

Aesthetic Reconstruction of Large Scalp Defects by Sequential Tissue Expansion Without Interval

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Abstract. Tissue expansion is indicated in the reconstruction of various scalp defects when there is inadequate adjacent tissue to allow either primary closure of the defect or repair with a local flap. It is the most important armamentarium for aesthetic hair-bearing scalp reconstruction in cases of congenital or required defects. This technique was used sequentially without interval to achieve scalp reconstruction for 12 patients with a defect ranging from 30% to 75% of the scalp (average, 55%). For 12 patients, 32 expansion treatments were undertaken between September 1997 and January 2002. The 12 patients included 3 women, 4 men, and 5 children with a mean age of 20 years (range, 45 days to 36 years). All patients had more than one period of treatment. The most common conditions treated were burns (n = 7), trauma (n = 1), congenital naevi (n = 2), and male pattern baldness (n = 2). Reconstruction of 12 large scalp defects has been performed with a 3.1% rate of major complications. Results show that tissue expansion is a safe and efficient but time-consuming technique for aesthetic scalp reconstruction, especially in the case of “side-burn” scenario or large defects. There was no significant alteration in ratio of complications although tissue expansions were made sequentially.

Key words: Complication—Reconstruction—Scalp defects—Sequential expansion

Tissue expansion has gained a wide range of applications since the technique was popularized by Ra-

dovan in 1978 [4]. Extensive soft tissue defects of scalp pose significant problems for the plastic surgeon. Hair-bearing scalp is optimally replaced by local tissue of similar quality and characteristics. Where the use of local flaps is precluded by an inadequate amount of adjacent tissue, tissue expansion provides a useful reconstruction option [2,4]. Expansion of scalp shows typical biphasic progress: An initial period of resistance is followed after a few weeks by destruction of the galeal barrier, with a continuous and rapid increase in skin compliance [2]. Traumatic alopecia, burns, male pattern baldness, and congenital naevi can be corrected by expanding and rearranging the remaining hair-bearing tissue [1,8]. Burn alopecia has serious sequelae, both aesthetic and psychological, particularly in children [12]. Thanks to the expansion technique, tissue expanders are applicable in pediatric populations. It is a valuable tool in the reconstruction of scalp defects with excellent results. Although tissue expansion is simplistic in concept, judgment and very careful preoperative planning are required to ensure optimal results [3]. Numerous reports describe the surgical technique, complications, and results of scalp reconstruction with tissue expansion in the relevant literature [4,6,9,11,13].

The current study reviews our clinical experience with the aesthetic treatment of large scalp defects (alopecia) using sequential tissue expansion. We also describe the principles of the tissue expansion technique and the surgical details for getting the maximum expansion that improve the results of conventional treatment for large alopecia when nearby healthy tissue to be expanded is very limited. Additionally, the relevance of sequential tissue expansion to the success rate for the aesthetic treatment of large scalp defects is discussed.

Clinical Material and Methods

Tissue expansion was used for 12 patients with large alopecia that involved approximately one-half of the total hair-bearing scalp. The ages of these patients ranged from 45 days to 36 years (average, 20.9 years). Among these patients, there was no smoking, diabetes, obesity, or other concomitant medical illnesses. The morbidities included scarring and alopecia attributable to burn ($n = 7$), avulsion injury ($n = 1$), congenital naevi ($n = 2$), and male pattern baldness ($n = 2$). For all the patients, rectangular-shaped Radovan tissue expanders were preferred. The filling reservoir usually was located in the mastoid region. Altogether, 32 tissue expanders of various sizes (250–750 ml) were used. The follow-up period ranged from 18 months to 78 months (average, 48 months).

Preoperative preparation for insertion of tissue expanders included bathing with antibacterial soap immediately before surgery. All patients received a preoperative antibiotic prophylaxis 6 h before the procedure, preferably first- or second-generation cephalosporin. With the patient under general anesthesia, the following intraoperative protocol was followed. An incision was made, whenever possible, within the borders of the lesion, and the direction was always perpendicular to the expander's major axis, preventing suture from exposure resulting from diastatic action of the expansion. A generous pocket for the expander was created between the galea aponeurotica and pericranium adjacent to the defect to be repaired. To obtain a more homogeneous distribution of the hair follicles, tissue expanders as large as possible were preferred [6]. Two separate pockets were prepared for the tissue expander and the filling reservoir through the same single incision. Maximum attention was paid to ensuring that the pockets were large enough to accommodate the expander.

