Original Article

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Endoscopic Approach for Tissue Expansion for Different Cosmetic Lesions in Pediatric Age

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Background/Purpose: *The use of tissue expanders in plastic and reconstruction surgery is now well established for large defects in adults & children. Tissue expansion is one of the reconstructive surgeon's alternatives in providing optimal tissue replacement when skin shortage is a major problem. Predesigned plan about the criteria of tissue expansion should be implied before embarking on removal of a lesion. Endoscopic placement of tissue expanders has the benefit of reducing operative time, major complication rate, time to full expansion and length of hospital stay compared to the open technique for tissue expander placement.*

Materials & Methods: *The study was carried on 15 cases for which 22 expanders were inserted .All cases were in the pediatric age (6-15 years) .Nine cases had melanocytic pigmented naevi, four cases had post-burn scars, one had pigmented lymphangiomatous lesion & the last case had post grafting scarring .Eight patients needed single insertion of the expander followed by definitive reconstruction (2 months later), 4 cases needed multiple expanders on the same session & 3cases needed sequential expansion. The process of expander placement was done through a remote incision using endoscopic approach, after the required inflation (usually 2 months) reconstructive surgery was carried on for flap designing.*

Results: *Twenty two expanders were inserted in 15 cases .operating time ranged from 50-70 min. (mean= 1 hour) in early cases .Later on the time was shortened to a mean of 40 ± 5 min. The mean duration for completion of expansion to the required dimensions needed for the flap was 2 months (± 2 weeks) . Complication rate was 18%. They occurred in 4 out of 22 expanders (hematoma ,wound dehiscence and seroma around 2 expanders).*

Conclusion: *Tissue expansion in the pediatric population has its implication in different plastic problems .Endoscopic assisted expansion is a new trend in expander placement that has its role in decreasing complications related to insertion of expanders.*

Index Word: *Tissue expansion- Endoscopic- Pediatric.*

INTRODUCTION

The concept of tissue expansion in surgical practice was first reported by Neuman,[1] skin expansion was pioneered by others that worked independently as Radovan and Austad.[2,3] 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.[4]

Soft tissue expansion is a process in which the surgeon implants a silicone elastomer balloon that is filled by injection of sterile isotonic saline solution over a period of weeks to months. The process of inflation of the balloon stretches the overlying soft tissue and induces growth. If given enough time, expansion can provide enormous increase is soft tissue that becomes available for reconstruction of adjacent defects.[5]

Compared with other methods of plastic surgery, this method possesses the unique ability of generating skin with an almost perfect match of colour, texture and sensation without additional scars in donor areas.

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Tissue expansion requires a favorable environment to accommodate a temporary expander because it gradually stretches the overlying stable soft tissue over time. The implant is not only a foreign body but is also a dynamic structure that imposes forces on surrounding areas. The insertion site should be free of bacterial contamination, infection, unstable scar tissue and poorly vascularized tissue. For these reasons, this technique is primarily an elective surgical procedure to provide coverage with the same type of tissue.[6,7,8]

Although expanders can be inserted at the time of trauma or adjacent to an open wound, the complication rate in these cases may be increased because of the potentiality for contamination and ischemic or devitalized tissue.[9]

Successful reconstruction requires careful attention to optimal patient selection, preoperative planning, insertion of expander, the expansion process and the delivery of tissue during the final procedure.[10].

PATIENTS AND METHODS

The study was conducted on 15 patients in pediatric age for various cutaneous lesions. They were operated upon in Beni Sweif university hospital.

Twenty two expanders were inserted. The period of study extended for 3 years from April 2006 to April 2009. Nine cases had melanocytic pigmented naevi, 4cases had post burn scars (8 expanders), one case had lymphangiomatous lesion in the lower thigh & knee, and the last case had post grafting pigmented area (one expander). In the study, 8 cases needed insertion of a single tissue expander followed by definitive reconstructive surgery. Four cases needed simultaneous insertion of two expanders, and 3 cases needed sequential insertion of expanders at 2 settings (total number of expanders were 22). All the selected cases were in the pediatric age ranging from 6 to 15 years with mean of 8 years ($\pm$ 0.6). Nine cases were females and 6 were males. All shapes of expanders were used, crescent, round and rectangular ((Mentor,Mentor corp.USA).

