



Tissue Expansion: A Valuable Tool for Reconstructive Surgery in Head And Neck Scar

KEYWORDS

Post burn scar, post traumatic scar, tissue expander.

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ABSTRACT *Background: Resurfacing of large facial scar is a formidable challenge because of the unique character of the region and the limitation of well-matched donor site. In this study , we introduce a technique for using the tissue expanded skin flap for facial resurfacing, in an attempt to meet the principle of flap selection in face reconstructive surgery for matching the color and texture, large dimension, and thinner thickness of the recipient.*

Methodology:

From 1st September 2013 to 29 February 2016 total of 82 patients with scar over head and neck region were enrolled in this study. All patients were treated with tissue expansion technique. And total 104 expanders were palced.

Results:

The expanded skin flaps were transferred to the recipient site for facial resurfacing. All facial scars were successfully covered by the flaps. Although varied degrees (17.30%) of complication occurs. The results in follow-up showed most resurfaced faces restored natural contour and regained emotional expression and good patient satisfaction.

Conclusion:

Our experience in this series of patients demonstrated that the expanded skin flap could be a reliable alternative tool for resurfacing of head and neck scars.

INTRODUCTION

Facial disfigurement, especially resulted from massive soft tissue defects after burn or post traumatic injury, represents a profound disruption of body image and may constitute a major social and psychological crisis. The head and neck area contains many specialized tissues that must be matched appropriately to achieve optimal aesthetic reconstruction. Aesthetic reconstruction is maximized by mobilization of adjacent local tissues rather than by transfer of distant tissues with poor match of color, texture, or hair-bearing capability. Tissue expansion therefore allows optimal aesthetic reconstruction by use of a similar adjacent tissue area to reconstruct a defect without creation of a donor site.^{1,2}

Skin expansion allows the surgeon to generate additional amounts of precious tissue, to thin the flap, and to increase its vascularity³. Tissue expansion was developed for specific indications. Tissue expansions have been successfully employed to address a variety of defects including birth defects, burn injuries, traumatic wounds, and reconstruction of breasts after tumor removal. Tissue expansion is certainly the ideal strategy to grow skin that matches the color, texture, hair bearance, and thickness of the surrounding healthy skin, while ensuring easy resurfacing of the donor site also.^{4, 5, 6, 7} it allows surgeons to cover defects using local skin of appropriate color, texture, and adnexal structure⁸. Aesthetic subunits of the face can be replaced by skin of identical or similar qualities, and distant donor sites can be avoided. Sensate and hair-bearing skin

can be expanded and used for specialized areas of facial reconstruction; usually, the color and texture match are excellent⁹. Tissue expansion is contraindicated in infected tissues, malignancy, skin grafted tissues and irradiated tissue beds. Tissue expanders are best avoided in the central face, hands, feet, or in a psychologically non-compliant patient. Although expansion is possible in radiated or scarred tissue, it is associated with a much higher complication rate and should therefore be avoided.^{5, 6, 7} The overall complication rates are in the range of 13- 20%.^{7, 10} The major complications are infection, implant exposure, expander extrusion, implant rupture and flap ischemia. The minor complications include seroma, hematoma, filling port problems, dog ears at donor site, widened scar and transient pain at the time of expansion.^{5, 6, 10}

MATERIALS AND METHODS

This study was conducted in tertiary level burns and plastic surgery center over 2 years and six month's duration from 1st September 2013 to 29st February 2016. Study sample comprises 82 patients with scar of head and neck region. 32 patients were male and 50 were female, age group ranges from 12 to 56 years, admitted directly in department or referred from peripheral health centers and private hospitals.

The etiology of scar was post burn in 52 patients (63.41%), post traumatic in 20 patients (24.39%) and post surgical scar in 10 patients (12.19%). In 60 cases we used single large expander, and in 22 cases 2 expanders were used

according to scar size.

out of 104 expanders 82 (78.85%) were rectangular, 14 (13.46%) crescentic, and 8 (7.69%) were rounded with distant port placement in all cases.

Full history was recorded for each patient to clarify the etiology of the defect, age and weight of patient, concomitant diseases and working activity.

General and local examinations of the patient were also conducted. Reconstruction should be carried out after all wound have thoroughly healed and scars have matured.

Laboratory studies included: Complete blood count (CBC), Blood sugar, renal function tests, Prothrombin time and activated partial thromboplastin time. Imaging studies: Chest radiograph if indicated by medical examination or the patient's history, ECG.

