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Research Article

Decoding a Decade: The Daring Dance of Over inflation in Tissue Expanders – Unveiling our Unique Journey

Muhammad Aslam Khan,[1] Farhan Gohar,[2] Hassan Saeed Khan,[3] Umar Iqbal,[4] Tauqeer Nazim,[5] Zameer Abbas Mir[6]

[1-3]The Children's Hospital, Lahore; [4]Rashid Latif Medical College, Lahore; [5-6]Sheikh Zayed Hospital, Lahore

Abstract

Background: Reconstruction of large scalp defect like post burn alopecia, post traumatic alopecia and congenital naevi require not only well-vascularized skin but also hair bearing scalp for better aesthetic outcome. Tissue expansion has always been the valuable reconstructive option in scalp reconstruction and is superior to any other option as it provides hair-bearing scalp. We have changed the traditional way of tissue expansion by using over expansion to two to three times of its recommended expansion to prevent multiple expansions.

Objective: The objective of this study is to established the safety of tissue expander in overexpansion. Methodology: This prospective case series was conducted from January 2013 - December 2022. Patients requiring scalp expansion for reconstruction of post burn alopecia , congenital melanotic naevi and post traumatic alopecia were included in this study. Flap advancement for covering the percentage area of the scalp defect was assessed as the outcome.

Results: 13 patients were included, 6 (46%) patients required 2 expanders and 7(54%) patients required single tissue expander. Average flap advancement was 9 cm. Average tissue expansion was 650 ml, over expanded twice to thrice the recommended volume. No patient had any expander complication, wound breakdown or flap necrosis. Hair density was adequate on visual analogue scale.

Conclusion: Two to three times over expansion in tissue expander is valuable and safe tool for covering large area of alopecia without the need of expansion multiple times.

Keywords | Tissue expansion, scalp alopecia, post burn scalp defects, congenital melanotic nevus scalp

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Corresponding Author| Dr MuhammadAslam Khan, The Children's Hospital, Lahore. **Email:** muhammad.raoaslam@gmail.com

Introduction

Since its introduction in 1957, tissue expansion has been used widely for various reconstructions in plastic surgery. Role of tissue expansion is well established in paediatric population in reconstruction of giant congenital melanotic naevia, sebaceous naevi, abdominal wall reconstruction and various other body defects.[1,2]

Tissue expansion has been used for last many years as an important reconstructive tool for reconstruction of scalp defect and for excision of scalp lesions like CMN and post traumatic defects.[3-6] Scalp is ideal for expansion as it has thick skin and less chances of expander extrusion and minimal infection due to rich vascularity of scalp skin and having solid base of skull bone for maximal tissue expansion.

Tissue expansion is two stage procedure, one for placement of expander and other for removal of expander and advancement of expanded flap and there may be chances of complications during the process of expansion which in literature has been described to range from 13-40 %.[6,7]

Large scalp lesions sometime may need multiple expansions sessions, which increase duration and the cost

of the treatment. We have over expanded the tissue expanders two to three fold to its recommended volume for maximum tissue expansion in single session to avoid further sessions without complication. Objective of this study is to establish the safety of tissue expander in overexpansion and changing the traditional way of expansion.

Methodology

This study was conducted at The Children's Hospital Lahore from January 2013 to December 2022. After obtaining permission from ethical review board, we included patients who needed scalp reconstruction by hair bearing skin. Patients who were unable to get regular expansion from hospital or self-inflation were excluded.

All the preoperative data was recorded on proforma. Overexpansion of expander above the recommended volume, total flap advancement and percentage of total defect coverage was recorded. Hair density before expansion and 6 months after the flap insetting was assessed by visual analogue scale by twodifferent plastic surgeons on the scale of 1-10 from preoperative and post-operative pictures. Data was recorded for any complication like tissue infection, implant extrusion, port failure.