Preioperative assessment of expansion factors includes; defect size; available donor tissue; number, size, shape and placement of expander units; anticipated scar line; estimated duration and frequency of expansion and possible need for secondary expansion.

Standard expanders were used: round expanders with capacities from 100 to 2000cc, rectangular expanders from 100 to 1000cc and crescent from 100 to 1000cc.

Internal remote valves were used with filling tubes connected to the center of the base of the balloon. The incision was made away from the defect site, perpendicular (radial) to the implant & valve pockets to decrease the stresses of expansion forces. The level of dissection was deep to the subcutaneous fat where the expander was inserted.

General anesthesia for all patients was used. Broad spectrum antibiotics were given at induction of anesthesia (3rd generation cephalosprin (50-100mg/kg/day)+ amoxicillin- Claveulanic acid (30-50mg/kg/dose)). Injection of adrenaline- saline 1:200.000 at the site of incision, along the track of dissection & at the proposed site of expanders insertion was done. Antibacterial agents in saline solution stained with methylene blue (to detect leakage from expander unit during insertion and helps target the proper valve chamber for injections was used. Expanders were filled intraoperatively to tissue tolerance to reduce the incidence of hematomas & seromas and to avoid the creation of stubborn implant folds that may later erode through the skin. Valve was also positioned in same plane.

A primary tunnel was created bluntly from the incision to the planned expander site, the port (12mm) was introduced through the incision, the camera was then introduced and the site of tough & vascularized bands were marked & then devascularized & transected using ligasure (Tyco Health, Valley lab) to avoid burning of the skin when using diathermy coagulation. The expander was rolled on itself & deflated & then was introduced through the same port incision (sometimes lengthening of the incision was needed at this step) introduction of expander was done after holding it with a long ovum forceps with it is jaws covered by fingers of surgical gloves to avoid inadvertent balloon perforation. Inflation of the expander was carried on after securing a safe & proper site for the valve. Three cases needed insertion of a closed system tube draining to avoid seroma. The incision was closed in 2 layers, the skin was closed by subcuticular manofilamentous absorbable sutures. Tissue expansion was initiated on the operating table. (Fig. 1: A,B,C)

Postoperatively, Filling was done (twice weekly) with normal saline and was suspended before capillary circulation was compromised as determined by degree of pallor & blanching (tissue tolerance) or the

patient's complaint of discomfort or pain (patient tolerance).

The primary criterion for adequate expansion was the generation of sufficient or slightly more tissue to reconstruct the defect successfully. The domed flap width should be 2.5 to 3.0 times the defects width.

Most of the cases needed from 1.5 to 2.5 months of expansion before the definitive procedure. At the reconstructive operation, intra operative advancement was carried on after the patient was anaestheized, and introperative expansion was done for duration of 10 to 15 minutes to gain 1 to 2 cm of additional tissue. Incision was done at the border between the lesion and the expander. Capsulectomy followed by advancing the flap & unfurling of its dome. Single cutback, double cutback, or over-the-top advancement designs were considered to maximize delivery of tissue.

RESULTS

The study was conducted on 15 patients, 9 females & 6 males, on 3 years period on pediatric patients from 6 to14 years, 8 cases needed insertion of single tissue expander, 4 cases needed simultaneous insertion of 2 expanders, 3 cases needed sequential insertion of two expanders with an interval of 6 months after flap inset. The sites of insertion of expanders are illustrated in table 1.

Operating time decreased gradually through the study, it ranged from 50 to 70 min (mean 1 hour) for single expander insertion and in later cases , the mean operative time was 40± 5 min. (The duration of the reconstructive procedure and flap designing was not calculated as it is variable from site to another & out of the scope of this study).

The average time needed for expansion was 2 months (± 2 weeks).

