Excision of Strip of Deep Fascia to Reduce Seroma Formation and Extrusion of Tissue Expanders

Adel M. Wilson MD, FRCS
Assistant Professor of Plastic Surgery; Cairo University

ABSTRACT

Tissue expansion has enjoyed a wide range of applications since the technique was popularized in the latter quarter of the last century. During the expansion process, subcutaneous fat liquefies, skin becomes thinner, muscles atrophy, blood inflow increases, and lymphatics get occluded. All these factors predispose to seroma formation and implant extrusion. A similar problem occurred with lymphoedema patients, and one of the lines of treatment was creation of a connection to the deep lymphatics to facilitate absorption of accumulated fluid. The same principle was extrapolated to 56 patients having tissue expanders inserted in the neck and limbs. This reduced the incidence of seroma to zero % and markedly reduced the overall incidence of complications. Patients and results are presented in the article.

Keywords: Tissue expander – seroma- extrusion- lymphatics- deep fascia.

INTRODUCTION

The techniques of tissue expansion have been used for many years to expand normal skin adjacent to the site of a defect. Initially described by Neuman in 1953\(^1\), it gained widespread popularity in the eighth decade of the last century after the work of Radovan\(^2\), and has been progressively popular since.

The physiology of prolonged tissue expansion was not just a matter of stretching skin, but the actual formation of additional new skin which had all the attributes of the original tissue. Austad et al.\(^3\) postulated that tissue expansion caused a decrease in cell density in the basal layer of the skin and that cell density might regulate skin mitotic activity. A lower cell density resulted in a greater cell proliferation, resulting in growth of additional skin. Inflation of the tissue expander was found to cause a threefold elevation of epidermal mitotic activity within 24 hours, followed by a gradual return to normal baseline over 2 to 5 days\(^4\). Conversely, deflation of the expander caused a transient decrease in epidermal mitotic activity. The increase in mitosis returned to normal 4 weeks after expansion.

The dermis and subcutaneous tissues were thinned as a result of tissue expansion leading to an overall decrease in tensile strength of the expanded skin\(^5-7\) and this persisted 36 weeks after expansion. The subcutaneous layer of fat was intolerant to stretching causing significant thinning. With faster expansion, fat necrosis could be seen. Pressure necrosis on subcutaneous fat led to liquefaction and seroma formation\(^8,9\).

With progression of expansion compression of superficial lymphatics resulted in their occlusion and lymph accumulation. Furthermore, the muscle layer in pigs, which was similar to the platysmal layer in humans, tended to atrophy with maximal expansion. As expansion proceeded, there was an increase in the number and size of the blood vessels within flaps supplied by random-pattern vessels and, if present, axial vessels. These changes corresponded to the demonstrated increase in blood flow to expanded flaps. In the study by Saxby\(^10\) this lead to surviving lengths after expansion being 50 percent greater than the delayed controls, and nearly 150 percent greater than comparable flaps raised acutely.

These histologic and physiologic findings would explain the high incidence of seroma formation\(^11\) with tissue expanders especially...
those inserted in areas rich in subcutaneous fat, such as the neck (12) and limbs. During the expansion process, subcutaneous fat liquefies, skin becomes thinner, muscles atrophy, blood inflow increases, and lymphatics get occluded. All these factors when coupled with the fact that mere presence of a foreign body incites fluid exudation (13) would be a frank invitation for seroma formation and implant extrusion.

Reported rates of seroma (14,16,17) varied in the literature between 5-18%. Its effect ranged from minor complications that that did not interrupt the expansion process or require any operative intervention (32%) (15-17) up to major complications that required additional operative intervention (12%).

Opinions differed between authors regarding seroma prevention. Several authors omit use of drainage procedures to prevent infection. Others use closed suction drains (18) but there was an increased risk of infection; and seromas tended to occur following their removal.

External filling ports might drain seromas through the entry port, but at the risk of increased infection rates (19). Over inflation of the expanders to obliterate any dead space came with the risk of overlying skin ischemia and necrosis.

As a projection to the hypothesis of Thompson (20) on lymphoedema management, this study was performed to find the effect of opening new drainage channels between the superficial and deep lymphatics on the incidence of seroma formation.

**PATIENTS & METHODS**

Between February 2005 and June 2008, 88 tissue expanders were inserted in 56 patients to treat various post burn scars and deformities in the neck and limbs. Patient age ranged 4-56 years (mean 28.8 years), and 30 were females (53.5%) whereas 26 were males (46.5%). 75 (84%) of these expanders were rectangular, whereas 13 (16%) were circular. Size of expanders ranged between 100-800 ml (mean 425ml), and base dimension ranged between 6x4.6 cm to 28x9 cm.