Surgical technique:

Incision and expander insertion-

The key to successful expansion is meticulous planning before any incision is made. Ideally, planning is done so that: (1) incisions are incorporated into tissue that will become one margin of the flap; (2) aesthetic units are reconstructed; (3) scars are in minimally conspicuous locations; and (4) tension on suture lines is reduced.

A prophylactic antibiotic was prescribed for all the patients during expander insertion and removal procedure. Expander insertion was performed under general anesthesia.

We are planning a fasciocutaneous flap the expander will be located below the deep fascia. After flap elevation is completed, fine hemostasis and washing with antibiotic solution (500 ml normal saline and 160 mg gentamycin) was done. Insertion of a sizer for various expander designs verifies the correct expander dimensions. In general expander should be slightly smaller than the dissected space beneath the flap territory. The size of the implant selected should closely relate to the size and shape of the donor surface. An implant equal to or slightly smaller than the donor area is selected. Because there is minimal risk in hyper inflating the prosthesis to several times the manufacturer's designated volume, less importance is placed on the implant's specific volume than on its overall base size.

In general, the use of multiple small expanders is better than the use of one large expander. Inflation of multiple prostheses proceeds more rapidly and complications are fewer. Multiple expanders also allow the surgeon to vary the plan for reconstruction after expansion has been achieved.

After the expander is inserted, a tunnel is made for placement of the distant port. This tunnel should not cross beneath the incision line and at least 6 cm long. Port should be placed in superficial position to allow easy palpation during subsequent injections for implant inflation. Initially the expander is only filled to 10% to 20% of capacity. This allows closure of "dead space" to minimize seroma and hematoma formation. It also smoothes out the implant wall to minimize risk of fold extrusion. The wound closed in multiple layers, fascia and subcutaneous area was repaired using vicryl suture and the skin was closed using nylon 6/0.

Expander inflation

The expansion process is not started until 2 to 3 weeks after expander insertion to allow complete healing of the insertion site. A 23-gauge butterfly intravenous needle is used for inflation of implant at weekly interval. There are two approaches of expansion 1) injection of saline solution to a maximal end point at which pain or blanching of skin territory is observed and subsequent deflation until skin capillary refill or discomfort has resolved and 2) injection of 10% to 20% of the total volume at each visit.

The expander device is inflated to maximal volume during a specific time interval of 2 to 3 months. Tissue expansion was measured by subtracting the tissue expander's base size from the width of the skin on the exposed tissue expander. This measure must be at least 10-20% more than the scar width.

Expander removal and flap inset

The flap dimensions are outlined on the expanded cutaneous territory. Flap is ready for transposition following flap elevation and removal of the expander. The capsule surrounding the expander limits flap advancement for this reason multiple capsulotomy incisions are made at 3 to 4 cm intervals, taking care to preserve vascularity of flap. A closed suction system is used at the donor site to avoid seroma formation in postoperative period. If repeated expansion is planned reinsert the expander beneath the expanded flap 3 to 6 months later.

Patient activities are restricted postoperatively for 5 to 7 days to avoid tension at the flap closure site and subsequent wound dehiscence.

RESULTS:

During the time period of September 2013 to February 2016, 82 patients underwent tissue expansion. All patients who had a cutaneous expander for reconstructive purposes were reviewed retrospectively. 32 patients were male (39.02%) and 50 (60.97%) were females. The most common indication for tissue expansion was burn sequelae, trauma, and scars from previous surgery (Table 1).

TABLE 1-

| Indication | Number of patients | Percentage |
|--------------|--------------------|------------|
| Burns | 52 | 63.41 |
| Trauma | 20 | 24.39 |
| Post surgery | 10 | 12.19 |
| Total | 82 | 100 |

The ages of patients ranged from 12 to 56 years (average 21.9 years). All of expander placed in head and neck region. We preferred to place rectangular implant (78.85%). (Table 2)

Table 2-

| Type of expander | Number | Percentage |
|------------------|--------|------------|
| Rectangular | 82 | 78.85 |
| Crescentic | 14 | 13.46 |
| Rounded | 8 | 7.69 |
| Total | 104 | 100 |

The medical records and operative reports of all patients were analyzed. Each patient was studied with respect to indication for the procedure, location, and shape of expander, previous expansion if any and complications. Data

such as expander volume and dimensions were not always found in the medical records and could not be used in this study.

