

Pros and Cons of Soft Tissue Expansion in the Limbs

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Abstract:

Tissue expansion is a widespread and accepted concept in reconstructive surgery, but is also afflicted with a variety of complications. The limbs are a common area for skin expansion, which can be used to treat some functional and cosmetic skin disorders of both upper and lower limbs, leaving only minor residual scarring. Surgical management of benign tumors, such as giant naevi, and the removal of extensive areas of disabling or unsightly scar tissue are the main indications. The aim of this study is to evaluate and to refine the use of tissue expanders in both upper and lower limbs, detect the best types and sites of skin incisions, plane insertion for the expander and the number of expanders used for each case. It also detects the complication rates and to evaluate the cosmetic as well as the functional benefits for each case. The study showed that expanders in the lower limbs have much higher complication rates than the upper limbs and certain measures should be taken to minimize the incidence of complications including careful patient selection, good pre-operative planning, with detailed pre-operative instructions to the patients to have reasonable expectations.

Keywords: Tissue expansion, Upper Limb, Lower limb, Tissue expanders.

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Introduction:

The concept of tissue expansion in surgical practice was first reported by Neumann in 1957, while skin expansion was pioneered independently by Radovan, Austad, and Lapin. In retrospect, it was the combination of Radovan's clinical work and Austad's scientific work that elevated tissue expansion from a forgotten reference to a leading reconstructive tool ⁽¹⁾. Tissue expansion has since been used in all areas of the body for a wide variety of indications, all with efficacy and success. Primarily established for breast reconstruction, skin expansion represents one of the major developments in reconstructive surgery in recent years, particularly as a valuable approach for many problems in reconstructive burn surgery ⁽²⁾. Endoscopic expansion surgery, although recently introduced, has shown to be very beneficial. A few series are already available and document the advantages of this technique. Further improvements in the endoscopic technique associated with better instrumentation and more sophisticated devices make this approach the ideal way to perform safer expansion surgery with smaller scars and less morbidity ⁽³⁾.

In the past, reconstruction strategies like facial resurfacing procedures generally included the use of split thickness skin grafts. Incomplete graft take resulted in recurrent scarring and pigment imbalances with a reduced aesthetic outcome. Tissue expansion on the other hand, allows large areas of burn scar to be resurfaced and provides tissue of similar texture and colour to the defect to be covered and has the advantage of minimal donor site morbidity. Furthermore, the expanded tissue displays high vascularity, which is considered to be superior to surgically delayed flaps ⁽⁴⁾.

The limbs are a common area for skin expansion, which can be used to treat some functional and cosmetic skin disorders. Indications for tissue expansion include aesthetic as well as reconstructive uses. During the era of cost containment and lesser availability of reconstructive microsurgical procedures may make

tissue expansion a method of choice to augment the soft tissue envelope. Specific indications include surgical management of benign tumors, such as giant naevi, patient with restricted range of motion because of skin adhesions to the underlying muscle, and scar revision to improve cosmesis ⁽⁵⁻⁷⁾.

Patients and Methods:

During a period of 36 months, 28 expanders were inserted in 20 patients (15 females and 5 males) who presented to Kasr Al-Ainy Hospital in the period from March 2007 to February 2010. Their ages varied from 12 to 43 years (mean age: 22.5).

The patients were instructed that two operations are required with temporary deformity that may be inconvenient and hard to disguise. All patient were subjected to complete history taking, general and local examination especially the Skin surrounding the site of insertion.

Indications to insert tissue expanders in this study included Post-burn Scars in 12 patients, Post-traumatic Scars in 4 patients, Giant Nevus in 2 patients, Excision of Xanthelasma on the elbow in 1 patient, Tattoo excision in 1 patient.

Exclusion Criteria included extremes of age, patients who are suspected to have bad compliance and those with chronic medical diseases (i.e. Diabetes, hypertension. etc.).

Anatomical Distribution of the inserted expanders included 9 in the Lower Limbs of 7 patients (2 in the Gluteal region, 5 in the thigh and 2 in the leg). 19 were inserted in the Upper Limbs of 13 patients (11 in the arm and 8 in the forearm).

Internal valves were used in 18 patients (26 expanders), external valves were used in 2 patients only (2 expanders) as the patients did not comply with the presence a tube and a valve getting outside the wound for a long time.

To minimize complications new expanders were used in most patients (22 expanders in 16 patients), Re-used sterilized expanders (with Ethylene Oxide for 24h) were used minimally (6 expanders in 4 patients).