52 expanders were placed in the side of the neck in 37 patients (66%), 25 expanders were placed in the upper limbs of 13 patients (23%), and 11 expanders were placed in the lower limbs of 6 patients (11%). Different brands were used since there was no relevance in using a particular make; but all had a distant reservoir. Self-inflating expanders and those with incorporated reservoirs were not used in this series. Allexpanders were used once and then discarded.

All expanders were inserted in the operating room under general anesthesia. The universal incision described by Matton et al to minimize dehiscence (21) was used to insert the expanders. Incisions were placed in an inconspicuous site and planned so as not to compromise the viability of advancement flaps planned for reconstruction after the expanders were removed. No drains were inserted in any patients of this series. Ports were kept internal, about 4-6 cm from the expander, and placement of the reservoir dome was considered carefully to avoid kinking of the connecting tubing and pressure necrosis of overlying skin. Perioperative antibiotics were given to all patients.

In the limbs, the placement of the expander was beneath the subcutaneous fat. In the neck, expanders were placed strictly sub-platyzmal (and/or sub SMAS). A large enough pocket was dissected so that the expander would fit without any folding. Following dissection of the pocket, a 1-2 cm strip of deep fascia was excised along the whole length of the pocket. After meticulous hemostasis, the wound was closed in two layers and enough saline was instilled into the expander so that the dead space would be obliterated.

Following the initial 10 days, expansion was instituted by instillation of saline into the reservoir with a 25-gauge needle at a volume of approximately 10% of the expander size. The end point of expansion was achieved when the overlying skin became tense or the patient complained of significant discomfort. Care was
taken to ensure that the skin blanched with pressure from the expander, but capillary refill returned to normal after adequate pressure was withdrawn. Expansion was carried out twice weekly, for 4-6 weeks (mean 5.2 weeks). In none of our patients was there a need to over inflate the expander.

At the conclusion of expansion, the second surgery was promptly done. The expander was removed and capsule merely crosshatched to allow for further lengthening of the flap of expanded tissue without thinning it or compromising its vascularity. Scar or deformed tissue were excised, and expanded flaps mobilized and sutured in place in two layers.

RESULTS

Expansion was successful and continued to the preplanned volume in 54 patients (96.4%), whereas in only 2 patients it terminated prematurely. Stitches were taken out on the 10th postoperative day, and compression garments used for 3 weeks to ensure smooth inset of the flap. Follow up period ranged 6-10 months (mean 8.2 months), and all patients in which the procedure was completed were satisfied with the end result.

During the expansion process, none of the patients developed seromas or hematomas. The expansion process was uneventful except in the two patients who developed complications: one patient developed resistant infection that turned out to be Klebsiella which failed to respond to parenteral antibiotics, warm compresses, or partial implant deflation. The implant was removed, pocket irrigated, drained and left to heal. The second patient developed skin necrosis over the port with implant exposure and extrusion. The procedure was aborted, and another expansion scheduled one year later.

None of the other patients developed any other complications nor implant extrusion.

Figures 1-11 show the appearance of 11 patients in this series at the end of the expansion procedure with the expanders fully inflated.
Fig. 1: A 4-year old child with post burn scarring in the lower cheek and line of mandible. Note a fully inflated 300 ml rectangular expander under the healthy neck skin.

Fig. 2: A 5-year-old child with post burn scarring in the nasolabial region. Note a fully inflated 280 ml rectangular expander under the healthy neck skin.

Fig. 3: A 7-year old child with post burn scarring in the parotid region, temple, and along the mandibular border. Note a fully inflated 350 ml rectangular expander under the healthy neck skin.

Fig. 4: A 39-year old female with post burn scarring in the lower lip, chin, right cheek and mandibular border. Note a fully inflated 800 ml rectangular expander under the healthy neck skin.

Fig. 5 a, b: A 28-year old male with post burn scarring in the chin, left cheek, nasolabial regions and mandibular border. Note two fully inflated 600 ml and 400 ml rectangular expanders under the healthy neck skin.

Fig. 6: A 22-year old male with post burn scarring in the left side of the neck and anterior chest wall. Note two fully inflated 600 ml and 400 ml rectangular expanders under the healthy neck skin.

Figure 7: A 42-year old male with post burn scarring in the left cheek, nasolabial region, temple and anterior chest wall. Note a fully inflated 700 ml rectangular expander under the healthy neck and epaulette skin.