Operative Technique:

All surgeries were performed under general anesthesia with local infiltration. Expander size was selected by careful measuring the defect size and available donor area. Expander length was selected as per defect parallel length. Width and height were selected from available expander sizes and low profile less volume expander was chosen from available chart. Average size of 250 ml expander was chosen for more than 7 cm wide defect. Width of expander was kept at least half of expander length to expand maximal area of available scalp. Incision was planned in the normal skin 2-3 cm away from interface of normal and burned area. Long incision were preferred for ease of insertion. Subgaleal pocket was made by blunt dissection and adequate pocket was made larger than the base of expander to accommodate expander without tension. Separate incision was made for the port and small size port was used and placed approximately 6-8 cm away from expander. Pocket was packed for 10 minutes with gauze followed by wash withsaline. 100ml, 200ml, 250mland 320 ml rectangular expander (Polytech,Germany) were used. Expander was folded over the base to prevent any fold on the upper surface to prevent any pressure on skin flap. Closure was done with single layer continuous polypropyline stitching. Small port was used and placed on average 6cm away from the expander through separate incision. Expander was inflated 10-20 % of its volume by sterile water and leakage was identified. Drain was placed for at least for 24 hours and loose dressing was applied.

Table 1: *Data of all patients included in this study*

No.	Gender	Age in Years	Etiology	Soft tissue defect location	No. of expanders	Expander size	Total volume expanded	Average duration of expansion	Average flap advancement
1	Male	6	Burn	Frontal	One	250ml	600ml	12 weeks	9 cm
2	Female	5	Trauma	Temporal	One	250ml	650ml	14 weeks	8 cm
3	Male	7	Trauma	Frontal and temporal	Two	250ml 200ml	450ml 400ml	16 weeks	8 cm
4	Male	6	Trauma	Frontal and temporal	Two	250ml 200ml	650ml 500ml	13 weeks	7 cm
5	Female	4	CMN	Frontal,Temporal	Two	100ml 200ml	300ml 600ml	18 weeks	6 cm 10 cm
6	Male	10	CMN	Frontal	Two	250ml 200ml	625ml 500ml	12 weeks	8 cm 7cm
7	Female	13	Trauma	Frontal	One	320ml	750ml	12 weeks	14cm
8	Male	11	CMN	Temporal	Two	200ml 200ml	520ml 520ml	18 weeks	7 cm 9cm
9	Female	5	Trauma	Frontal , Temporal	Two	250ml 100ml	650ml 375ml	13 weeks	7cm 5cm
10	Female	6	Trauma	Frontal	One	320ml	800ml	20 weeks	15cm
11	Male	9	CMN	Frontal	One	250ml	470ml	17 weeks	9cm
12	Male	6	Trauma	Temporoparietal	One	320ml	800ml	15 weeks	13cm

13	Male	9	Burn	Frontal	One	320ml	640ml	16 weeks	9cm

No antibiotic solution was used for expander pocket instillation. Patient were followed regularly. Any notable sign andsymptomslikeextremepain on inflation, persistent blanching and any redness were recorded in follow up visits andwereconsideredtheendpointforexpansion during session. All expanders were expanded 2-3 time over to expander recommended volume. Expansion was stopped one month prior to flap advancement after achieving sufficient length of the advancement flap. Expansionwasdonetwiceweekly.[Figure1],[Figure2]

Figure 1: *A 10 years old girl with post burn scalp alopecia (120cm^2) on the fronto-temporal and parietal regions (a)frontal view (b)right lateral view (c) posterior view pre-operative (d)frontal view post implant placement and expansion (e)lateral view post implant placement and expansion(f) posterior view post implant placement and expansion (g) frontal view pre implant removal (h)lateral view pre implant removal (i)posterior view pre implant removal (j) final frontal view(k) final lateral view (l) final posterior view*

Figure 2: *A patient with Post-Burn Scalp Alopecia on temporoparietal regions (a, b), with expander placed (c, d). almost all the area covered by rotation advancement flap as can be seen in frontal and lateral views of the patient (e,f)*