After careful hemeostasis, the expander was inserted under the galea. During insertion of the expanders, attempts were made to avoid any knuckling or bending of the prosthesis. The incision then was closed in two layers. First, the galea on both sides were sutured together along with the subgaleal fascia and pericranium with 2/0 vicryl sutures to stabilize the suture line against tension. Later, the skin was closed with 3/0 monofilament prolene. Expanders were filled to about 10% to 20% of their volume to allow better hemeostasis through pressure. A suction drain was kept in the pocket until suction was completed.

Postoperatively, we routinely used antibiotics for a period of 5 to 7 days during the initial placement of the expanders. The wounds were dressed with a light gauze wrap. The dressing was removed within 48 h and left open to air. Expansion was begun after the second postoperative week. To prevent infection, the inflation site was prepared carefully with betadine solution immediately before inflation. The prosthesis

Table 1. Etiology and quantity of expanders used

Patients	Etiology	Age (years)	No. of expanders used	Periods of treatment
S.D	CIN	0.12	5	3
E.T	Congenital naevi	11	2	2
Y.M	Avulsion injury	13	4	2
E.T	Burn	14	5	3
O.B	Burn	14	2	2
S.A	Burn	21	2	2
M.B	Burn	22	2	2
Ö.A	Burn	24	2	2
M.A	Burn	35	2	2
M.Y	Male pattern baldness	36	2	2
S.D	Male pattern baldness	38	2	2
S.B	Burn	38	2	2

CIN, cerebriform intradermal nevus

was inflated every 2 days with saline. This procedure usually required 2 to 3 weeks. Recent experimental and clinical experience suggest that expansion for 1 to 2 weeks is just as effective as the longer delayed expansion of 6 to 8 weeks [14]. Expansion was carried out to the point of tightness, blanching, and mild patient discomfort. All the patients had more than one period of treatment (Table 1).

At removal of the expander, the capsule surrounding the tissue expander was not removed. The capsule and sometimes the galea were incised routinely with a multiple-crossing incision. This allowed an additional 10% increase in flap length and width to be obtained without compromising flap circulation [6].

During adaptation of the flap to the defective area, another suitable expander was placed under the flap for the second stage of the expansion procedure. Then the flap was sutured to a stable structure such as the galea or pericranium of the unaffected scalp with 2/0 vicryl. This maneuver probably helps to prevent long-term capsular contracture, allowing early and safe expansion [6,14].

Our clinical experience suggests that if the expander is left beneath the skin for a time after expansion, the stretch-back ratio of the skin can be reduced significantly, and the maximum amount of expansion can be achieved. After the expanders had been maintained for 4 weeks [14], the second stage of the expansion was begun. The expanders were inflated every 2 days with saline in the same manner as in the first stage of the expansion. Inflation was continued until the possible optimal result was obtained. This usually required 3 weeks. Two patients with large alopecia (60–70%) underwent a third stage of expansion. Intraoperative expansion during removal of the expander was not performed in any of

Table 2. Complications of expansion

Major complication	n (%)
Infection	1 (3.1)
Flap necrosis	—
Implant exposure	—
Implant failure	—
Seroma	—
Hematoma	—
Pain	3
Scar widening	1
Total complication	5
Total expansion	32

the cases because it was doubtful whether there was any gain in the expanded skin [6]. Finally, a reexpanded skin flap was adapted and sutured in a relaxed tonus because the tension of flap causes hair loss rather than circulation problems [7]. The flap also was sutured to the galea or pericranium. In all cases, a suction drain was placed under the flaps.

Results

In this classification, complications were categorized according to the classification of Manders et al. [9]. Hematoma, infection, prosthesis exposure, and implant failure were named as major complications, whereas widening of scar, pain, and seroma were regarded as minor complications.

