

Study of Tissue Expansion in the Reconstruction of Nevus and Scars.

Rasmi Ranjan Mohanty¹, Bibhuti Bhusan Nayak², Annada Prasad Patnaik³, Arun Kumar Choudhury³

¹Assistant Surgeon, Department of Burns, Plastic & Reconstructive Surgery, S.C.B. Medical College, Cuttack, Odisha, India.

²Associate Professor, Department of Burns, Plastic & Reconstructive Surgery, S.C.B. Medical College, Cuttack, Odisha, India.

³Professor, Department of Burns, Plastic & Reconstructive Surgery, S.C.B. Medical College, Cuttack, Odisha, India.

Received: April 2019

Accepted: May 2019

Copyright: © the author(s), publisher. It is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: For management of nevus & various scars various methods are described like excision, skin grafting, dermabrasion, flap cover, dermatraction etc. but reconstruction of various scars by tissue expansion is a novel procedure.

Aims & objectives: 1. Study of tissue expansion in the reconstruction of nevus & scars. 2. Advantage & disadvantages of tissue expansion. 3. Complications of tissue expansion. **Methods:** The study was conducted in SCB MCH, dept of Plastic surgery from October 2015 to April 2018. No. of patients in this study were 41 which includes post burn scars, post traumatic scars & nevus. **Results:** study includes age group from 11- 42 yrs with female predominance. It mainly includes post burn scars, facial scars. Neck was the most common site of expander used. Expander mostly used were rectangular type. Volume ranges from 50 to 540ml. Of total 46 expanders 5 cases two expanders used. Various complications of expanders included infection, blebs, hematoma, wound dehiscence etc of which extrusion of expanders were most common. Complications were more common in extremities. HTS & partial skin necrosis common scar related complication.

Conclusion: Tissue expansion is an excellent technique to treat scars, pigmented lesions and alopecic patches. This provides the best tissue quality and matching as regards tissue characteristics. Flaps and skin grafts are inferior in treatment of these lesions when tissue expansion is possible. However this technique has its complications like infection, exposure and failure of expander. Therefore proper planning and selection of expander is extremely important.

Keywords: Biological Creep, Mechanical Creep, Nevus, Tissue expander.

INTRODUCTION

Tissue expansion is a unique reconstructive procedure which helps in stretching the skin and soft tissues of our body for coverage of wound. The basis of stretch ability depends on the inherent viscoelastic properties of skin. Tissue expansion can be observed in a variety of developmental, medical & cultural concepts. For example in tribal practice to increase the size of lip & ear lobules by metallic rings, enlargement of fetal skull by brain, enlargement of abdomen in pregnancy etc.^[1]

In 1905, Codvilla applied the principles of using an external, distractive force to encourage tissue expansion in bone. In 1957, Neumann implanted a subcutaneous balloon to induce soft-tissue growth purposefully for the reconstruction of external ear deformity. Radovan, Austad & Rose simultaneously developed the concept of implanted silicone balloons as expanders. Where Austad used self-inflating

balloon, Radovan used a self-sealing valve through saline was periodically injected.^[1] In 1982, the first National Tissue Expansion Symposium was sponsored by the Plastic Surgery Educational Foundation. This marked the recognition of first a new advance in reconstructive surgery.^[2]

Tissue expansion acts in the principle of mechanical creep & biological creep. Mechanical creep is essentially cellular stretch. However, biological creep is a cellular proliferation that results from the disruption of gap junction and increased tissue surface area.^[2]

The scars when planned to manage properly like tissue replacement for like tissue always give very good result. Tissue expander provides the use of adjacent tissue to provide optimum aesthetic result with reduced morbidity of donor site.^[3-5]

Advantages of expanded flap are thin & large flaps can be planned, with colour & texture match, sensation and donor side can be closed primarily.^[6,7] Diameter of expanded flap should be two to three times the diameter of skin excised.^[8]

In this study we use tissue expansion in reconstruction of nevus and scars.

Name & Address of Corresponding Author

Dr Bibhuti Bhusan Nayak,
Associate Professor,
Department of Burns, Plastic & Reconstructive Surgery,
S.C.B. Medical College,
Cuttack, Odisha, India.

