

## A MODIFIED TECHNIQUE FOR APPLICATION OF TISSUE EXPANDERS FOR EXTREMITIES IN BURN SCARS PATIENTS

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### ABSTRACT

**Background:** Tissue expansion is considered a major advancement in reconstructive surgery. However, there are limitations to their application in the extremities and carries relatively higher rates of complications. The aim of this study was to propose a modification to this technique and assess the rate of complications with slower rate of expansion.

**Methodology:** Thirty females (age range 14 to 40) with burn scars in the upper or lower extremity (15 cases in each) were the subjects of this investigation. Various sized rectangular expanders were used and expanded at a rate of 5% of the maximum inflatable size over 20 weeks.

**Results:** All of the cases of expansion completed the procedure uneventfully. In one case that developed necrosis at the edge of the flap, one week after removal of the expander, which was debrided and repaired successfully completed the treatment.

**Conclusion:** Slow expansion method is a useful method which can safely be applied for burn scars in the extremities.

**KEY WORDS:** Tissue expanders, Slow expansion, Extremities, Burn scars.

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### INTRODUCTION

One of the main difficulties in plastic and reconstructive surgery has been the lack of tissue for repairing the burn scars. In order to resolve this problem, surgeons resorted to the use of various skin substitutes taken from different sources ranging from autologous skins taken the patient himself,<sup>1</sup> homologous taken from another human source such as amniotic membrane<sup>2</sup> and heterologous which are prepared from another species such as pig.<sup>3</sup> With progress in this field, the majority of cases that

need skin substitutes are prepared by autologous skin grafts.

The latest method for preparing skin flaps is the use of tissue expanders. The pioneering work of Neumann, which at that time was a great revolution in tissue expansion or second revolution in plastic and reconstructive surgery was the first to suggest the use of tissue expansion technique for repairing the congenital ear (microtia).<sup>4</sup> Radovan and Austin used silicon prosthesis for producing tissue expansion.<sup>5</sup> Supplying of local tissue for reconstruction has distinct advantages that improved the ability of the surgeon to replace lost or surgically excised tissues with neighboring tissue of similar color, texture, sensation, and thickness. In addition, hair bearing capability is retained, and removal of a remote donor site is avoided.<sup>6</sup>

Tissue expansion is a physiological phenomena that occurs in situations such as expansion of abdomen skin during pregnancy. Histopathological studies on the expanded skin showed thickening all layer of epidermis and

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the most common was in the cornium and granulosum layers,<sup>7</sup> Contrary to the epidermis, the dermis, the hypoderm and muscle layers become hypotrophic, and new blood vessels are formed within the expanded tissue. The formation of these excessive new blood vessels is due to ischemia that develops from the pressure that the tissues expanders create and are needed for flaps safety.<sup>8</sup>

Tissue expanders are silicone envelopes that have self-sealing injection ports and at weekly intervals, saline is progressively injected through a remote injection port and it passes into the expander space, which then enlarges thus allows the surgeon to generate additional amounts of precious tissue to replace the defected tissue.<sup>9</sup> Following the removal of the tissue expanders, the dermal layers change to normal condition within 1.5 to 2 years. The indications for use of tissue expansion are burns (50%) trauma (32%) scare of previous surgery (8.8%) and skin cancers (9.2%).<sup>1</sup>

However, the application of tissue expanders carries inherent complications such as wound infection, extrusion of the envelope from the implantations site due to unhealed wound margins or flap necrosis, that develop as a result of ischemia following the expansion of the envelope. These complications are more common in the extremities where the vessels are very narrow and the blood supply is insufficient. For these reasons application of tissue expanders are not generally recommended in extremities, unless meticulous attention to details is given to reduce the incidence of these complications. Generally the tissue expanders are inserted subcutaneously and normally saline injections are performed weekly. Normally the volume for injection is 10% of maximum volume of the expander used, and after 10 weeks the injections are completed. No previous study has been conducted to assess if a slower rate of expansion can safely be employed for extremities. Therefore, the aim of this study was to assess if a more gradual expansion of the tissue expanders can be used safely in the treatment of burn scars in the extremities. In this proposed modified procedure, we injected

saline solution weekly at a rate of 5% of expander's volume and after 20 weeks the injections are completed.

## SUBJECTS AND METHODS

*Subjects:* The subjects of this study comprised 30 females from all age groups (14 to 40 years old) and who visited our centre for treatment of their burn scars in both upper and lower extremities. Selection criteria for inclusion of this study were: an area burn scars that ranged from 5x 10 cm in leg area to 7x 15cm in the thigh while in the forearm was 5 x 10 and 5 x 10 in the arms.

*Materials:* Rectangular tissue expanders used were made from Nagor (UK), Supa (Iran), Koken (Japan), and Silimed (France). The capacity of the expanders employed varied from 50 to 200ml. The capacity that were employed for the upper extremities ranged from 50 to 100ml for forearm and for the arm this volume ranged from 100 to 150ml. While the capacities used for the legs and for the thighs ranged from 50 to 100ml and 150 to 200ml respectively.

*Procedure:* Using standard surgical methods,<sup>9</sup> insertion of the flat expanders was facilitated by a small (3- 4cm long) incision which was initially made at the border of the scars and a pocket prepared subcutaneously. One week after insertion of the tissue expanders, and removal of the sutures, tissue expansion was started by injection of normal saline at the injection port at weekly intervals up to 5% of the maximum capacity of the expander used. During the injection procedure the expanded flap was carefully observed for any sings of ischemia. In such cases injection was delayed and resumed after resolution of ischemia signs. One week after achieving the desired expansion, the flap was prepared by removal of the capsule at the incersion site and a highly vascular edge, to the size required, was advanced over the area of the defect which was already created from the excised burn scar and finally fixed by suturing with 5-0 nylon threads. The final size of the inflation was 100% of the nominal volume of the expander.