A

B

Fig 1 A,B,C Endoscopic insertion of tissue expander

Complications in the form of hematoma occurred in one case (4.5%), wound dehiscence in one case (4.5%) , seroma in 2 cases (=9%), no expander extrusion, no necrosis, no valve exposure & no expander leakage occurred. (table 2).

Table 1: Sites of insertion of expanders:

Site of Insertion Of expander	Number	Pathology
Back	8	Cong. naevi
Lower limbs	2	Lymphangioma, PBCS
Buttocks	4	Cong. naevi
Neck	1	PBCS
Scalp	4	PBCS
Chest	2	PBCS
Upper limb	1	PBCS (history of grafting)

Table 2: Post operative complications:

Type of Complication	Number of cases	Percentage
Hematoma	1	4.5%
Wound dehiscence	1	4.5%
Seroma	2	9%
Extrusion	-	-
Necrosis	-	-
Valve exposure	-	-
Expander leakage	-	-
Total	4 cases	18%

DISCUSSION

Tissue expansion takes advantage of the viscoelastic properties of skin to increase surface area in response to intrinsic& extrinsic forces. Theoretically, the expansion results from the plastic deformation of the skin collagen network as well as displacement of the fluid & ground substance.[11]

Analysis of multiple sites over the implant and its periphery has revealed an increase in epidermal thickness during the process of expansion. In the early after placement period of the prosthesis there is significant thickening of epidermis, within 4-6 weeks epidermal thickness generally returns to normal levels. Hair follicles and accessory skin structures are compressed but show no evidence of degeneration. Melanocytic activity is increased during expansion but return s to normal within several months after completion of reconstruction.[12]

Tissue expansion is an effective method of reconstructive and plastic surgery, however, its significant high local complications rate considerably limit its wide clinical application [15]. Also, psychological aspects play an important role and should not be underestimated. Defects of appearance are not life threatening and patients should not suppose that they are going to be switched –off from their usual lives along the period of their expansion.

Tissue expansion in pediatric population has been indicated in various plastic procedures as microotia, hemangiomas, scrotal reconstruction, meningiomyelocele, aplasia cutis congenita, clubfoot deformity, midfacial cleft, Romberg disease, Poland syndrome, vaginal agenesis,Volkmann contracture and reconstruction for conjoined twins.[13,16] Congenital pigmented naevi are associated with an increased risk for developing malignant melanoma.[17,18] This risk is raised by a number of characteristics of the lesion most notably the size of the naevus.[19,20] Congenital nevi are classified according to size with those of diameter greater than 10 cm as large and those with a diameter greater than 20cm as giant.[20] Bauer et al highlighted the benefits of expanded transposition flaps for treatment of giant cell melanocytic naevi (GCMN).[21,22]

Tissue expansion has a firm foundation in secondary burn reconstruction in children.[23,24]

The site of implantation has different prognosis from area to another. Pisarki et al reported a series of 281 expanders placed in 224 patients that complications were most prevalent in the lower extremity followed by head& neck in pediatric burn patients.[24] Another series of 180 expanders placed in 128 children demonstrated that extremity expansion resulted in more complications than expansion in other regions.[25]

Elias et al reported that the scalp followed by the trunk was the regions associated with the greatest rate of tissue expansion related problems.[15] On the other side some series including a large series from Boston children's hospital have found no difference in complication rates based on anatomical region.[13,16,26]

In this study, there was no peculiar complication related to anatomical region, however due to the small number of patients, statistical analysis could not performed.

There is debate about correlation between the age of the patient and the complication rate of tissue expansion but, in general, the younger the age the more the complications related to deflation or

disruption of expander.[16,25]

In our study age ranged from 6 to 15 years, There was no complications related to disruption but in the younger patients there was needle phobia in relation to time of expansion and in the older ones psychological impacts were more. Serial expansions is another factor that seems to be associated with increased risk of expander related complications. There's no solid evidence of the condition but correlation with the disease process that lead to serial expansions in a study on evaluating 37 expanders placed in 14 children by Iconomou &colleagues founded no correlation between disease process & complication rate.[26]

Despite its versatility, tissue expansion has been associated with significant complications since its inception. Initial rates of complication were as high as 40% when expanders were used in infants and children.[15]

An initial series from Shiners burn institute in Cincinnati reported an overall complication rate of 30% from 1984 to 1987.[27]A subsequent report covering the period from 1987 to 1993 demonstrated an overall complication rate of only 18% .[23]This emphasize that a" Learning curve" exists for effective tissue expansion.