MATERIALS AND METHODS

The study was performed in S.C.B. Medical College Plastic Surgery Department from 2015 to 2018. It included 41 patients who had post traumatic, post Infective, post burn scars and nevus.

After proper counselling, the patient was advised to take shower the night before the surgery & on the day of surgery. A prophylactic antibiotic was prescribed for all the patients during tissue expander insertion and removal procedures. Tissue expander insertion was performed under general or regional anaesthesia. At first, the skin was prepared with betadine followed by adrenaline solution infiltration over incision site and the pocket area. Proper haemostasis and washing of the pocket area was performed using normal saline. Afterwards, the tissue expander was inserted in the pocket. Before inserting the tissue expander it was examined for leakage. During the insertion proper care was taken to prevent any bending or kinking. The pocket of size 10-20% larger than the tissue expander created for placement of expander. Port site was created far from the expander site, which was easily distinguishable and accessible. There shouldn't be any kinking and rotation to prevent unsuccessful expansion. A minivac or romovac drain was placed in the site if necessary to prevent fluid collection & haematoma formation. Skin was closed in two layers to prevent pressure over suture line. Then expander was expanded with 10-20% of volume with normal saline. The wounds were dressed using sterile gauze.

Post Operatively

After placement of expander 2 weeks of gap was given for wound healing. Serial expansion of the device was started, by saline injections at one to two weekly intervals till the desire expansion achieved. After desire expansion achieved a further resting period was allowed, roughly equal to two to four weeks. A second operation was then performed to remove the implant, excise the pathological tissues and some rotation advancement of the expanded tissue done to cover the defect.

RESULTS

A total of 41 patients underwent tissue expansion for various scars and nevus during study period of October 2015 to April 2018.

Age Distribution

Range was 11 years to 42 years. Majority of the patients were in the age group 20-30 years (41.5%). Mean age was 24.49 years.

Gender Distribution

Female predominance was noted in this study. Out of 41 patients 24 (58.5%) were female.

Length of Hospital Stay

Hospital stay ranged from 7- 14 days with average period was 10 days.

Conditions for using Tissue Expansion

Tissue expansion was used for post burn scars, nevus and trauma out of which burn scar patients were highest in numbers.

Table 1: Conditions for using expanders

Conditions For Using Expanders			
Sl No	Conditions	No Of Expanders Used	%
1	Burns	19	46.3
2	Naevus	16	39
3	Post Traumatic Scar	6	14.6
	Total	41	100

Anatomical Regions of Defect & Pathology

Burn scars, Nevus and other scars of different parts of body were operated. Most common region was face (56.1%).

Anatomical Locations of Tissue Expander Used

Expanders were used various regions of the body; mostly face and neck region [Fig 1a-d], scalp [Fig 2a,b] and back [Fig 3a-c].

Table 2: Anatomical localisation of expanders

Anatomical Localisation Of Expanders			
Sl No	Anatomical Sites	No. Of Expanders	%
1	Scalp	7	15.2
2	Face	11 (Cheek= 7, forehead= 4)	23.9
3	Neck	15	32.6
4	Chest	3	6.5
5	Extrimity	5(ARM=2, forearm=3)	10.9
6	Back	5	10.9
	Total	46	100

Volume of Expansion

Expanders were used of different sizes ranges from 50 to 540 ml. Average size was 248.26ml. Average size of rectangular expander was 266.25 ml. Average size of round expander was 206.25 ml. Average size of crescentric expander was 208.33ml.

Average Expansion Time by Region

Average expansion period ranges from 8.67 weeks to 13.3 weeks. Maximum time was taken in chest and back regions.

Type of Expander Used

Total no of expander used were 46 out of which five cases two expanders used in one person. Most cases we used rectangular expanders (69.6%).

Table 3: Types of expanders used

Type Of Expanders			
Sl No	Type Of Expanders	No	%
1	Rectangular	32	69.6
2	Round	8	17.4
3	Crescent	6	13

No of Expander Used Per Patients

Double expanders were used in 5 patients and rest 36 cases we used single tissue expander.

Complication

Two types of complications observed. One due to expander related and other was after the procedure on scar management. Out of 41 cases 7 cases had expander related complication.