The results were evaluated using the rate of complications as criteria of fulfillment of the reconstruction and patient satisfaction. Those cases with no complications were classified as a highly satisfactory result. Complications were divided into major and minor categories. Major complication was defined as that resulting in a premature loss of expander that required additional surgery, or when the preoperative plan was not completed, thus yielding a poor result. The minor complication was defined as that resulting in only partial satisfaction of the preoperative plan and thus defined as a fair result¹¹. Beside, the complication related to the reconstructed skin were observed in 5 patients, including wrinkling (3 cases), inadequate coverage (3 cases), and superficial necrosis (1 cases). Overall, most of the patients were satisfied with the operation results. reconstruction of face and neck scar using this method not only have been very pleasant in term of beauty for both patient and his/her family, but a significant improvement on the patient's appearance. (figure-1A-C, 2A-B)

Post operative complications (Table 3) occurred in 18 (17.30%) patients. Most common complications are Exposure of implant in 6 (5.77%) expanders, Infection in 4 (3.85%) expanders, port failure in 3 (2.88%) expanders, suture dehiscence in 3 (2.88%) expanders, distal flap necrosis in 1 (0.96%) expander and expander rupture in 1 (0.96%) . (figure 3 A-D)

Table 3-

| Complication | Number of expanders | Percentage |
|----------------------|---------------------|------------|
| Exposure of implant | 6 | 5.77 |
| Infection | 4 | 3.85 |
| Port failure | 3 | 2.88 |
| Suture dehiscence | 3 | 2.88 |
| Expander rupture | 1 | 0.96 |
| Distal flap necrosis | 1 | 0.96 |
| Total | 18 | 17.3 |

DISCUSSION:

Cutaneous expansion is used increasingly in reconstructive surgery for the treatment of a variety of problems in children and adults. The reconstruction of many congenital and acquired defects has been made possible through the use of this technique¹². The cause of scar was burn (63.41%) followed by trauma (24.39%) and post surgical scar (12.19%). Selection of size, shape, and location of tissue expander and location of injection port is very important. Motamed et al. used rectangular tissue expander and claimed that using these expanders might increase the option for flap design¹³. In general tissue expanders are placed in the regions near the scar on face, neck, or scalp which have the most similarity with the skin colour.¹³ based on the present study results, neck was the most common site for expander placement (60%). Previous study have also been shown that healthy skin of neck has the maximum similarity with the facial skin.¹⁴ In the current study Post operative complications occurred in 18 (17.30%) expanders. Most common complications are Exposure of implant in 6 (5.77%) expanders, Infection in 4 (3.85%) expanders, port failure in 3 (2.88%) expanders, suture dehiscence in 3 (2.88%) expanders, distal flap necrosis in 1 (0.96%) expander and expander rupture in 1 (0.96%). According to Spence et al. the patients complications include infection

(5%), exposure of tissue expander (3%), tissue expander or injection port malposition (3%) and loss of part of flap (3%)¹⁵. Furthermore, Chung and colleagues reported a complication rate of 12% in their research¹⁶. Meticulous and careful planning for using flap donor while application of tissue expanders leads to a reduction in the complications and face deformities¹³. Regarding the use of tissue expanders, the reconstructed flap texture and colour should be in good assimilation with the recipient area¹⁷