The risks of tissue expansion have been described in numerous studies and stratified by patients age, wound type, surgeon experience and socioeconomic class. Recent series report overall complication rates in the range of 13%to 20%.[16,24,25]

In a trial to overcome the complications related to incision, expander extrusion & duration of expansion distant access using minimal invasive procedure is carried on.

Endoscopic techniques &instruments made it possible to create the required cavity for an expander in the selected anatomical layer of tissue, with good hemostasis control through remote 5-10 mm incisions made parallel to the tension vectors. The endoscopic equipment allows for increased visualization of the tissue expander pocket where more expanders can be placed in less time, with better intraoperative control of hemostasis and fewer complications.

The smaller remote incisions permit earlier initiation of tissue expansion because of reduced concern about wound tension.[28] This advantage may translate into a reduction in time of full expansion and decreased rate of wound dehiscence and extrusion. In addition, a remote wound that is not placed under significant tension during early tissue expansion lead to more rapid healing and shorter stay in hospital.[28-29]

Modifications of the technique are implied regarding the visualization system and addition of dissection technologies as the balloon dissection and introducing system.[30,31,32]

Some problems were confronted at the beginning of this study regarding creation of optical cavity & site of the incision but later on more experience was gained especially on putting the incision on the same plane of the desired expander site as extensive curvatures obscure visualization. Using another one or two small incisions for portless instrument application to facilitate dissection & hemostasis and same stab incision could be used for drainage. The original incision used for the camera is slightly widened when introducing the folded expander.

CONCLUSION

Tissue expansion in pediatric population is an effective reconstructive modality, despite its potential complications. Endoscopically assisted approach for insertion is a step toward reducing the overall complications. Its application in the pediatric population is a new trend. The procedure has "Learning curve". Success of the procedure is multifactorial .Effective education and guidance beginning before surgery & continuing throughout the expansion process are imperative to achieve the required outcome. Because the process is carried on several steps, intense family & patients cooperation & understanding are needed.

Generally carrying the procedure by endoscopic approach is gaining acceptance from the patients& family .

REFERENCES

1. Neumann CG: The expansion of an area of skin by progressive distention of a subcutaneous balloon, Plast Reconstr Surg 19:124, 1957.

2. Radovan C: Reconstruction of the breast after radical mastectomy using a temporary expander, Plast Reconstr Surg 69:195, 1982.

3. Austad E: A self-inflating tissue expander. Paper presented at annual meeting of the American Society of Plastic and Reconstructive Surgeons, Toronto, October 1979.

4. Austad ED: Evolution of the concept of tissue expansion, Facial Plast Surg 5:277, 1988.

5. Manders EK, Schenden MJ, , Hetzler PT .et al Soft tissue expansion: concept and complications, Plast Reconstr Surg 74:493, 1984.

6. Mottaleb M, Manders EK, Sasaki GH et al. Tissue expansion. In Riley WB, editor: Instructional courses: Plastic Surgery Educational Foundation, vol 1, St Loius, 1988, Mosby.

7. Sasaki GH: Tissue expansion. In Jurkiewicz MJ, Krizek TJ, Mathes SJ, Ariyan S, editors: Plastic surgery: principles and practice, St Louis, 1990, Mosby.

8. Shively RE: Skin expander volume estimator, Plast Reconstr Surg 77:482, 1986.

9. Sugihara T, Ohura T, Kim C, et al: The extensibility in human skin. Paper presented at PSEF International Tissue Expansion Symposium, San Francisco, October 1987.

10. Joss GS, Zoltie N, Chapman P: Tissue expansion technique and the transposition flap, Br J Plast Surg 43:328, 1990.

11. Louis C. Argenta and Malcolm W. Marks (2006): Principles of tissue expansion in plastic surgery 2nd edition by Stephen J. Mathes and Vincent R. Hentz (2006) volume I A page 451.