Expander Related Complication

Various complications were observed like hematoma & seroma, infection, blebs, wound dehiscence and exposer of expander. Of which exposer rate was 7.3%.

Scar Related Complication

4 cases had scar related complications out of 41 cases. Two patients had hypertrophic scars and two had partial skin necrosis.

Complications In Different Regions

Complications were found in different regions with high percentages in upper extremity. Out of 7 cases 3 were in neck and 2 in upper extremity. Out of 7 cases 6 cases were rectangular expanders and one crescentic.

Table 4: Complication rate in different regions

Complication Rate In Different Regions				
Sl No	Regions	Expander Used	Complication No	%
1	Scalp	7	0	
2	Face	11	1	9.1
3	Neck	15	3	20
4	Chest	3	0	
5	Back	5	1	20
6	Upper Extremity	5	2	40
	Total	46	7	15.2

Complications in Different Cases

Out of 7 cases 3 cases were burn and two each for nevus and trauma patients.



Figure 1 (a): Pre op picture with facial scar.



Figure 1 (b): After placement of tissue expander in left cheek and right neck.



Figure 1 (c): Intra operative picture after tissue expander.



Figure 1 (d): Post operative picture.



Figure 2(a): Post burn alopecia of scalp with two tissue expanders on both side scalp.



Figure 3(b): Post burn scar with tissue expander.



Figure 2(b): Post op picture after excision of scar and advancement of expanded flaps.

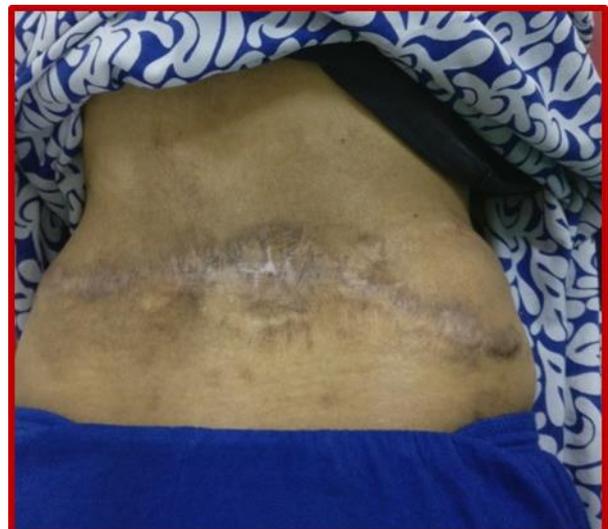


Figure 3(c): Post op picture after excision of scar and advancement of expanded tissue.



Figure 3(a): Post burn scar on back.

DISCUSSION

Tissue expansion has been described as a great advance in plastic surgery.^[9] Cutaneous expansion is used increasingly in reconstructive surgery for the treatment of a variety of problems in children and adults. It enables defects to be covered with tissue similar in texture, colour and type. Also donor site morbidity is generally minimal.^[7] Donor site morbidity becomes extremely important in children due to their growth capacity and children add an extra challenge with their tendency to hypertrophic scarring along the reconstructive suturing lines.^[16] Tissue expansion that preferred method allowed us to replace large scars in only two stages especially scalp and extremities reconstruction, where it is possible to leave minimal residual scars, located in less visible areas. However, initially it was

associated with a relatively high complication rate similar in literature,^[7] with increasing experience, these complications become less common in the recent studies.

The result of this study was; the mean age of the patients was 24.48 years. Besides, 24 patients (58.54%) were female. In the study by Motamed et al. also, the mean age of the patients was 25.5±8.3 years and the majority of them (70.59%) were female.^[10] In another study by Gao et al., 57.17% of the patients were female.^[11] Farahvash et al. also came to similar results.^[12]

Female patients were predominant, in the studies of Almeida and Nakamoto et al.^[17,18] perhaps due to a stronger concern about aesthetics.

