

Editorial

Tissue Expansion: A Valuable Adjunct to Reconstructive Surgery

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Plastic surgery is a highly dynamic discipline of medicine that relies on traditional surgical skills as well as surgical innovations in order to cope with the challenging management of congenital and acquired defects and deformities. The last few decades have particularly witnessed the universal popularity of two such innovations namely tissue expansion and vacuum assisted closure therapy. These have not only emerged as novel adjuncts to the established plastic surgery techniques but also continue to evolve further with widespread usage across a range of acute and chronic wounds and defects of different origins.^{1,2} Tissue expansion has certainly earned the status of being an indispensable reconstructive technique for many indications.

We in Pakistan are now witnessing a growing trend towards their use by plastic surgeons.

How does the tissue expansion yield extra tissue?

Interestingly owing to its considerable functional plasticity, skin can adapt gradually to the environmental changes. Tissue expansion technique exploits this adaptability quality and induces a controlled in situ skin growth. Stretches beyond the skin's physiological limit invoke several mechano-transduction pathways, which increase mitotic activity and collagen synthesis, ultimately resulting in a net gain in skin surface area. All these induced changes can be categorized into two main phenomena, namely mechanical creep and biologic creep. The former denotes the morphologic changes that occur on a cellular level in response to the stretch on cells while the later describes the tissue growth by cell proliferation that tries to restore the resting tension of the stretched tissues to the baseline.^{1,3,4}

What kind of changes occur in the expanded skin with tissue expansion?

Histologically, both adult and paediatric skin responds to expansion in the same manner. Initially the epidermis thickens while the dermis thins. The skin appendages remain the same in number. Subsequent cellular proliferation reduces the resting tension of the skin with eventual return to its baseline thickness. Acutely, the tissue expansion is associated with slight epidermal thickening and significant dermal thinning, resulting in an overall thinning and a reduced

tensile strength. Chronically, the phenomenon of tissue expansion is associated with the gradual restoration of baseline histology, baseline mechanics, and baseline structure. Histologically, a comparison of piglet tissue in the expanded and non-expanded regions has demonstrated a chronic restoration of the number of epidermal cell layers as well as epidermal thickness. Also on immune-cytochemistry the expanded tissue retains its original phenotypical characteristics and native program of cellular differentiation.^{1,3,4} In a net shell, the changes induced by tissue expansion are analogous to the physiological local expansion of abdominal wall typically seen in pregnancy, with reversal to normal upon removal of the cause. There is no neoplastic transformation involved.

How is the desired tissue expansion effected in a patient?

Commercially available traditional tissue expanders are silicone balloons employed to achieve desired tissue expansion in a given region of the body. These are available in different shapes and sizes, including round, rectangular and crescent shapes. The capacity of the round ones ranges from 100-2,000 cm³ while that of rectangular ones ranges from 100-1,000 cm³. The rectangular ones are the best as they diversify the possible designs of future flaps. The expander is serially inflated with normal saline solution from a remote injection port over a period of weeks, generating new tissue in response to the constant stretch caused by the progressively enlarging expander. Once enough new skin is produced, typically after a period of multiple weeks, the device is removed, and the new skin and tissue is used to pursue the planned tissue reconstruction.^{3,4}

Anecdotaly we employ the "rule of 10" as regards the filling of the tissue expander, i.e. 10% filling is performed intra-operatively, postoperative filling is started at the 10th postoperative day, 1/10th of the total capacity is filled in each filling session, the entire filling process is completed over 10 weeks, and 10% overfilling beyond the prescribed capacity is routinely performed.