12. Takei, Teiji, Katsuguki et al (1998): Molecular Basis for tissue Expansion: Clinical Implications for the Surgeon, Journal of Plastic & Reconstructive Surgery, Issue: Volume 102(1), July 1998, pp 247-258.

13. Iconomou TG, Michelow BJ, Zuker RM. Tissue expansion in the pediatric patient. Ann Plast Surg 1993; 31:134-140.

14. Paletta C, Campbell E, Shehadi SJ. Tissue expanders in children, Clin Plast Surg 1991; 28:22-25.

15. Elias DL, Baird WL, Zubowicz VN. Applications and complications of tissue expansion in pediatric surgery. J Pediatr Surg 1991; 26:15-21.

16. Gibstein LA, Abramson DL, Bartlett RA, et al. Tissue expansion in children: a retrospective study of complications. Ann Plast Surg 1997; 38:358-364.

17. Zaal LH, Mooi WJ, Sillevis Smitt JH, et al. Classification of congenital melanocytic naevi and malignant transformation: a review of the literature. Br J Plast Surg 2004; 57:707-19.

18. Bauer BS, Margulis A. The expanded transposition flap: shifting paradigm based on experience gained from two decades of pediatric tissue expansion. Plast Reconstr Surg 2004; 114:98-106.

19. Bauer BS, Few JW, Chavez CD, et al. The role of tissue expansion in the management of large congential pigmented neiv of the forehead in the pediatric patient. Plast Reconstr Surg 2001; 107:668-75.

20. Ruiz-Madonado, R. Measuring congential melanocytic nevi. Pediatr. Dermatol. 21:178, 2004.

21. Bauer, B. S., and Vicari, F. A. An approach to excision of congebtial gaint pigmented nevi in infancy and early childhood. Plast. Reconstr. Surg. 82:1012, 1988

22. Bauer, B. S., Vicari, F. A., Richard, M. E. Expanded full-thickness skin grafts in children: Case selection, planning and management. Plast. Reconstr. Surg. 92:59, 1993.

23. Neale HW, Kurtzmann LC, Goh KB, et al. Tissue expanders in the lower face and anterior neck in pediatric burn patients: Limitations and pitfalls. Plast Reconstr Surg 1993; 91:624-631.

24. Pisarski GP, Mertens D, Warden GD, et al. Tissue expander complications in the pediatric burn patient. Last Reconstr Surg 1998; 102:1008-1012.

25. Friedman RM, Ingram AE, RJ, et al. Risk factors for complications in pediatric tissue expansion. Plast Reconstr Surg 1996; 98:1242-1246.

26. Iconomou TG, Michelow BJ, Zuker RM. The relative risk of tissue expansion in the pediatric patient with burns. J Burn Care Rehabil 1993; 14:51-54.

27. Neale HW, High RM, Billmire DA, et al. Complications of controlled tissue expansion in the pediatric burn patient. Plast Reconstr Surg 1988; 82:840-845.

28. Toranto, Jason D, Yu et al.Endoscopic versus open tissue-expander placement: Is less invasive better Journal of American Society of Plastic Surgeons, vol 119 (3), March 2007; 894-895.

29. Egeland, Bront M, Dederna et al. A Minimally Invasive Approach to the Placement of Tissue Expanders; semina in plastic surgery, Frontiers in Endoscopic Plastic Surgery 2008; 22:9-17.

30. O'Brien JJ: Endoscopic balloon-assisted abdominoplasty. Plast Reconstr Surg 1997; 99:1462-3.

31. Jones GE, Nahai F, Eaves FF: Placement of tissue expanders. In: Boswick J, Eaves FF, Nahai F (eds). Endoscopic Plastic Surgery. St Louis: Quality of Medical Publishing, Inc 1995; 466-85.

32. Takeuchi M, Nozaki M, Sasaki K, et al: Endoscopically assisted tissue expander insertion using balloon dissection. British Journal of Plastic Surgery 1998; 51:90-95

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