The cause of scar was burn (46.34%) followed by Nevus (39%) in most of the cases. Similarly, Motamed et al. showed that the most common cause of burn was flame (47%) and boiling water (26.5%).^[10] Our study results indicated that the scars were mostly located on the face (56.1%). Consistently, Motamed et al. reported that the scars were mostly located on the face (70.59%) and the neck (23.53%).^[10] Nakamoto et al. (70.6%), Pitanguy et al. (60.7%), and Marks (53.3%). Ranking second in our experience were back (12.2%) & upper limb (12.2%), similar to the literature, where the torso was more common.^[18-20]

Scalp alopecia is a common sequela to sustained burns of the head region; scalp reconstruction surgery after burns has become a common procedure.^[21] The advent of tissue expansion started a new era of aesthetically reconstructed scalp alopecia by providing a major, hair-bearing scalp area with acceptable hair density.^[22,23] The major advantage of this procedure is that the donor site morbidity. However, drawbacks are the long duration of the treatment with numerous clinical visits and a long period of disfigurement. Currently, it is believed that an alopecia area involving 50% or more of the total scalp surface can be repaired using tissue expansion (multistage or serial tissue expansion).^[24,25] In our case we treated scalp alopecia in 4 cases (9.8%).

Selection of size, shape, and location of tissue expander and location of injection port is very important. Motamed et al. used rectangular tissue expanders and claimed that using these expanders might increase the options for flap design. Rectangular shaped prosthesis was used in the majority of the patients in this study (69.6%). Motamed et al. in another study showed that rectangular prostheses were used in 58.82% of the cases.^[10]

In this study, the mean volume of the prosthesis was 248.26 ml (minimum: 50 ml and maximum: 540 ml). Gao et al. showed that the volume of prosthesis expansion was between 800 and 1200 ml.^[11] In another study, the initial volume was selected between 250 and 500ml.^[10]

In general, tissue expanders are placed in the regions near the scar on the face, neck, or scalp which have the most similarity with the skin colour.^[33] Thus, reconstruction of skin scars with these areas is highly desirable.^[31] Based on the present study results, neck was the most common site for expander placement (32.6%). Previous studies have also shown that the healthy skin of the neck has the maximum similarity with the facial skin. Areas around the neck, such as shoulders, scapula, and pectoralis region, are also similar to the neck.^[30]

In the current study, complications of prosthesis were detected in 7 patients (17%), including prosthesis exposure in 3 patients (7.31%), blebs in one (2.43%), hematoma in one (2.43%), wound dehiscence in one (2.43%) and infection in one (2.43%). In the study by Bozkurt et al.^[9] the complication rate was estimated to be approximately 30%. Other studies have reported 1.22%,^[33] 4%,^[9] and 5% of infection rates.^[32] According to Spence et al., the patients' complications included infection (5%), exposure of tissue expander (3%), tissue expander or injection port malposition (3%), shrinkage of tissue expander (7%), and loss of a part of the flap (3%).^[32] Moreover, Kawashima et al. mentioned the complication rate to be 34.8%, including prosthesis exposure (13%), tissue expander laceration (8.7%), hematomas (8.7%), flap necrosis (4.3%), and infection (4.3%).^[13] Furthermore, Chung and colleagues reported a complication rate of 12% in their research.^[14] In the study conducted by Motamed et al., the only problem was epidermolysis of the distal flap which was seen in 2 patients who were treated by medical therapy.^[10]

The present study also showed that the complications of skin reconstruction were detected in 4 patients (9.75%), including hypertrophic scar in two (4.88%) and superficial necrosis in two (4.88%). Nevertheless, 92.7% of the flap donor site scars and 95.1% of the reconstructed site scars were acceptable. Meticulous and careful planning for using flap donor while application of tissue expanders leads to a reduction in the complications and face deformities. Standardization of preoperative care and placement, expansion, and reconstruction techniques will reduce the rate of the subsequent complications, as well.^[33]

Methodologically, cutaneous overexpansion can be considered one of the solution for avoiding a compromised result if surface area gain is insufficient.^[26] Overexpansion appears safe without risk of implant failure by factors of 5–10 times the vendor stated maximum volume.^[27,28] Using this approach, we started to apply it also only to obtain wider and more pliable flaps. Using tissue overexpansion we have lived up the goal of replacing large scars in a one-stage procedure. A good example of this is described in scalp and extremities reconstruction, where it is possible to

leave minimal residual scars, located in less visible areas.

