so it is recommended to delay the session of expansion (Fig. 3).
• The ideal measurements of the extra expanded skin are calculated approximately:
  o The width of the expanded extra skin above the dome of the expander is approximately equal the sum of the width of the deformed skin plus the width of the base of the expander plus the 25% extra above the sum of the previously two measurements.
  o The length of the expanded extra skin above the dome of the expander is approximately equals the sum of the length of the base of the expander above the previous length plus 25% extra above the length.
• The timing for the reconstruction to be done is delayed for four weeks after the last session of expansion.

• During the reconstruction (inset of the expanded flap):
  o The deformed area is positioned under high tension and the flap is designed.
  o Before excision of the deformed skin the expanded skin will be overlaid above the deformed skin to assess its reachability and marked by simple scratches.
  o Then the simple marked scratches are connected by the scalpel and the deformed area is excised.
  o Respecting the aesthetic units and vectors of the pull of the flap must be put in considerations (Fig. 4).

Fig. (1): The preoperative planning of site, size, and number of expanders according to size of the disfigured skin.

Fig. (2): Port is inserted under the planned area of resection.

Fig. (3): Dilated capillaries “neovascularization” in the expanded flap.

Fig. (4): Respecting the aesthetic unit during design of flaps.
Fig. (5): Upper photos: design of the planned donor area and size and shape of expander. Lower photos: The expander after over-inflation “five folds” and after excision of the lesion.

Fig. (6): Arm and forearm expanders after completion of the expansion “four folds”. Post-operative photos after excision of lesion.

Fig. (7): Scalp expander after completion of expansion “four folds” (above) and post-operative photos after excision of alopecic area (below).

Fig. (8): Patient with three trunk expanders and one arm expander after completion of the expansion process “4 fold arm expander expansion, 6.4-8.2 folds trunk expanders”. 
RESULTS

Thirteen patients (31 expander) were included in this case series study. Table (1) summarized the main indication of expander based reconstruction.

The initial volume of the used expander ranges from 80cc: 1000cc.

The following table shows the end volume of the expanders, its number and the outcome. One of the main drawbacks of the overfilling is long duration of the expansion process as showed in Table (4).

Table (1): Indication of the expansion and number of the patients with deformed skin.

<table>
<thead>
<tr>
<th>Indication of expansion</th>
<th>Number of patients</th>
<th>Number of expanders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post burn scar</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Benign tumor:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giant hairy naevus</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Neurofibroma</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Bomb explosion</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ablation of graft</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Motor car accident scar</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table (2): Shows the volumes of the inserted expander and their sites.

<table>
<thead>
<tr>
<th>Position</th>
<th>Number</th>
<th>Mean volume</th>
<th>Range</th>
<th>Overfill times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head &amp; neck:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalp</td>
<td>2</td>
<td>250</td>
<td>200-300</td>
<td>(3-4) 3.5</td>
</tr>
<tr>
<td>Forehead</td>
<td>2</td>
<td>115</td>
<td>80-150</td>
<td>(4.6-8) 6.3</td>
</tr>
<tr>
<td>Neck</td>
<td>3</td>
<td>416</td>
<td>400-450</td>
<td>(2.75-4.75) 4</td>
</tr>
<tr>
<td>Trunk:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>1</td>
<td>416</td>
<td>400-450</td>
<td>(3.7-4.25) 4</td>
</tr>
<tr>
<td>Abdomen</td>
<td>5</td>
<td>640</td>
<td>500-800</td>
<td>(2.8-7.8) 5.8</td>
</tr>
<tr>
<td>Flank</td>
<td>7</td>
<td>617</td>
<td>500-800</td>
<td>(2.7-8.2) 5.2</td>
</tr>
<tr>
<td>Back</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper limb:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm</td>
<td>3</td>
<td>600</td>
<td>300-1000</td>
<td>(2-4) 3.1</td>
</tr>
<tr>
<td>Forearm</td>
<td>4</td>
<td>400</td>
<td>400</td>
<td>(3-4) 3.37</td>
</tr>
<tr>
<td>Lower limb:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thigh</td>
<td>2</td>
<td>500</td>
<td>500</td>
<td>(4.4-8.8) 6.6</td>
</tr>
</tbody>
</table>

Table (3): The overfilling volumes.

