

Tissue Expansion: Not Yet Expendable

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Stretching of the skin over a slowly expanding underlying structure is a well-known natural phenomenon seen during pregnancy and massive weight gain. It is also used in tribal rituals to stretch body parts. Controlled tissue expansion is a medical application of this natural ability of skin to stretch extensively.

Controlled tissue expansion is produced by incremental inflation of a prosthesis placed beneath the skin. When adequate expansion has been achieved the prosthesis is removed and the generated tissue is then used to fashion local flaps to resurface cutaneous and soft tissue defects or to provide coverage for different implants. Expanders are available in many sizes and shapes, but may also be custom made to fit specific needs. The device itself consists of a soft pliable pouch, a self-sealing inflation reservoir, and connecting tubing. The reservoir is placed a short distance from the pouch to reduce the risk of puncture during inflation. In some expanders the injection port is incorporated into the expander and protected to prevent puncture of the pouch [1,2].

The increase in tissue surface area during expansion is due to tissue regeneration and the stretching and mechanical creep that are allowed by the viscoelastic properties of the skin. The mechanism by which stretch results in growth seems to involve cellular proliferation in reaction to what has been referred to as the “stretch-induced signal transduction pathways,” which include

cytoskeletal, extracellular, enzymatic, membranous and cytosolic components.

Histological studies have demonstrated the changes that occur in expanded tissue. As the skin expands, increased mitotic activity is seen at the basal layer of the epidermis which maintains its thickness close to normal. The dermis, however, is almost always attenuated and is the layer of skin most affected during the process of expansion. As the tissue is stretched, skin appendages such as hair follicles and sweat glands located in the dermis are pulled apart from one another. These structures remain undamaged and continue to function normally. Although individual hairs lie further apart, they appear natural. A thick capsular membrane similar to that which forms adjacent to any prosthesis in the body forms within a matter of several days. Rapid growth of blood vessels is usually seen in the expanded dermis and adjacent to the fibrous capsule [3,4].

The skin sensation in the expanded tissue remains intact since the cutaneous nerves are not damaged. Underlying muscle tissue compressed by the expander may temporarily become compact and thin, but regain its bulk and strength after relief of the pressure.

Unlike other reconstructive techniques, expansion provides ample local tissue that closely matches the required color, texture and hair-bearing characteristics and enables esthetic and functional results in challenging reconstructive situations. Sufficient tissue is often generated to resurface both donor and recipient sites simultaneously, thus minimizing the donor site deformity. The final result is frequently superior to that obtained by alternative means of reconstruction.

The widest use of tissue expansion has been for cosmetic breast reconstruction after mastectomy, for reconstruction of the

face and scalp (which have unique qualities of texture, color, sensation, muscle function, and hair-bearing structures), in the surgical treatment of very large skin lesions, and in reconstructive surgery of burn patients. The results of tissue expansion vary greatly and are related to anatomic site, skin laxity, vascular supply, thickness of subcutaneous tissues, scarring, and the presence or absence of an additional layer of muscle or fascia [5].

Although tissue expansion is a reliable, safe, and cost-effective reconstruction modality, it is not without complication. Peri-operative infection may occur, as with the placement of any prosthesis. Exposure of the expander during the incremental inflation process is not uncommon and has been attributed to several factors: surgical technique, dehiscence of the incision, a fold in the expander that has eroded through the skin, inadequate tissue coverage, or manipulation of the expander by a non-compliant patient. Patient selection plays a significant role in the success of reconstruction with tissue expansion. Because the reconstruction requires more than one procedure as well as frequent visits to the surgeon for incremental inflation of the expander, the patient's cooperation is a major factor. Success often depends on the patient's commitment and motivation [6-9].

Some patients in whom some form of complication occurred with tissue expansion require a revision in the original treatment plan. These revisions include the implementation of ancillary medical or operative procedures, temporary reductions in the rate or quantity of serial inflations, and premature discontinuation of expansion. However, the consequences rarely involve loss of tissue. In general, complications are inconveniences that usually result in delay rather than in failure of the

reconstructive effort.

Recently developed allotransplantation of complete organs, limbs and faces can provide exceptional functional and esthetic results and is therefore a compelling reconstructive option for the severely burnt and disfigured patient [10]. Its use is still limited and raises some moral and ethical dilemmas due to the considerable morbidity related to the mandatory continued use of immunosuppressive medication in allotransplantation. This limitation is even more pronounced in pediatric patients. Facial allotransplantation is still regarded as an experimental procedure. Due to the complexity involved, its indications appear to be currently limited to only severely disfiguring facial defects in the case of burns with severe functional and cosmetic impairment. Immune tolerance and stem cell research may contribute to amelioration of the immunosuppressive risks and enhance the already demonstrated feasibility of this new reconstructive technique. Thus, tissue expansion is presently still one of the best surgical options for esthetically match-

ing resurfacing in the rehabilitation of burn patients and serves as an important reconstructive tool.

The article by Margolis et al. in this issue of *IMAJ* [11] is an important reminder of the pivotal role of tissue expansion in reconstructive post-burn surgery, and further expands our understanding of its complications in both the pediatric and adult populations. Physicians should be familiar with the merits, demands and limitations of this technique, and should discuss them with the individual patient during planning of the reconstructive strategy in order to achieve the best possible rehabilitation – functionally, esthetically and socially.

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