Regarding the use of tissue expanders, the reconstructed flap texture and colour should be in good assimilation with the recipient area.^[11] In this study, the assimilation of the flap's colour (80.5%), consistency (87.8%), and thickness (82.9%) with the surrounding skin was desirable in most of the cases. Ultimately, a study showed that most patients (78%) were satisfied with the operation results. Feng et al. showed that the use of ultra-thin cervico-pectoral flaps using tissue expanders for complete reconstruction of the anterior neck was associated with excellent results in 4 and good results in 2 patients.^[15] Motamed and colleagues also showed that both patients and the surgeon were satisfied with the operation results.^[10] In another study, the results of reconstructive surgery were quite satisfactory in all the patients.^[33]

One of the limitations of this study was the impossibility of following some patients up after the surgery. Also, because many patients were referred from a distant city, sometimes the injection interval became too long. Average duration of expansion in this study was 11.97 weeks with range of expansion varies from 6 weeks to 15 weeks.

Unfavourable results with tissue expansion are most often the result of poor patient selection or faulty techniques. Fochtman et al state that complications are higher in expansions of paediatric patients, lower extremities, and larger total body surface area of scars.^[29] Risk is also higher in expansion of unhealthy skin or with serial expansion. Bozkurt et al however, in a retrospective analysis found no statistical correlation between implant failure with age, gender, shape or number of implants.^[9] In our study we found upper extremity expansion had higher failure rate (40%) and trauma cases had higher failure rate (33.3%).

Yet, more research is required to investigate some methods for lessening the complications of these techniques.

CONCLUSION

Tissue expansion is an excellent technique to treat scars, pigmented lesions and alopecic patches. This provides the best tissue quality and matching as regards tissue characteristics. Flaps and skin grafts are inferior in treatment of these lesions when tissue expansion is possible. However this technique has its complications like infection, exposure and failure of expander. Therefore proper planning and selection of expander is extremely important. Though it requires two stages of surgery and multiple office procedures the procedure is worth undertaking when the outcome is taken into consideration.