Tissue expansion has developed as a routine procedure in plastic surgery in the past two decades. In 1956, Neumann was the first to recognize the potential of tissue expansion for reconstructive surgery. He implanted a balloon beneath the temporal region for reconstruction of an absent ear. In 1976, Radovan used the tissue expander concept for reconstruction of the breast after mastectomy. Subsequently, the use of tissue expansion has been popularized among plastic surgeons and has become the treatment method of choice for many congenital and acquired defects in children and adults^{18, 19, 20}. Expanders are silicone envelopes that have self-sealing injection ports. At weekly intervals, saline is progressively injected through the port and passes into the expander, which enlarges. As the volume inside the implant increases, tension placed on the overlying and adjacent tissues increases²¹. Tissue expansion technique exploits the adaptability quality of skin and induces a controlled *in situ* skin growth. Stretches beyond the skin's physiological limit invoke several mechano-transduction pathways, which increase mitotic activity and collagen synthesis, ultimately resulting in a net gain in skin surface area. All these induced changes can be categorized into two main phenomena, namely mechanical creep and biologic creep. The former denotes the morphologic changes that occur on a cellular level in response to the stretch on cells while the latter describes the tissue growth by cell proliferation that tries to restore the resting tension of the stretched tissues to the baseline.^{5, 10, 22} Histologically, both adult and pediatric skin responds to expansion in the same manner. Initially the epidermis thickens while the dermis thins. The skin appendages remain the same in number. Subsequent cellular proliferation reduces the resting tension of the skin with eventual return to its baseline thickness. Acutely, the tissue expansion is associated with slight epidermal thickening and significant dermal thinning, resulting in an overall thinning and a reduced tensile strength. Chronically, the phenomenon of tissue expansion is associated with the gradual restoration of baseline histology, baseline mechanics, and baseline structure. Histologically, a comparison of piglet tissue in the expanded and non-expanded regions has demonstrated a chronic restoration of the number of epidermal cell layers as well as epidermal thickness. Also on immune cytochemistry the expanded tissue retains its original phenotypical characteristics and native program of cellular differentiation.^{7, 10, 22} In a net shell, the changes induced by tissue expansion are analogous to the physiological local expansion of abdominal wall typically seen in pregnancy, with reversal to normal upon removal of the cause. There is no neoplastic transformation involved. Commercially available traditional tissue expanders are silicone balloons employed to achieve desired tissue expansion in a given region of the body. These are available in different shapes and sizes, including round, rectangular and crescent shapes. The capacity of the round ones ranges from 100-2,000 cm³ while that of rectangular ones ranges from 100-1,000 cm³. The rectangular ones are the best as they diversify the possible designs of future flaps. The expander is serially inflated with normal saline solution from a remote injection port connected by

a closed tube system or by a integral port which are incorporated directly in shell of expander over a period of weeks, generating new tissue in response to the constant stretch caused by the progressively enlarging expander. Once enough new skin is produced, typically after a period of multiple weeks, the device is removed, and the new skin and tissue is used to pursue the planned tissue reconstruction.^{5, 6} Recently an osmotic self-filling tissue expander (Osmed™), available as a few centimeter sized device, has come in vogue in the developed societies with much easy placement and no need for inflation from outside.⁷ The device spontaneously inflates by sucking body fluids at a predictable rate to a final volume of up to 10-12 times its original size. These osmotic self-inflating tissue expanders offer apparent benefits particularly in the pediatric population. The device is small, requiring only a small incision and small pocket for insertion, which can be performed under local anaesthesia. The patient experiences less discomfort because of the gradual nature of the expansion. Fewer visits to the hospital are required. The risk of iatrogenic infection is greatly reduced. The device is a dehydrated hydrogel consisting of a modified co-polymer of N-vinyl-2-pyrrolidone and methylmethacrylate, surrounded by a porous silicone membrane that limits the osmotic filling speed.⁷

Advantages of tissue expansion include no new unduly disfiguring effects, the avoidance of distant flaps, sensation maintenance, good color and texture match, preservation of hair-bearing quality, and increased vascularity and greater length of survival of random flaps elevated in expanded skin.

Disadvantages of tissue expansion are frequent office visits for inflation, discomfort, and a period of increased deformity during the time of inflation. In the pediatric population, emotional disturbance may accompany the use of tissue expanders. Formation of a scar tissue capsule may result in reduced skin elasticity, and impeded flap movement and expanded skin has a tendency for postoperative retraction¹⁷.

CONCLUSION:

The study showed that most patients were satisfied with the operation results. One of limitation of study was the impossibility of following some patients up after surgery. Overall, the result of this study has shown that using tissue expander in reconstruction of extensive head and neck scar has lead to satisfactory results. reconstruction of head and neck scar using this method not only have been very pleasant in term of the beauty for both patient and his/her family, but also it has shown a significant improvement on the patients appearance. Yet more research is required to investigate some methods for lessening the tissue complications of this technique.

Figure1 (A)- Expander in situ in patient 1 for post burn scar



Figure 1(B)-Immediate post operative picture of patient -1





Figure 1(c)-Post operative picture of patient- 1



Figure 2(B) -Post operative picture of patient 2



Figure 2(A)- Expander in situ in patient 2 for post burn scar alopecia scalp



Figure 3 complication-
3(A) Implant exposure-



3(B) Infection-



3(C) Port failure



3(D) distal flap necrosis



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