In our clinical experience with reconstruction of large scalp defects, we have encountered one major complication: infection (Table 2). However, we treated this infection using broad-spectrum antibiotics without the need for prosthesis removal. Minor complications that occurred included pain in three patients that could be controlled by analgesics and mild widening of the scar (0.5 cm) in one patient, which was acceptable cosmetically.

Case 1

A 45-day-old boy with a large congenital cerebriform intradermal nevus covering 75% of his scalp had three periods of treatment with expanders variable in size (450 ml, 400 ml, 250 ml, respectively). All the expanders were rectangular. In last period of expansion, a complication of infection occurred, but prosthesis removal was not required. In the end, an aesthetic scalp reconstruction was achieved without any sequela (Fig. 1a–e).

Case 2

A 13-year-old girl had a defect involving 45% of her scalp that covered the right parietal and temporal

areas. This included a sideburn defect at the same site and part of the occipital region. The defect was the result of an avulsion injury. The large soft tissue defect had been skin grafted. A previous attempt at tissue expansion had failed. The remaining scalp was expanded in three stages using four rectangular expanders, each of them 400 ml in size. During these periods of treatment, the only minor complication was pain, which was relieved by an analgesic. At the end of the reconstruction, the patient's satisfaction was perfect (Fig. 2a–c).

Discussion

Twelve patients with large scalp defects have been treated by the sequential tissue expansion technique, with a low rate of complications (3.1%), the same or lower than those reported in the literature [1,6,11]. We believe the main reason for exposition of tissue expander is inappropriate surgical technique or careless planning. We had no exposition in our series.

Although scalp defects have been treated traditionally by skin grafting and local flaps, these methods often have led to suboptimal aesthetic results. The aesthetic reconstruction of large scalp defects is challenging. No tissue in the human body adequately mimics the hair-bearing scalp [1]. For the reconstruction of scalp defects, the donor site with the most similar and suitable tissue from the aesthetic point of aesthetic is the rest of the scalp. Unfortunately, a paucity of donor-site scalp usually results from the extensive nature of large defects. The loss of sideburn (Fig. 2a–c) with subsequent alopecia is relatively frequent as a consequence of burn trauma or surgical processes [13], and not many techniques of sideburn reconstruction have been reported. Because these defects are not amenable to primary closure, they remain a challenging problem. Furthermore, large scalp defects have serious aesthetic and psychological sequelae [13]. Therefore, the main goal of scalp reconstruction is not only to resurface the defect, but to ensure optimal aesthetic results (Fig. 2d–e).

The use of tissue expanders allows maximal use of any available scalp tissue for the resurfacing of scalp deformities. The prime advantage of tissue expansion is the generation of local skin flaps sharing the color, thickness, and hair-bearing qualities of the adjacent tissue lost to the defect [10]. As much of the remaining hair-bearing scalp as possible should be expanded to obtain a homogeneous distribution of follicles [1]. This method creates “new” scalp tissue for the coverage of defects with normal hair-bearing skin [10]. Although the hair density does not increase, the transplantation of existing hair follicles on expanded flaps often allows successful coverage of bald spots, or at least, recreation of an acceptable hairline [13]. The recent use of tissue expanders has improved the ability to perform aesthetic reconstruction of large scalp defects.



Fig. 1. (a) A 45-day-old boy with a large congenital cerebriform intradermal nevus covering 75% of his scalp, posterior view. (b) Preoperative anterior view. (c) After second expansion. (d) Postoperative left lateral view. (e) Postoperative right lateral view.

