

## **EVALUATION OF USING TISSUE EXPANDER FOR RECONSTRUCTION OF POST BURN ALOPECIA OF SCALP**

**Ari Raheem Qader\* & Suzan Fadil Jabber<sup>@</sup>**

\*Assistant Professor, Department of Surgery, College of Medicine, University of Sulaimania.

<sup>@</sup>Diploma in plastic surgery, Department of Surgery, Sulaimania Plastic and Burn surgery Hospital.

\*Email: drzangana@yahoo.com, Mobile no.-009647701526316

### **Abstract**

Tissue expansion represents one of the major advances in surgery and is particularly applicable to burn reconstruction. The technique provides tissue of similar texture and color to the defect to be covered and has the added advantage of minimal donor site morbidity.

This study aimed to assess the results & complications in the correction of post burn scalp alopecia using a tissue expansion, prevention of implant extrusion, lower the infection rate in tissue expansion and expander selection.

Forty patients with scalp burn alopecia treated with tissue expansion of the scalp, were included in this prospective study in Sulaimania hospital of burn and reconstructive surgery from February 2002 to September 2009 with age groups ranging from (4-30) years with an average of 15.5 years. Twenty three patients were females.

The time period between burn injury and reconstruction ranged between (4-25) years, their scalp defects ranging between (5x10cm -13x25cm). We were able to completely reconstruct 77.5% of the total patients with single or multiple sessions of expansions. The remaining 22.5% patients have benefited from reduction in the percentage of alopecia and recreation of anterior hair line to camouflage their defects. Major complications occurred in 6 cases(15%), in which the expansion process interrupted with removal of the expander.

In conclusion, It is not always possible to measure the absolute efficacy of a surgical technique or determine a general guideline its indication of the tissue expansion procedure although afflicted with a broad range of possible complications, the tissue expansion procedure remains a valuable and reliable technique for the reconstruction of post burn alopecia of the scalp.

### **Introduction**

Scalp burn alopecia is a healed burn scar resulting in permanent destruction of hair follicles and irreversible hair loss. Once it becomes established the psychological impact of such a defect can be quite dramatic<sup>1</sup> and their reconstruction may prove a difficult task particularly when the defect is extensive. Scalp rotation flaps are excellent for small defects, but even the orticochea three flap repairs (orticochea 1971) is inadequate for reconstruction of the largest defects. The pedicled paritoccipital flap (Juri 1975) and the long temporal vertical flap (Nataf 1984) reconstruct the frontal hairline with but

likewise are unable to cover more extensive defects. Free hair-bearing scalp grafts (Orrenteich, 1959) such as punch and strip grafts produce very variable and frequently unsatisfactory results. Serial excision, microvascular flap transfer and free hair transplantation have many drawbacks including lengthy hospital stays, flap necrosis, and inability to cover major scalp defects. Recently the introduction of controlled tissue expansion to treat scalp defects has started a new era of reconstruction<sup>2,3</sup>.

In 1957, Neuman first described the use of gradual tension, leading to the expansion of skin by an inflatable

balloon, buried subcutaneously above the ear<sup>4-6</sup>. In 1975 Radovan and Austad working independently, developed the concept of tissue expansion with a silicon implant, three years later after considerable laboratory and clinical experience and subsequent presentations at local meetings by Radovan, Argenta and other surgeons, tissue expansion gained wide clinical acceptance<sup>7</sup>.

Tissue expansion represents one of the major advances in surgery and is particularly applicable to burn reconstruction. The technique provides tissue of similar texture and color to the defect to be covered and has the added advantage of minimal donor site morbidity, in fact the only sequel of tissue expansion should be the scar. It does have the disadvantage of being a two stage procedure, and requiring multiple hospital visits, in addition to the discomfort and period of increased deformity during the period of scalp expansion.

Another of the great advantages of tissue expansion is the massive increase in vascularity of the expanded tissue. This translates into a very robust flap. Experimental work has shown a 117% increase in vascularity compared with a normal flap. This is much better than even a surgically delayed flap<sup>2,8</sup>.

Expanders are silicon envelopes that have self sealing injection ports. At weekly or twice weekly intervals, saline is progressively injected through the port and passes into the expander, which enlarges. As the volume inside the implant increases, tension placed on the overlying tissue increases<sup>7,9</sup>.

Expanded tissue arises from two sources: recruitment from adjacent tissue and two main biological changes in the skin:

Tissue creep: is the time dependant plastic deformation of any material in response to constant stress, it gradually stretches the skin.

Stress relaxation: as tissue stretches it relaxes and less force is required to maintain it stretched.

The result will be increase in tissue volume through proliferation of epithelial cells, increased epidermal mitotic activity, expansion of the subdermal vascular network, and increased synthesis of collagen by fibroblasts<sup>10,11</sup>.

On molecular level panoply of growth factors, cytokines, hormones, adhesion molecules, cytoskeletal elements and signal transduction proteins are induced in response to expansion, confirming that tissue expansion is a dynamic process<sup>11</sup>.

The purpose of this study was to evaluate the results and complications in the correction of post burn scalp alopecia using a tissue expansion.

