Soft tissue expanders in maxillofacial region - A Review

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***Abstract*: Aesthetic reconstruction of maxillofacial tissue defects with the similar kind of tissue is very challenging as the skin of the other parts of the body does not match properly. Tissue expansion using expander is being used more frequently in reconstructive surgery for the treatment of a variety of oral and maxillofacial problems. The concept of tissue expansion has opened a whole new frontier in reconstructive surgery. The tissue expansion technique is advantageous in facial reconstruction because it makes it possible to resurface wider defects with neighbouring skin that is similar in colour and texture. Conventional tissue expansion may result in epidermal hypertrophy, decreased dermal muscle and adipose thickness, bone resorption. To overcome such problems, the review discusses on tissue expanders of medical grade silicone with a mixture of biocompatible materials which is highly flexible and cost effective are being mentioned in the article.**

***Index Terms*: Soft tissue expansion, tissue expander, reconstruction, tissue expansion.**

INTRODUCTION

The reconstruction of tissue defect is a clinical challenge in modern reconstructive surgery. Soft tissue expansion is a surgical procedure that provides space for the development of additional skin, bone or other tissues(1).The phenomenon of tissue expansion is observed in nature all the time. The properties of the human skin to stretch, expand and yield extra skin if placed under continuous stress over a prolonged period of time has been utilised for reconstructive purposes with the help of a silicon balloon inserted under the skin and progressively filled with saline(2). This technique enables the surgeon to create a new local expansion of skin and subcutaneous tissue. These tissue expanders are silicone envelopes that have a self-sealing injection port, where saline is injected to enlarge the expander.(1)

Skin grafting and local, distant or free flaps are other viable options to close the defects.to prevent the donor site complications, tissue expansion can be considered as an option to accomplish soft/hard tissue reconstruction in the head and neck.

HISTORY

Initial attempts of tissue expansion were directed at the bone and not soft tissue. In 1905, Codvilla reported femoral elongation using bony traction. Later, in 1908 Magnuson used an external traction device to surgically lengthen shortened bones as well as to stretch the soft tissues in the leg. In the year 1921,(3) Putti observed lengthening in the bone, along with vital soft tissues such as muscles, nerves and blood vessels.(4)

Dr.Charles Neumann in the year 1957 published the first clinical report of reconstruction of part of the external ear using a latex balloon. Dr. Chedomir Radovan used the latex baloon clinically for the first time in January 1976 to resurface an arm defect.(5) The idea of self-inflating tissue expansion was first described by Austad and Rosein 1982.(6) He created a permeable silicone balloon filled with concentrated NaCl solution. During the early stages of expansion, balloon rupture resulted in the release of hypertonic NaCl and necrosis of the tissue. K.G Weise in 1993 has replaced NaCl solution with Hydrogel to overcome the problems with hypertonic solution.(7)

DEVICE(3): -

A tissue expander is a silicone elastomer inflatable expander, which is either custom made or pre-shaped, with a remote silicone injection dome connected to a flexible tube for filling it. The expander has a fixation screw and pores that allow fluid to reach the osmotic active hydrogel(8). The silicone envelope over the expander stretches and thins out as it keeps expanding. The advantage of a remote filling tube prevents the risk of puncturing the expander while inflating to the required dimension. A tissue expander is normally implanted below the muscles and is accessible by a syringe needle which is periodically used to inject sterile isotonic saline until the tissue expander attains the required dimension(3).

The commercially tissue expanders usually available in circular, rectangular or crescentic (croissant) forms and in required volumes/capacities from 50 cc to 1000 cc in increments of 50 cc-100 cc. they can be used satisfactorily for reconstruction in most instances. Usually indicated for reconstruction of breast after mastectomy, scar revision surgery, development of skin flap.

TYPES OF SOFT TISSUE EXPANDERS

Differential expanders are designed to produce more expansion in one part of the expander than the other around the same expander. This is achieved by altering the stiffness or thickness of the silicon envelope differentially in different areas of the expander.

Custom-built expanders are those, which are patient/defect specific. They are indicated for patients with congenital abnormalities such as trauma and extremities, skin pathology such as burns, vascular deformity, severe irregular scars and post infection defects. Indicated in ear reconstruction surgery nose reconstruction surgery.(9)

Anatomical expanders are those, which were used specifically used for scar revision surgery, reconstruction procedure for hypoplasia and tissue defects in maxillofacial region.

GUIDELINES FOR INSERTION OF EXPANDER (4):

Dimensions of the defect/lesion to be made and the expander size/shape/volume is selected based on the same, the outline of the expander is marked on the skin at the donor site and at the planned remote site for placement of the injection valve.

The incision for expander insertion must be 3-5cm, based on the direction of future advancement of the expanded flap. The incision should usually either be adjacent to the lesion where it would be the leading edge of the advancement flap or it could even be within the lesion taking care that the closure would be safe.[10] The incision should be placed radial or perpendicular to the expander to lessen the risk of wound dehiscence during the process of expansion.

The plane of dissection/insertion should be in a relatively avascular plane over the muscle fascia. In the scalp and forehead, it may be in the subgaleal plane to minimise bleeding. Thickness of the overlying skin also should be considered.