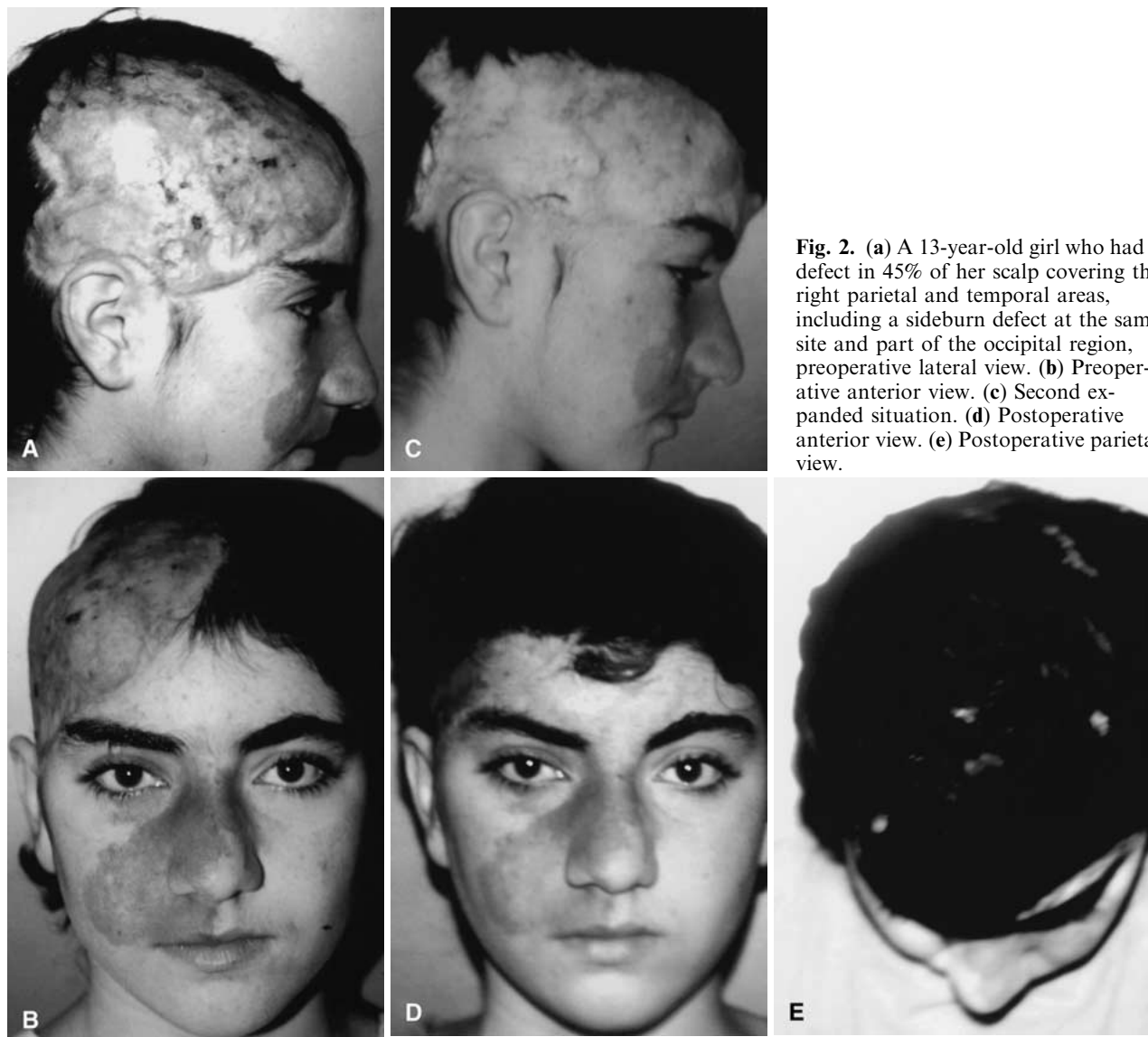


Fig. 2. (a) A 13-year-old girl who had a defect in 45% of her scalp covering the right parietal and temporal areas, including a sideburn defect at the same site and part of the occipital region, preoperative lateral view. (b) Preoperative anterior view. (c) Second expanded situation. (d) Postoperative anterior view. (e) Postoperative parietal view.

For large scalp defects, careful planning helps to decrease the complications. Aggressive expansion in a high-risk anatomic area such as a scar tissue area may increase the complications of product failure and ischemic ulcerations [11]. Large scalp defects may not always be amenable to closure in one period of treatment. Repeated expansion procedures can be applied if necessary [11].

Seven of 12 patients in our series had alopecia attributable to burn sequelae. The elasticity of the remaining scalp tissue in these patients had been partially lost. We could not have achieved the desired results in first period of treatment. Again, two patients with congenital naevi had defects so large that the healthy scalp tissue to be expanded was not adequate to cover the defective region in one period of treatment. For such patients with very limited healthy scalp tissue, we considered it very important

to achieve the maximum amount of expansion without serious complications, and to reduce the stretch-back ratio of the expanded skin significantly so that the eventual results of reconstruction could be more aesthetic.