### Patients and methods

Forty patients with scalp burn alopecia treated with tissue expansion of the scalp, were included in this prospective study in Sulaimania hospital of burn and reconstructive surgery from February 2002 to September 2009 with age groups ranging from (4-30) years with an average of 15.5 years, 23 patients were females. The time period between burn injury and reconstruction ranged between (4-25) years, their scalp defects ranging between 5x10cm-13x25cm. Full history was taken from the patients regarding personal data in details, duration of burn, any medical or surgical treatments received by the patient.

The outcomes and possible complications have been discussed with the patient and the informed consent was signed. Preoperative photos have been taken, along with measuring defect size, and assessment of hair-bearing scalp, for donor selection. Multiple expanders were decided when the dimensions of the defect exceeded 25% of the total hair bearing scalp. All with remote valve system with different shapes (rectangular, rounded, and elliptical).

Per-operative antibiotic (i.v. Ampiclox) with induction of general anesthesia for all patients were done. Flap designed as simple advancement or rotation-

advancement flap which incorporates one of the major scalp vessels (e.g. occipital artery or superficial temporal arteries) adjacent to the defect. All the expanders were with remote valves Rectangular, crescent and rounded shaped expanders were used. Expanders were placed through either remote incisions (radially placed) or para-lesional incisions in the normal scalp 1-2 cm away from the defect. A sub-galeal pocket slightly larger than the base of the expander was dissected.

After expander placement it was injected with normal saline 10-20% of its actual volume, closed suction drains were put for some of the patients, after meticulous homeostasis the wound was closed in two layers, galea sutured with 4/0 vicryle, and the skin with subcuticular suturing by 3/0 prolene.

First post operative expansion started 2 weeks later, with small gauge 23 needle under aseptic condition and the amount of normal saline injected was guided by tissue response and patient tolerance.

The frequency of expansions was once or twice weekly. The amount of expansion achieved was loosely estimated by the difference in distances between the base diameter and the over-the-top distance. To achieve this, many of the expanders has been over inflated to above its volume that is recommended by the manufacturer and expansion continued until this is slightly exceeded. Then the patient was re-admitted for reconstruction after a period of two weeks past the last injection. The expander was removed by means of the original incision. The flap was next advanced to ensure adequacy of wound coverage. The scar was then excised and the wound edges were closed with two layer suturing.

## Results

1-Etiology of scalp burn: The most common etiology of scalp burn was scald (Table I).

2- Site of alopecia: The most common site of alopecia was temporo-parietal region (Table II).

**Table I: Different etiologies of burn.**

Etiology of burn	Number	Percentage
Scald	20	50%
Flame	16	40%
Chemical	4	10%
Total	40	100%

**Table II: Different sites of alopecia.**

Site of alopecia	Number	Percentage
Frontal	10	25%
Parietal and Temporal	21	52.5%
Occipital	9	22.5%
Total	40	100%

3- Sizes of expanders: Various sizes of expanders were used (seven 100cc expanders, thirteen 250cc expanders, five 300cc expanders, and fifteen 400cc expanders).

4- Site for placement of injection port (valve): The most common site for placement of injection port (valve) was subcutaneous (internally placed) (Table III).

**Table III: Sites of valve placement.**

Site of valve	Number	Percentage
Subcutaneous(internal)	30	75%
external	10	25%
total	40	100%

5- We were able to completely reconstruct 77.5% of the total patients with single or multiple sessions of expansions. The remaining 22.5% patients have benefited from reduction in the percentage of alopecia and recreation of anterior hair line to camouflage their defects.

6- We have encountered a complication rate of 25% as follows:

*Minor complications* (10%): which did not interrupt the expansion process includes:

-Seroma: developed in 2 cases (5%) in immediate post-operative period, which responded to repeated aspiration and broad spectrum antibiotics.

-wound dehiscence: occurred in 1 case (2.5%) in the 9th postoperative day, he underwent secondary suturing and received broad spectrum antibiotics, the first expansion was delayed till complete healing was achieved.

-cellulitis: at the suture line developed in 1 case (2.5%) in the 6th postoperative

day, which was responded well to broad spectrum antibiotics and local wound care, but caused some delay in wound healing and subsequently delay in postoperative inflation.

*Major complications* occurred in 6 cases (15%), in which the expansion process interrupted with removal of the expander, including:

-infection: profound infection accounted for 10% (4 cases) in the early post-operative period, which necessitated removal of the expander in the operation theatre, swab taken for C&S and antibiotics given accordingly. We arranged for them another operation for expansion after 6 months

-expander extrusion: occurred twice 5%, before completion of the expansion process, the expander was removed in the operative theatre, under cover of broad spectrum antibiotic, they were acquired another operation for expansion after 6 months (Table IV).

**Table IV: Complication rate in our study.**

Complications		Number	Percentage
Minor	Seroma	2	5
	Wound dehiscence	1	2.5
	Cellulitis	1	2.5
Major	Profound infection	4	10
	Expander extrusion	2	5
Total		10%	25%

Statistical analysis showed no significant influence of the site of incision (parallel to scar or remote) or the site of valve placement (subcutaneous or externally

placed) on the failure rate outcome (P values 0.253, 0.609 respectively) (Table V).