General endotracheal anesthesia was used in all patients; Pre-operative antibiotics were given in all patients (Penicillin group). Open technique (to dissect the pockets for the expander insertion and hemostasis) was used in all patients except in 1 patient where endoscopic technique was used. Remote incisions were used for the insertion of the expanders as the incisions were placed 1cm from the margin of the scar on the scar side in stable tissue that is expected to heal. The level of dissection was always subcutaneous and over the deep fascia of the underlying muscles. Dissection of the pocket was planned to be as the size of the base of the expander with extended dissection to be inserted 2-3 cm away from the incision site to avoid expander extrusion. Before and after insertion of the expander it was tested by injecting sterile saline to detect any leak. Suction Drains were always used. About 10-15% of the expander size was injected with sterile saline to close the dead space and help hemostasis. Wound closure was in three layers. The first layer was 2cm from the incision to separate the pocket from the incision, the second layer was in the subcutaneous tissue, and the third layer was the skin. Drains were removed when the discharge was minimal (about 20cc/day), the patients were discharged 3 - 4 days post-operative and they were followed up in the outpatient clinic.

Injection of the expanders started 2-3 weeks post-operative depending on the healing of the scar; it was done gradually 1-2 times weekly. The amount of saline injected per session differed according to the expander size (about 10% of the expander's volume/week). The guide for the stoppage of injection included pain and blanching of the overlying skin. After reaching the full expansion in non-complicated patients the expanders were left for 2-3 weeks to provide more elasticity in the skin.

Expander removal was done after reaching full expansion (either reaching the full expander volume or if a complication occurred as ulceration of the skin or late extrusion), the expander was removed through the same incision of the expander's insertion. Advancement flaps were always used in this study to avoid scarring at the donor site, leaving only one fine longitudinal scar, which is much more compatible with the functional and cosmetic goals of surgery on the limbs. The scar or lesion was excised and the flap was placed. Suction drains were always used and antibiotics were given to all patients.

Results:

In 14 out of 20 patients (70%) expansion was achieved without any complications (22 out of 28 expanders 78.6%) resulting in complete excision (14 patients) or partial excision (5 patients) of the lesion. Any complication likely to compromise the success of the procedure was considered as Major Complication.

Major complications: From a total of 28 prostheses, 6 had major complications: Extrusion in 2 patients (7.1%), Infection and prostheses removal without expansion in 1 patient (3.57%) and Ulceration of the skin overlying the prostheses in 3 patients (10.7%) with overall complication rate (21.4%). The patient who was complicated by prostheses infection, 5 days post-operative manifested by redness and tenderness of the overlying skin with infected discharge coming out of the wound, The patient was given antibiotics and continuous dressing of the wound was done but this failed and the expander had to be removed two weeks post-operative. The pocket was cleaned with Betadine and Saline and a suction drain was inserted before the wound was closed. In the two Patients of Extrusion: One occurred early during expansion after 6 weeks from the start of the expansion and it compromised the expansion of the skin leading to failure of coverage of the pre-planned lesion. The

other failure occurred lately (after 3 months from the start of expansion) through the suture line did not compromise the skin flap and good coverage of the pre-planned lesion. In the three patients of Skin ulceration of the skin overlying the expander: All occurred in the late stages of expansion after gaining satisfactory skin flap and that allowed good coverage of the desired skin lesions.

Minor complications: Seroma: only one patient of seroma formation (3.5% of prostheses); prophylactic antibiotics were given and the rest of the procedure went smoothly.

The incidence of major complications with new expanders was 18.2% while in reused expanders after sterilization was 33.3%, as shown in table (1)

Table (1) Complications according to the type of the expander

		Total No.	Type of Expander	
			New 22 Expander	Reused 6 Expanders
Not Complicated	Number	22	18	4
	Percentage	78.6%	81.8%	66.6%
Complicated	Number	6	4	2
	Percentage	21.4%	18.2%	33.3%

The incidence of major complications in expansion of the Lower Limb was 44% while in the Upper Limb was 10.5% as shown in table (2).

Table (2) Complications of tissue expansion in different anatomical sites

Site		No. of Expanders	Total No.	Incidence of Complication	Total Incidence	Extrusion	Infection	Ulceration
Upper limb	Arm	11	19	9.1%	10.5%			1 (New)
	Forearm	8		12.5%		1 (New)		
Lower Limb	Gluteal Region	2	9	50%	44%			1 (Reused)
	Thigh	5		50%		1 (Reused)	1 (New)	1 (New)
	Leg	2		0%				

Post-operative Sequelae: From the total number of 20 patients: 5 patients showed partial coverage of the desired lesion (25%), 1 patient showed complete failure to cover pre-planned area due to early extrusion of the prostheses (5%), 3 patients showed widening in the scar gradually post-operatively (15%) and 2 patients complained of keloidal scars post-operatively (10%).