Hair is an inseparable element of external appearance for every human being. Although various fashion trends come and go, the lack of hair is a major aesthetic and psychological problem for many. Hair loss on the head is particularly distressing for children. This stems from the nature of children and also from the fact that peer pressure is much higher among children than among adults [7].

To improve the results of conventional treatment for alopecia with tissue expansion, some modifications and meticulous approaches were defined in the literature. Guzel et al. [6] applied some surgical maneuvers and Z-plasties to expanded flaps for the

reconstruction of large alopecia. In their series, they mentioned large alopecia involving approximately one-third of the total hair-bearing scalp. Z-plasties may provide better adaptation of the expanded flap, avoiding linear scar formation, but may change the direction of the hair. It is obvious that for larger scalp defects, more and more expanded skin is needed to cover the defect. On the other hand, a relaxed tonus of the expanded scalp flap during the suturing procedure is one of the most important things enabling the creation of a more cosmetic reconstruction.

Treated with sequential tissue expansion, the hair of our patients grew in exactly the same direction as it had grown before. Such a result would have been difficult to achieve by any other technique (Fig. 1a–e).

Reconstruction of huge scalp defects, whatever their origins, using reexpansion and leaving the expander beneath the scalp after adaptation of the flap until the next expansion period avoids flap contraction, decreases the number of surgical procedures, and yields better cosmetic results. Sequential tissue expansion is preferable to aggressive expansion, which results in many complications and unaesthetic reconstructions, leaving psychological problems unsolved.

References

1. Argenta LC: Tissue expansion In: Sherell J ed *Aston, Grabb, and Smith's Plastic Surgery* Lippincott-Raven, p 93, 1997
2. Azzolini A, Riberti C, Cavalcab D: Skin expansion in head and neck reconstructive surgery. *Plast Reconstr Surg* **90**:799, 1992
3. Baker SR, Swanson NA: Tissue expansion of head and neck: Indications, technique, and complications. *Arch Otolaryngol Head Neck Surg* **116**:1147–1153, 1993
4. Chun JT, Rohrich RJ: Versatility of tissue expansion in head and neck burn reconstruction. *Ann Plastic Surg* **41**:11–16, 1997
5. Giraldo F, Gonzalez C, Garnica I, Ferron M, Rus JA: Sideburn reconstruction with an expanded supraauricular trapezoidal flap. *Plast Reconstr Surg* **100**:257–261, 1997
6. Güzel MZ, Aydın Y, Yücel A, Hariri S, Altintas M.: Aesthetic results of treatment of large alopecia with total scalp expansion. *Aesthetic Plast Surg* **24**:130–136, 2000
7. Kolasinski J, Kolenda M: Algorithm of hair restoration surgery in children. *Plast Reconstr Surg* **112**:412–422, 2003
8. Manders EK, Graham WP 3rd, Schenden MJ, Davis TS.: Skin expansion to eliminate large scalp defects. *Ann Plast Surg* **12**:305, 1984
9. Manders EK, Schenden MJ, Furrey JA: Soft tissue expansion: Concept and complications. *Plast Reconstr Surg* **74**:493, 1984
10. Nordstrom RE, Devin JW: Scalp stretching with a tissue expander for closure of scalp defects. *Plast Reconstr Surg* **75**:578–581, 1985
11. Pisarski GP, Mertens D, Warden GD, Neale HW: Tissue expander complications in the pediatric burn patients. *Plast Reconstr Surg* **102**:1008–1012, 1998
12. Silfen R, Hudson DA, Soldin MG, Skoll PJ: Tissue expansion for frontal hairline restoration in severe alopecia in a child. *Burns* **26**:294–297, 2000
13. Sniezek JC, Sabri A, Burkey BB, Barielle DJ: Reconstruction after burns of the face and neck. *Otolaryngol Head Neck Surg* **8**:277–281, 2000
14. Zeng Y, Xu C, Yang J, Guang-ci Sun, Xiao-hu Xu: Biochemical comparison between conventional and rapid expansion of skin. *BJPS* **56**:660–666, 2003