**Table V: Distribution of the study group by site of incision and major complication.**

Major complication	Sites of incision						p-value
	Para-lesional		Remote		total		
	N	%	N	%	N	%	
yes	5	20	1	6.7	6	15	0.253
No	20	80	14	93.3	34	85	
total	25	100	15	100	40	100	

### Discussion

The main objective of alopecia reconstruction is aesthetic therefore, the ultimate goal of treatment is complete closure of the defect to restore the hair bearing surface of the scalp. If this is not possible, camouflaging the residual defect by decreasing the percentage of alopecia and /or recreation of an anterior hair line is desirable. Serial excision, rotational scalp flaps, and on rare occasions, free hair follicle transplantation or micro vascular scalp transfers have been found to be effective in attaining this objective,

however, they may present problems of excessive blood loss, lengthy hospital stays and scalp flap necrosis<sup>6,12</sup>.

The results of the present series have shown that by tissue expansion, total reconstruction of post-burn alopecia could be achieved in 77.5% of the treated patients either from single session or multiple sessions. Most of these patients could not be easily managed by any of the other conventional reconstructive techniques (figures 1&2).



**Figure 1: A five year old child with scalp alopecia (8x12cm).  
A- Preoperative, B and C during expansion, D- Immediate post-operation.**



**Fig 2: A four year old child with (5x10x22cm) scalp alopecia was completely reconstruct after two sessions of tissue expansion.**

Our results were higher than that achieved by A.Bozkurt who had completely reconstructed 71.6% of his patients, and Zaki M.S<sup>3</sup> who had 70% rate. It is comparable to the results achieved by D.A Hudson 80%<sup>8</sup> and Yuosif Salih 87.5%<sup>13</sup>. But lower than the results of the study of Farhad Hafezi 90%<sup>14</sup>.

Similar to every surgical procedure, tissue expansion is associated with complications. The complication rate in our study was 25%; this rate was lower than that of A.bozkurt 28.4%, that of Yousif Salih 34.75%, Farhad Hafezi 27%, and the same results were found with D.A Hudson 25%.

Our failure rates (interruption of expansion process) was 15% (6 cases), this is comparable to that of A.Bozkurt 7.5%, Farhad Hafezi 6%, D.A Hudson 20%, Yousif Salih 13.25%, and Laura H. Zaal 17.2%.

However, direct comparison is limited due to varying definitions of complications (major or minor complications vs. absolute or relative) and rates (either presented only general complication rate or failure).

Furthermore, complication or failure rates of expander therapy for burn patients

were not always explicitly stated but had to be calculated from provided data.

The above complications may be attributed to the following causes:

Expander selection: shortage of a specific shape and size for the patient leading us to select other available types.

Rectangular shaped tissue expanders are always preferred in scalp reconstruction because it provides 40% tissue gain which is much higher than that achieved by round expanders 25% and crescent expanders 35% so the added tissue gained by rectangular flaps may increase the choices possible for flap design as compared to round hemispherical devices which requires single or multiple edge incisions or bifurcation of the flap after tissue expander removal, but because of shortage, we could not be able to use rectangular expanders in all cases<sup>6,8,15</sup>.

Inflations: in some patients who live very far from our hospital, they were not able to do all the injections under our supervision that's why increasing the complication rate.

Unavailability of special retractors which are malleable copper retractor, molded to the curvature of the skull. This is helpful in developing the pocket for a large

expander. Consequently we made big incisions for better visualization, which may be one cause of expander extrusion.

In general, tissue expanders are considered as a great advance in reconstructive surgery. This method particularly shows beneficial effects for the reconstruction of post burn alopecia. Despite the disadvantage of being (at least) a two-stage procedure, the expander technique provides tissue of the same texture and color with minimal donor site morbidity<sup>6,8</sup>.

However, to fully harness these advantages and achieve success, the expansion process must also aim to minimize complications. This starts with careful planning preoperatively. Many of the more recent articles on tissue expansion have focused on identifying risk factors for complications and the technical aspects of tissue expansion have received less attention.

It is not always possible to measure the absolute efficacy of a surgical technique or determine a general guideline its indication of the tissue expansion procedure although afflicted with a broad

range of possible complications, the tissue expansion procedure remains a valuable and reliable technique for the reconstruction of post burn alopecia of the scalp.

To lower the infection rate in tissue expansion, perioperative antibiotics are recommended, but prolonged antibiotic usage is not necessary. Irrigation with an antibiotic solution may be used at the time of placement. If an expander does become infected, the port is externalized, and irrigation and antibiotic therapy are instituted immediately. A catheter may be placed along the tube egress path for irrigation.

Prevention of implant extrusion is minimized by the following: (1) Inflation of the expander should not be instituted unless the incisions will not be affected by filling; (2) the expander should be initially inflated only enough to fill the dead space with a drain for 24 hours; (3) expansion should proceed with strict aseptic techniques and (4) incision closure should be achieved in two layers with absorbable synthetic sutures used for the deeper layer.

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