## RESULTS

Out of the total 30 patients enrolled in this study, 15 cases of tissue expanders were in the lower extremities of which nine cases were located in the thigh and six cases in the leg (Table-I). One week after removal of the tissue expander and primary repair, a 40-year old patient, in the leg area group, developed necrosis and sloughing 1cm at the margin of the flap. The necrotic tissues were debrided and repaired by advancement-flap which resulted in complete recovery after three weeks. In all the cases, the expanded skin matched the normal local skin. All of them were stable and had normal sensation. While in the other 15 cases of the upper extremities, eight cases were in the arms and seven cases in the fore-arm (Table-I). None of the lower extremity group developed any complications.

## DISCUSSION

All the patients, who voluntarily had the procedure were those visiting our centre, were females and had the indications for burn scar repair. The reason for this sex-oriented subject of this study is most likely to be due to cosmetic psychological sensitivity that females have towards skin defects, including burn scars.

Normally, a good cosmetic improvement is most often achieved in the thigh. On the contrary in the leg, the highest rate of complications is observed. Therefore researchers normally had recommend more meticulous care to be taken and perform this procedure in limited selected patients.<sup>10</sup> The patient selection criteria that was adopted in this study was limited to burn scars that ranged between 5x 10cm

in leg area to 7x 15cm in the thigh while in the forearm and arm were 5 x 10, all of which achieved optimum desired outcomes.

Application of tissues expanders has found its wide spread use in various fields of surgery including post skin cancer resection such as in the scalp, head and neck, post mastectomy due to breast carcinoma and trunk. Furthermore, it has been used in repair of defects in various trauma cases. However, its application in burn scars for extremities has been used with limited success because of higher risk of failures. This may have been due to increase in the rate of expansion that was employed. This study showed that although it takes a longer period of time visits, the use of reduction in the rate of expansion can overcome these difficulties and reduces the failure rate

Similar studies recommended tissue expansion as a satisfactory method compared with skin grafts or local flap, when used for burn scars in extremities.<sup>10</sup> However; in these reports no details on the outcomes of application of tissue expanders on the extremities were reported. In addition, because of the fact that the extremities have a poor circulation and blood vessels are less, tissues injuries are repaired with delay and caution was expressed when applied to legs and limited to selected cases.<sup>10</sup> In our study the size of burn scars in the thigh were within 7 x 15cm which were treated successfully by this method. Based on the results of the present study, the highest amount of expansion needed for burn scars was in the thigh, and the lowest was for the leg. This was fortunate, because the vascularity in the thigh is higher in contrast to the leg, where there is a very few narrow vascularity.

Table-I: The number of patients, the size and sites of application of the tissue expanders among 30 female patients with burn scar

<i>Extremity</i>	<i>Location</i>	<i>Number</i>	<i>Tissue expander size (ml)</i>	<i>Out-come</i>
Lower	Thigh	9	150-200	All successful
	Leg	6	50-100	One developed sloughing and necrosis at the margin of the flap, repaired by advancement flap
Upper	Arm	8	100-150	All successful
	Fore-arm	7	50-100	All successful

Despite the various advantages that are associated with the employment of tissue expanders in cosmetic surgery and their pivotal role in providing extra tissue as an integral part of cosmetic surgery, there are various complications. These complications can arise from two sources: major type which results in termination of the procedures in up to 22.2% of cases.<sup>1</sup> It occurs after expander extrusion, port failure, rupture of the expander and infection. While the minor type of complications are reported to be 12.5<sup>11</sup> and 13.17%.<sup>1</sup> Minor complications are normally treatable and do not result in expander failure may be due to pain, hematoma, cellulites, suture dehiscence after primary repair and margin necrosis of the flap.<sup>11</sup> In our study no major complications were seen among the patients, with exception of one case who developed flap necrosis after removal of the expander, repair of the defect was made possible by debridement of the margin and closure by advancement flap. The application of tissue expanders made from different companies had no influence on the outcome of this procedure and all were found to be equally useful.

Although previous studies have remarked on slower rate of expansion as a means to reducing complications, especially in children no independently conducted study has addressed the potential benefits of application of slow expansion in burn scars.<sup>12</sup> Relative to other sites, extremities are more prone to complications with an incidence rate of 12<sup>13</sup> and 14.3%<sup>1</sup> when applied to the upper limbs. While for the lower limbs, this figure was higher reaching 51.9%.<sup>14</sup> The reason attributed for higher rate of complications in the lower extremities was stated to be due to surgical technique and patient selection.<sup>1</sup> In the present study, only one case developed minor complication which occurred after removal of the expander and the defect was repaired successfully.

Put together, the finding of this study demonstrated that slow expansion and use of appropriate size of expanders, are important parameters for selection of the patients for circumventing the development of complications

that were reported in previous studies. Furthermore, although requiring more visits and injections, this study suggests that this procedure can be applied more widely in burn scars at the extremities.

## CONCLUSIONS

This study has demonstrated that the use of tissue expanders with slow expansion technique, in both upper and lower extremities, in treatment of burn scars is a very useful and effective method with a high success rate.

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