<table>
<thead>
<tr>
<th>Overfilling (times)</th>
<th>Number of expanders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2</td>
<td>2</td>
</tr>
<tr>
<td>2-2.9</td>
<td>3</td>
</tr>
<tr>
<td>3-3.9</td>
<td>6</td>
</tr>
<tr>
<td>4-4.9</td>
<td>8</td>
</tr>
<tr>
<td>5-5.9</td>
<td>4</td>
</tr>
<tr>
<td>6-6.9</td>
<td>1</td>
</tr>
<tr>
<td>7-7.9</td>
<td>3</td>
</tr>
<tr>
<td>8-8.9</td>
<td>3</td>
</tr>
<tr>
<td>Failed</td>
<td>1</td>
</tr>
<tr>
<td>Total number</td>
<td>31</td>
</tr>
</tbody>
</table>

DISCUSSION

Tissue expansion considered to be revolution of plastic surgery in 20th century [4]. It can create tissue in reaction to tension. It provides tissue of the same color, texture, and hair bearing abilities. Many surgeries and disfigurement during expansion are the main disadvantages [5,6].

To replace the scarred or the pathological skin with a healthy skin, there should be expanded flap with double or triple length of the diameter of the affected skin [6].

One of the main challenges that face us during use of the tissue expansion to replace scared skin or giant skin lesion is lack of a large donor area. The lack of availability of the customized implants as well as its cost leads to use the overfilling of the available sizes and shapes to achieve customized sizes of the expander.

Few studies addressed the safety of the overfill of the expanders both in vivo and in vitro. In our study we tried to minimize the major complications of the tissue expansion that can abort the expansion process. The main feared complications early post-operative is the hematomas or seroma, wound infection. The late complications that may develop during expansion are wound dehiscence, mechanical failure and flap ischemia.

In our patients’ series, we were strict to the following recommendations to avoid infection. Skin preparation was done; the night before surgery and pre-incision of the skin, before expander placement, and before application of the sterile dressing. Shaving the site of surgery is prohibited to avoid minor scratches near the operative field. Handling of the expander; the pocket is washed with gentamicin containing solution, changing the gloves before handling expander and avoid contact between the expander and skin or any instrument before insertion.
Patients are discharged the night of surgery and instructed to avoid humid hot climate postoperative.

The used of prophylactic doses of antibiotics; first dose was given at night of surgery and the second dose after induction and before skin incision.

There was no recorded complication of wound infection in our patient series.

The second major complication that was in our concern is hematoma. Infiltration of the incision site and the planned pocket of expander insertion with adrenaline 1/100,000 were done. Meticulous hemostasis was done and rechecks of hemostasis in the pocket before insertion of the expander. The dissected pocket should be a slightly narrower than expander base and intraoperative injection of 10% of the expander volume to obliterate the potential dead space. No drains are used to minimize the risk of infection. As previous studies support that the surgical site infections are caused by the microorganisms that colonize the drain tube. The increase the duration of the drain implantation carries the more the risk of the surgical site infection [7]. Again there was no recorded case of hematoma or seroma in our study.

Dissection of the pocket in subfacial plan, closure of the wound in three layers, delayed removal of the stiches and delayed first session in expansion all are used precautions to avoid wound dehiscence. Extrusion of the expander and failure of expansion process occur in one expander (3.2%).

The expander overfill is the solution if the desired surface area gain following tissue expansion had not been achieved according to the original volume. In the ex vivo study that was published by Hallock [8] stated that the overexpansion of the expander is safe up to 15 time the manufacturer’s maximum volume. Hallock G [9] again studied the safety of overexpansion but in this study it was done in vivo. He conducted his study on 97 expander (69 patients) and compared the complications occurred in the over expanded group in comparison to the under expanded group. There was fewer complication rate in the over expanded group with no evidence of mechanical failure. The largest volume was inflated in the expander was 3.5 times the recommended maximum volume.

In our study we conclude that overfilling is a safe procedure with few complication rates provided that the strict pre, intra, and post-operative recommendations that minimizes the major complications that preclude the completion of expansion process.

The drawbacks of the massive soft tissue expansion are the need of a cooperative patient who is committed to the instructions and the schedules of injections. The other drawback is the long duration of expansion process that reaches up to eleven months in some patients, which may be a problem in getting a long vacation due to disfigurement that last for a long period. The last complain that was reported by most of the patients that the difficulty to find well-fitting accepted clothes to be dressed in outdoors during follow-up visits.

REFERENCES