REFERENCES

1. Neligan's Plastic Surgery Principles, 3rd edition, vol- 1
2. Grabb and Smith's plastic surgery, 7th edition
3. Khalatbari B, Bakhshaeekia A. Ten-year experience in face and neck unit reconstruction using tissue expanders. *Burns* 2013; 39:522-7.
4. Fan J, Yang P. Versatility of expanded forehead flaps for facial reconstruction. Case report. *Scand J PlastReconstrSurg Hand Surg* 1997; 31: 357-63
5. Radovan C. Tissue expansion in soft-tissue reconstruction. *PlastReconstr Surg*. 1984;74:482-92
6. Vander Kolk CA, McCann JJ, Knight KR, et al. Some further characteristics of expanded tissue. *ClinPlastSurg* 1987; 14: 447-53
7. Argenta LC, Marks MW, Pasyk KA. Advances in tissue expansion. *ClinPlastSurg* 1985; 12: 159-71
8. Kryger Z., Bauer B. Tissue expansion . In: Kryger Z., Sisko M., editors. *Practical Plastic Surgery*. Landes Bioscience; Texas: 2007.pp. 61-64
9. Bozkurt A, Groger A, O'Dey D, Vogeler F, Piatkowski A, Fuchs P, Pallua N. Retrospective analysis of tissue expansion in reconstructive burn surgery: evaluation of complication rates. *Burns*.2008;34:1113-8.
10. Motamed S, Attarian Sh. Cervicofacial angle reconstruction whileinsetting flaps to treat chronicburns. *PejouhandehShahidBeheshtiUniv Med Sci*. 2009;14:1.
11. Gao JH, Ogawa R, Hyakusoku H, Lu F, Hu ZQ, Jiang P, Yang L, Feng C. Reconstruction of the face and neck scar contractures using staged transfer of expanded "Super-thin flaps" *Burns*.2007;33:760-3.
12. FarahVash MR. Tissue expander, a modality in the treatment of burn induced deformities: A 6-yearstudy of patients with burn deformities admitted to Plastic Surgery Department of Imam Hospital. *Tehran Univ Med J*. 2000; 58:20-5.
13. Kawashima T, Yamada A, Ueda K, Asato H, Harii K. Tissue expansion in facial reconstruction. *PlastReconstr Surg*. 1994;94:944-50.
14. Chun JT, Rohrich RJ. Versatility of tissue expansion in head and neck burn reconstruction. *AnnPlast Surg*. 1998;41:11-6.
15. Feng L, Gao J, Ogawa R, Hu Z, Jiang P, Feng C. Bilateral expanded cervico-pectoral "super-thin flap" for entire neck reconstruction. *Ann Plast Surg*. 2009;63:404-8.
16. Pisarski GP, Mertens D, Warden GD, Neale HW. Tissue expander complications in the pediatric burn patient. *PlastReconstr Surg*. 1998;102:1008-12.
17. Almeida MF. Expanded shoulder flap in burn sequela. *ActaChirPlast*. 2001;43:86-90.
18. Nakamoto HA, Cunha MC, Milcheski DA, Sturtz G, Herson MR, Fontana C, et al. *Expansoresteciduaisemtratamento de sequelas de queimaduras*. *Rev Bras Queimaduras*. 2001;1:21-4.
19. Pitanguy I, Amarin NFG, Radwanski HN, Lintz JE. Repeat expansion in burn sequela. *Burns*.2002;28:494-9.
20. Tavares Filho JM, Belerique M, Franco D, Porchat CA, Franco T. Tissue expansion in burn sequelae repair. *Burns*. 2007;33:246-51.
21. Wells MD. Scalp reconstruction. In: Mathes SJ, editor. *Plastic Surgery*. 2nd edition. Vol. 3. Philadelphia, PA: Saunders; 2006. p. 611.
22. Argenta LC, Watanabe MJ, Grabb WC. The use of tissue expansion in head and neckreconstruction. *Ann Plast Surg*. 1983;11:31-37.
23. McCauley RL, Oliphant JR, Robson MC. Tissue expansion in the correction of burn alopecia: classification and methods of correction. *Ann Plast Surg*. 1990;25:103-115.

24. Wieslander JB. Tissue expansion in the head and neck. A 6-year review. *Scand J PlastReconstrSurg Hand Surg.* 1991;25:47–56.
25. Gürlek A, Alaybeyođlu N, Demir CY, Aydođan H, Bilen BT, Oztürk A. Aesthetic reconstruction of large scalp defects by sequential tissue expansion without interval. *Aesthetic Plast Surg.* 2004;28:245–250.
26. Hallock GG. Safety of clinical overinflation of tissue expanders. *PlastReconstr Surg.* 1995;96:153–7.
27. Hallock GG, Rice DC. Objective monitoring for safe tissue expansion. *PlastReconstr Surg.* 1986;77:416–20.
28. Hallock GG. Maximum overinflation of tissue expanders. *PlastReconstr Surg.* 1987;80:567–9.
29. Fochtman A, Keck M, Mittibock, Rath Th. Tissue expansion for correction of scars due to burns and other causes: a retrospective comparative study of various complications. *Burns.* 2013;39: 984-989.
30. Motamed S, Davami B, Daghighaleh H. Trapezius musculocutaneous flap in severe shoulder and neck burn. *Burns.* 2004;30:476–80.
31. Adant JP, Bluth F, Jacquemin D. Reconstruction of neck burns. A long-term comparative study between skin grafts, skin expansion and free flaps *ActaChir Belg.* 1998;98:5–9.
32. Spence RJ. An algorithm for total and subtotal facial reconstruction using an expanded transposition flap: a 20-year experience. *PlastReconstr Surg.* 2008;121:795–805.
33. Motamed S, Niazi F, Atarian S, Motamed A. Post-burn head and neck reconstruction using tissue expanders. *Burns.* 2008;34:878–84.

How to cite this article: Mohanty RR, Nayak BB, Patnaik AP, Choudhury AK. Study of Tissue Expansion in the Reconstruction of Nevus and Scars. *Ann. Int. Med. Den. Res.* 2019; 5(4):SG05-SG11.

Source of Support: Nil, **Conflict of Interest:** None declared