Recently an osmotic self-filling tissue expander (Osmed™), available as a few centimeter sized device, has come in vogue in the developed societies with much

easy placement and no need for inflation from outside.⁵ The device spontaneously inflates by sucking body fluids at a predictable rate to a final volume of up to 10-12 times its original size. These osmotic self-inflating tissue expanders offer apparent benefits particularly in the paediatric population. The device is small, requiring only a small incision and small pocket for insertion, which can be performed under local anaesthesia. The patient experiences less discomfort because of the gradual nature of the expansion. Fewer visits to the hospital are required. The risk of iatrogenic infection is greatly reduced. The device is a dehydrated hydrogel consisting of a modified co-polymer of N-vinyl-2-pyrrolidone and methylmethacrylate, surrounded by a porous silicone membrane that limits the osmotic filling speed.⁵

We in Pakistan continue to use the traditional tissue expanders for various reconstructive pursuits. As these silicone implants are imported from outside world, prohibitive cost remains one major factor that limits their more liberal use in our country.

What are the clinical uses of tissue expansion? By and large, tissue expansion is employed to achieve desired expansion of a future rotation, transposition or advancement flap, or to produce the desired expanded area for harvesting full-thickness skin grafts. Tissue expansion has also been employed to expand myocutaneous and free flaps. Tissue expansions have been successfully employed to address a variety of defects including birth defects, burn injuries, traumatic wounds, and reconstruction of breasts after tumor removal. Tissue expansion is certainly the ideal strategy to grow skin that matches the color, texture, hair bearing, and thickness of the surrounding healthy skin, while ensuring easy resurfacing of the donor site also.³⁻⁵ In the developed world tissue expanders are frequently used for various cosmetic indications such as augmentation of the breasts.

Where should tissue expansion be avoided? Tissue expansion is contraindicated in infected tissues, malignancy, skin grafted tissues and irradiated tissue beds. Tissue expanders are best avoided in the central face, hands, feet, or in a psychologically non-compliant patient. Although expansion is possible in radiated or scarred tissue, it is associated with a much higher complication rate and should therefore be avoided.³⁻⁵

What can go wrong with the tissue expanders? Proper placement of the tissue expander, taking into consideration the design of the future flap is certainly an art and also follows a steep learning curve. Pocket dissection for the expander and the filling port should be

taken seriously because if it is taken as a casual surgical formality it often results in complications.

The overall complication rates are in the range of 13-20%.^{5,6} The major complications are infection, implant exposure, expander extrusion, implant rupture and flap ischemia. The minor complications include seroma, haematoma, filling port problems, dog ears at donor site, widened scar and transient pain at the time of expansion.^{3,4,6}

Hudson DA et al⁷ have beautifully described ten simple rules for successful tissue expansion. These include size and form of the expander, use of antibiotics, incision for the insertion of expander, size of the expander pocket, drainage, wound closure technique, expander filling, placement of the port and commencement of tissue expansion. The success of the procedure is certainly linked to the appropriate clinical indication and meticulous surgical technique. Proper placement and filling of tissue expanders follows a steep learning curve and the complication rate drops with growing experience.

References

1. Zöllner AM, Tepole AB, Kuhl E. On the biomechanics and mechanobiology of growing skin. *J Theor Biol.* 2012; 297: 166–75.
2. Saaq M, Din HU, Khan MI, Chaudhery SM. Vacuum-assisted closure therapy as a pretreatment for split thickness skin grafts. *J Coll Physicians Surg Pak.* 2010; 20(10):675-9.
3. Agrawal K, Agrawal S. Tissue regeneration during tissue expansion and choosing an expander. *Indian J Plast Surg* 2012;45:7-15.
4. Lentz AK, Bauer BS. Tissue Expansion. In: Thorne CH, Chung KC, Gosain AK, Gurtner GC, Mehrara BJ, Rubin JP, Spear SL, editors. *Grabb and Smith's Plastic Surgery*. 7th ed, Philadelphia, PA 19103 USA: Lippincott Williams & Wilkins;2014:87-93.
5. Lohana P, Moimen NS, Wilson YT. The use of Osmed™ tissue expanders in paediatric burns reconstruction. *Annals of Burns and Fire Disasters* 2012;25:38-42.
6. Lo Giudice J, Gosain RK. Pediatric tissue expansion: Indications and complications. *J Craniofac Surg* 2003;14: 866-72.
7. Hudson DA, Grob M. Optimising results with tissue expansion: 10 simple rules for successful tissue expander insertion. *Burns* 2005; 31: 1-4.