A separate tight tunnel and space away from the area of expander placement is dissected for the injection valve, such as that it is easily palpable from the surface. Eg. Over a bony prominence such as mastoid in the face or over the ribcage/iliac crest in the upper/lower torso.

The site of valve placement must be a snug fit to prevent valve displacement. An absorbable suture of 4-0 Vicryl may be used to retain the tubing in the place where it exits from the tunnel created for the valve so as to ensure that it stays in place.

SURGICAL PROCEDURE: -

Implantation: - Under local anaesthesia scalpel and scissors are initially used to make a small incision to create a submucosal patch without elevating the periosteum for easy insertion and removal of the tissue expander. Incision is normally made at a proper depth of 3 cm and wide enough to allow the expander to be placed bilaterally on either side of the defect area.(10) Incision can also be made at a position away from the attached gingival margin of the tooth distal to the level of the bone, in order to form a passage on the lateral part of the defect area. The same incision can be done on the distal part of the area to be expanded to tunnel a suture, which provides stabilization of the expander. A longitudinal incision is normally made either on the palatal or lingual aspect of the expanded tissue to remove the expander after about two weeks. Change of gloves may be considered at this point before the expander is directly touched. The expander is removed out of its sterile packaging once all the preliminary steps have been completed, the tissue expander is then placed beneath the skin, adjacent to the area of defect. The expander balloon is then gently inserted and smoothened into place in the pocket taking care that (1) the entire base sits comfortably on the pocket bed without any impingement onto the sides/ walls of the pocket and (2) any folds or sharp edges are smoothened out as much as possible. The connecting tubing must lie under the expander or to the sides, but definitely not over it to avoid any skin erosion.(11,12)

Self-inflating Stage: - This stage takes about 40 to 60 days to complete, followed by its termination. The ability of the tissue expander to self-inflate is due to the kinetic action of the hydrogen swelling caused by the capillary rise of water and diffusion across the hydrogel. This occurs together with water diffusion into the polymer network under the influence of network relaxation and water-polymer interaction.

Post-operative Stage: - Wound management is done to ensure that the potential complications arising from the procedure are reduced or prevented. Administration of antibiotics, mainly amoxicillin 750 mg or clindamycin 600 mg is given 1 hour prior to surgery and continued for 7 days. In addition, analgesic like Ibuprofen (400mg) is prescribed. Patients are advised for weekly follow-ups and given 0.2% chlorhexidine for rinsing until the suture is removed around 2 weeks after surgery. Expansion usually lasts about 6-8 weeks in order to reach its maximum volume and this is followed by bone augmentation.(11) Since tissue expanders are temporary, should not be used for more than six months and pre-existing infection should be treated before the implantation of the expander.

CLINICAL APPLICATION(13)**:**

SCALP: Expansion is always done below the galea layer,shows biphasic progress,all the perilesional scalp skin should be exploited for corrective purposesusing one or more expanders.

Expansion is particularly helpful in the surgical mangement of congenital arteriovenous malformations of the scalp.

FOREHEAD: In the forehead he expander is always inserted in the supraperiosteal layer and submuscular layer to preserve vascularization, innervation and muscle function. Lesions in the median region require two symmetrical expanders. In paramedian, two advancement flaps should the raised through upper incision in scalp an dlower in eyebrow region.(14)
NOSE: The total reconstruction of the nasal pyramid, insertion of supraperiosteal submuscular flap expander in the centre of the frontal region allows designing of midfrontal flap of adequate size for nasal correction and direct closure of frontal donor site.(15)
CHEEK: Reconstruction of cheek region can be performed by expanding helathy skin of parotid or paramandibular region.skin expansion in this region has allowed correction of congenital defects in this region.
NECK: Advantages with skin expansion helped difficult cases of reconstruction due to continuous movement, stress exerted by flexion. In the median lesions two bilateral llaterocervical expanders are placed. One to raise and second to advance flaps similar to a Z plasty.
The diffuse scars in the upper part of the neck , can be treated by a large single expanderan d a large single flap raised to mandibular lower border. Hyperexpansion or reexpansion can be used for scars of lowr third of face. (16)
CLEFT PALATE : An osmotic tissue expander is implanted under the mucoperiosteal layer of the hard palate, generates more tissue and provide facility for palate repair performed 24-48h later.(17,18)

COMPLICATIONS(19–21)**:**

MINOR COMPLICATIONS	MAJOR COMPLICATIONS
Haematomas and Seromas	Cellulitis and closed infections
Exposure of the valve	Exposure of the expander balloon itself
Inadequacy of the expansion	Deflation of the balloon
	Ischaemic necrosis of the overlying skin

CONCLUSION:
Tissue expansion is a vital and valuable tool in reconstructive armamentarium but correct patient selection plays a vital role, meticulous planning and precise step-wise execution is a pre-requisite for the success of procedure. It provides a satisfying solution for lesions and defects resulting from congenital and post-traumatic causes. Like all available options of reconstruction, there always lies a possibility of complication with the procedure, the long duration of process and several ambiguous intrinsic and extrinsic factors related make it a not so common technique to perform. However as long as one anticipates these sequelae and complications and is able to tackle them satisfactorily, it remains one of the most exciting reconstructive advancements in the last 50 years.

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