Patients Satisfaction (either due to complete excision of the desired lesion or due to good functional results as in post-traumatic contracture scars) was excellent in 80% of patients (16 out of 20 patients). Patients with incomplete satisfaction included 3 patients (15% of the patients) where only partial excision of the desired lesion could be achieved. Their over expectations of the post-operative results was high as their lesions were very wide to be covered in one session. Completely unsatisfied patient (5% of the patients) was that of the complete failure of the procedure.

Discussion:

Tissue expansion has become a well-recognized technique for reconstructing a wide variety of skin and soft tissue defects. ⁽²⁾. Indications for tissue expansion include aesthetic as well as reconstructive uses in the extremities as in Scar revision to improve

cosmesis either post-burn or post-traumatic, Removal of Benign Tumors, Nevus removal, Tattoo removal ⁽⁸⁾. These indications matched the indications of the patients operated upon in this study which included: Post-burn scars in 12 patients, post-traumatic scars in 4 patients, Giant Nevus excision in 2 patients, excision of Xanthelasma in 1 patient, Tattoo excision in 1 patient.

However, when using tissue expanders one must be prepared for complications, because they are inherited in a process in which skin is expanded by the repeated filling of an implanted foreign body. Complication rates increase when serial expansion of the same tissues is performed repeatedly, or if the expander is placed in the lower extremities. Outcomes are dependent on thorough pre-operative planning, patient compliance and meticulous surgical techniques ⁽⁹⁾.

For many years, skin expansion has been considered to be a hazardous procedure in the lower limb, with a high rate of complications especially below the knee ⁽⁷⁾. Major complications can compromise the success of the method and prevent the intended outcome: these include skin damage sustained during undermining and insertion of the prosthesis, infection, exposure of the prosthetic material, loss of the filling valve and necrosis of the flap after removal of the expander. Minor complications, such as hematoma, seroma, leakage of the prosthesis may require revisional surgery, slow down the reconstructive programme and incur expense, but do not affect the final result. Improvements in materials have reduced implant failure and surgical methods have gradually made it possible to limit the complications ⁽¹⁰⁾.

Early incision dehiscence can be averted by employing incisions well away from the site of expansion. Some authors Meland 1992 and Vögelin 1995 prefer radial incision away from the defect, in healthy tissue, which decreases the wound-healing problem. Although an adjacent incision can minimize scar creation, avoid devascularising tissue and be removed with the defect, early

dehiscence and exposure are possible. Through a distant incision, the skin is undermined with a traumatic blunt dissector, and the expander is inserted rolled on it ⁽¹¹⁾. In this study an incision 1cm from the margin of the scar was used on the scar side in stable tissue that is expected to heal. Suction drainage of the cavity should always be used to prevent hematoma and serum accumulation ⁽¹²⁾.

Once the prostheses have been removed, it is preferred to use an advancement flap, which decreases the likelihood of skin damage by avoiding extensive undermining, although it does limit the area gained by expansion. Transposition flaps allow for a greater use of skin but increase the risk of necrosis ⁽¹³⁾. Advancement flaps avoid scarring at the donor site, leaving only one fine longitudinal scar, which is much more compatible with the functional and cosmetic goals of surgery on the limbs ⁽⁷⁾.

The complications of soft tissue expansion were classified by Manders et al. 1984 and D.casanova et al. 2001 into two main categories: Major complications which interrupt the constructive programs of the patients in which they occurred and prevent achievement of the desired result. These include infection, implant extrusion and ulceration of the skin overlying the implant or implant failure. Minor Complications do not alter the course of the expansion including pain during expansion, seroma, dog ears after flap advancement and widening of the scar with time. In this study this classification of complications was followed into major and minor complications but widening of scars beside incomplete coverage and patients' unsatisfaction were considered as sequelae and not complications.

In previous studies as with Casanova et al 2001 including 103 patients they reported that there complication rates were as follows: Infection and sepsis of the prostheses 15.5% of the patients, expanders' extrusion 6.8%, implant failure in 4.8%, ulceration and necrosis 2.1%. In the study done by Bradely et al 1992 including 33 patients they reported that there complication rates were as follows:

Infection and sepsis of the prostheses 6% of the patients, expanders' extrusion 9%, implant Failure in 3%, ulceration and necrosis in 21.2%. In this Study, from a total of 28 prostheses 6 had major complications; extrusion in 2 patients (7.1%), infection and prostheses removal without expansion in 1 patient (3.57%) and ulceration of the skin overlying the prostheses in 3 patients (10.7%) but there were No Implant failure (due to disconnection of the valve from the envelope or due to leakage) with overall complication rate (21.4%).