Results

Out of 13 patients 8 (62%) were male and 5 (32%) were female. Mean age of expansion was 7 years (Age range 4 years to 13 years). 3 (23%) patients had post burn alopecia, 6 (24%) patients had post trauma scalp reconstruction using skin graft and 4 (30%) patients had congenital melanotic nevi. Most of patients had frontal (76%) and temporoparietal (46%) defects. 14 weeks were the average expansion time.[Table:1]

The average amount of flap advancement was 9 cm (Ranged from 5 to 15 cm) and average overexpansion factors was 2.5 times (Ranged from1.8 to 3 times) . In patients who underwent two-time expansion resulted in 86% coverage of the defect, whereas those who underwent three-time expansion achieved approximately 96% coverage of the defect. None of the patients in this study had any complications during the expansion period. Hair density was slightly reduced after expansion on visual analogue scale but it was not significant enough to alarm parents.

Discussion

The revolutionary impact of tissue expansion on modern plastic surgery is indisputable, transforming the landscape of reconstructive and aesthetic procedures. One illustrative example of physiological tissue expansion is evident in the remarkable changes that occur during pregnancy. Beyond the realm of contemporary practices, ancient rituals in Thailand and Chad have involved cervical and oral-labial expansion for centuries, providing cultural insights into the enduring significance of tissue modification.[8] In 1905, Codvilla ventured into uncharted territory by attempting to lengthen a femur through tissue expansion, a testament to the early curiosity surrounding its potential.[9] Neumann's 1957 publication documented successful tissue expansion in the reconstruction of atraumatic ear defect, utilizing arubber balloon over a four-month period without complications.[10] Subsequent milestones include Radovan's 1976 experience with breast reconstruction.[11] The pediatric application of tissue expansion emerged prominently in 1981 when Argenta et al. pioneered its use for post-burn neck contracture in children.[12] Tissue expansion has become as the treatment of choice in secondary burn

reconstruction in children and adults.[13-15]

In our study most of children were in their early age as there is no age limit for expansion and trend is to early age expansion to prevent peer pressure and behavioral changes in children at later age.[16,17,18] Many people often utilize external ports in children to avoid the discomfort of repeated needle pricks during follow-up visits. However, Lozano and Drucker[19] conducted a study and found that the rate of infection and exposure in patients with external ports was 17.6%. In order to prevent excessive pressure on the port and minimize the risk of accidental puncture, we utilized an internal low profile port positioned at least 6 cm away from the expander. This approach aligns with the findings of Bauer et al,[20] who emphasized the importance of aseptic measures during each expansion to reduce the likelihood of infection. Our research supports these recommendations.[21]

We made incisions that were positioned at right angles to the direction of expansion. Astudy has demonstrated that when an incision needs to be made close to the prospective defect, it is advisable to dissect the pocket as far away from the lesion as feasible. When utilizing expansion for the reconstruction of a large nevus, the incision should be positioned 2cm within the nevus itself. However, in the case of a burn, the incision should be made within the surrounding healthy skin.[22] Our strategy in tissueexpansionhasbeenthesame to enhance blood flow at the incision margins, so preventing wound infection and promoting optimal wound healing.

It is usual in clinical practice to inflate tissue expanders beyond the capacity suggested by the manufacturer. This practice is supported by studies indicating that overexpansion leads to fewer complications compared to underexpansion.Theimportance ofthis is emphasized by few other clinical investigations that have demonstrated the ability to overinflate expanders to their indicated capacity without any problems.[23,24] In this research, an expander was inflated to a volume that was 2-3 times greater than what the manufacturer had specified, and no issues were encountered. An ex vivo investigation conducted on expanders from various vendors has demonstrated that an average over inflation of 80 times the capacity specified by the manufacturers can be attained.[25]

Though we had successfully expanded and covered most of defects in patients included in this study without any complication which can be attributed to the meticulous selection process for patients and the expertise of a single surgeon performing the operations. In order to establish this procedure as a standard practice in tissueexpansion, it is necessary to developa randomized controlled study that includes participation from several surgeons and centers.

Conclusion

Expanding the volume of the expander by two to three times is asafeandeffective method to increase the length of the flap for rotation advancement, without generating significant issues.

Conflict of Interest: *None*

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