Figure 8: A 25-year old female with post burn scarring in the left elbow. Note two fully inflated 250 ml rectangular and 220 ml rounded expanders under the healthy arm skin.

Figure 9: A 16-year old female with post burn scarring in the left thigh. Note a fully inflated 700 ml rounded expander under the healthy thigh skin.

Fig. 10: A 27-year old female with post burn scarring in both thighs. Note two fully inflated 250 ml rectangular and 280 ml rounded expanders under the healthy skin of the left thigh and a fully inflated 500 ml rounded expander under the healthy skin of the left thigh.

Figure 11: A 31-year old female with post burn scarring in right thigh. Note two fully inflated 300 ml rectangular and 700 ml rounded expanders under the healthy skin of the right thigh.
DISCUSSION

Tissue expansion allows resurfacing of wide defects with neighboring skin similar in color, texture, sensation, and retained adnexal structures. In spite of its advantages, it is a tedious procedure that requires two separate surgical procedures: one to place the expander and the other to remove the expander and perform the reconstruction. This type of surgical procedure is also time and labor-intensive in that frequent visits to the office are necessary for inflation of the implanted expander and it takes several weeks to gain adequate tissue by expansion. Another disadvantage in the head and neck area is the visible deformity caused by the expansions, particularly toward the end of the expansion process.

The complication rate, which varied in the literature between 5-32%, was quite high and hard to accept by both patient and surgeon after going through such tedious surgery\(^\text{(12,15-17)}\). A cause of complications is the occurrence of seroma, which when coupled with the finding that expanded skin became thinner and weaker\(^\text{(5,6)}\), predisposed to implant extrusion and failure of the expansion procedure. The histologic and physiologic changes that occur with tissue expansion include liquefaction of subcutaneous fat, atrophy of muscles, increase in blood inflow, and occlusion of lymphatics; all enhance the formation of seroma, which predisposes to implant extrusion.

In order to reduce the occurrence of seroma with tissue expansion, it seemed logic to extrapolate the application of Thompson principle\(^\text{(20)}\) for treatment of limb lymphoedema to tissue expansion. In all patients of this series, a connection was established between the superficial and deep lymphatics in an attempt to open up new drainage channels for any seroma that might accumulate. A strip 1-2 cm wide was excised from the deep fascia at the time of expander insertion. It was considered prudent to excise deep fascia rather than merely incise it, to avoid healing of the incision by fibrosis during the 10-day lag period before expansion was instituted. As expansion proceeded, and in the event superficial lymphatics got blocked by the pressure of the expander, the deep lymphatics would remain patent and drain any seroma. The enhanced transudation of fluid by the presence of a foreign body\(^\text{(13)}\) and increased blood supply\(^\text{(10)}\), and fluid formed from liquefaction and necrosis of the subcutaneous fat\(^\text{(8)}\) would thus find an escape into the deeper lymphatics rather than form a seroma. Application of this principle to patients in this series led to an incidence of seroma of zero %, and marked reduction of overall complication rate when compared to that mentioned in the literature (3.6% versus 5-32%).

Expanders inserted in the limbs and necks were chosen for this series due to the high complication rate in these areas and presence of a well-formed deep fascia separating superficial from deep lymphatics. Those in scalp and abdomen were omitted due to absence of deep fascia in these areas.

The majority of expanders used in this series were rectangular (84%), since these provide the most effective surface area gain when compared to the round or crescent ones. Rectangular expanders gain 38% in tissue area of the calculated surface increase of the expander, whereas round expanders gain 25% and crescent expanders gain 32% of calculated surface increase. Most patients required more than one expander. Those with limb deformities required mostly two expanders so as to surround the area of scarring from two directions. Although expanders could be over inflated\(^\text{(22)}\) 15 times the vendors stated maximum volume, a disadvantage of over inflation was increased leakage from the dome of the injection port. Nordstrom\(^\text{(23)}\) found that the average pressure necessary for leakage from the injection port of an expander was 32 mmHg (range 8-110 mmHg), which was why all expanders in this series were inflated only to the level described by the vendor.

In view of the results of this study, we would recommend routine excision of a strip 1-2 cm wide in the deep fascia when inserting expanders in the limbs and neck.

**Conclusion**

Tissue expansion is accompanied by high complication rates, with accumulation of seroma being one of the complications. Creation of drainage pathway to the deep lymphatics by excision of a strip of deep fascia was found to significantly reduce the incidence of seroma and hence overall complication rate. We recommend this be a routine procedure while inserting any tissue expander in the neck and limbs.
REFERENCES