These results revealed that the rate of infection (3.57%) had decreased in this study due to good selection of patients, the use of new expanders and good sterilization of reused expanders even that the only case of infection occurred in a new expander. There was no implant failure as before and after insertion of the expander it was tested by injecting sterile saline to detect any leak. The rate of Ulceration and expander extrusion were almost the same as these are the commonest complication in Limb expansion due to the tightness of the limbs' skin (D.Casanova 2001) and as vasculature and lymphatic supply is of terminal end. This is why they do not tolerate wide undermining of the skin and prolonged compression. (N.Bradly 1992)^(7,14).

In a previous study done by Antonyshyn et, al. 1988 they reported that their complication rates in the Lower Limb was 80% and in the upper Limb was 13%. In another study by N.Bradely et, al 1992 they reported that there complication rates in the Lower Limb was 33.2% and in the upper Limb was 17%. In this study: The incidence of major complications in expansion of the lower limb was 44% while in the upper limb was 10.5%. The previous results revealed that lower limbs have much higher complication rates. The upper limbs have a better blood supply; can be easily immobilized during expansion than the lower limb to reduce migration of the implant to the suture line causing extrusion and infection.

Conclusion:

Functional and aesthetic problems have become important indications for the use of tissue expansion. With careful planning and a strict surgical protocol these problems can be reduced and skin expansion can be used in the extremities to achieve goals not otherwise possible in reconstructive surgery.

Complications such as infection and skin damage in the early stage period may require premature removal of the prosthesis. Complications occurring in the final stage near to the maximum volume do not affect the proposed reconstruction as sufficient tissue is often generated to reach partial or complete reconstruction.

Certain measures should be taken to minimize the incidence of complications including careful patient selection, good pre-operative planning, with detailed pre-operative instructions to the patients to have reasonable expectations and to have good compliance, the use of new expanders. The best incision is usually placed at the edge of the lesion as the scar in this position will be removed at the time of advancement. The pocket must be capacious to place the expander away from the incision site to avoid extrusion; the expander's base must lie flat. The expander back must not be curled or flexed. Intra-operative filling of the expander with small amount of saline helps to unfold the prostheses and to help hemostasis, peri-operative use of antibiotics and routine use of suction drains in both stages of the operation is mandatory.

Case (1):



Photo 1-i



Photo 1-ii



Photo 1-iii



Photo 1-iv

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- **Photo 1_i:** Pre-operative: Showing a post-burn scar in the anterior aspect of the thigh in a 26 y old female.
 - **Photo1-ii:** After Full Expansion: 400cc in about 3 months.
 - **Photo 1-iii:** Showing the dimensions of the scar (13x6 cm) and that of the expanded skin (22x26 cm).
 - **Photo 1-viii:** Three weeks Post-operative: showing good healing of the wound.

Case (2):



Photo 2-i



Photo 2-ii



Photo 2-iii



Photo 2-iv



Photo 2-v



Photo 2-vi

- **Photo 2_i:** Pre-operative: Showing a post-traumatic depressed scar in the left Gluteal region a 12y old female.
- **Photo 2-ii:** Insertion of a 250 cc rectangular expander through the edge of the scar.
- **Photo 2-iii:** After Full Expansion with 300cc saline in 10 weeks.
- **Photo 2-iv:** Immediately before expander removal: showing small ulceration.
- **Photo 2-v:** One week post-operative: showing good healing of the wound.
- **Photo 2-vi:** One month post-operative: showing widening in the anterior part of the wound

Case (3) :



Photo 3-i



Photo 3-ii



Photo 3-iii



Photo 3-iv

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- **Photo 3-i:** Post-burn Scar on the dorsal aspect of left forearm in a 25y old male with two expanders 120cc each (dorsal view).
 - **Photo 3-ii:** After Post-burn Scar on the dorsal aspect of left forearm in a 25y old male with two expanders 120cc each (medial view).
 - **Photo 3-iii:** Post-operative (palmar view): showing complete excision of the scar and closure without tension.
 - **Photo 3-iv:** Post-operative (dorsal view)

Case (4) :



Photo 9-i



Photo 9-ii



Photo 9-iii



Photo 9-iv



Photo 9-v

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- **Photo 4-i:** Post-burn scar on the medial aspect of the Lt. Arm (early stage) in a 26y old female.
 - **Photo 4-ii:** Late Stage of the post-burn scar (2 months later) showing decrease in the size of the scar
 - **Photo 4-iii:** Intra-operative acute tissue expansion (ATE) using a 300cc rectangular expander.
 - **Photo 4-iv:** Immediately post-op. showing complete excision of the scar without tension.
 - **Photo 4-v:** One month post-operative: showing good healing of the wound.

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