**INTRODUCTION**

Periodontitis is a multifactorial disease infectious disease resulting in inflammation within the supporting tissue of the teeth with progressive attachment loss and bone loss. To correct this defect, bone augmentation procedure is mandatory, to achieve adequate dimension of alveolar ridge. To preserve the ridge many different types of techniques have been described, such as horizontal or vertical ridge augmentation, guided bone regeneration, onlay grafting, distraction osteogenesis etc. The most common complication of all the above mentioned procedures is soft tissue dehiscence and poor tension free primary closure over the grafted area. To overcome this difficulty and unaesthetic failure procedure, soft tissue expansion procedure was introduced.

Tissue expansion is defined as, “The ability of at least some living tissue such as skin, mucous membrane to accommodate a slowly enlarging mass beneath it by increase in surface area”. As a result tissue expansion procedure aids to achieve, tension and complete free soft tissue closure and thereby it decrease soft tissue dehiscence, for a successful surgical procedure.

Soft tissue expander is mainly used for alveolar ridge reconstruction, it aids in formation of new cell and its growth, provide a good function and texture of skin or mucosa in the defect area. This new technique which is used for the construction of edentulous alveolar ridges also over comes the complications of all previously used techniques.

**History**

The first tissue expander was introduced by NEWMANN in the year 1957 for an ear defect which was made up of silicon rubber. It was a conventional expander where an external port was visible and this external port was used for manual inflations. The self-inflating tissue expander was then introduced by AUSTAD and ROSE in 1982. It was semi permeable silicon balloon filled with sodium chloride, without an external port. The alveolar ridge tissue expander was then introduced by LEW ET AL (1989) with hydroxyapatite which was a hard tissue expander. The novel self-inflating osmotically active soft tissue expander was introduced by WEISE in 1993, which was made up of co- polymers of hydrogel, where the inflation takes by the osmotic gradient.

**Characteristics of Ideal Expander**

- An ideal expander should be more comfortable and does not provide any damage to tissues and adjacent area of expander placement.
✓ Sudden rapid expansion should be avoided since it leads to perforation of the tissues.
✓ Hence slow and gradual expansion is advisable.
✓ The expander should be soft and easy to insert, the size of the soft tissue expander must be comparatively smaller than that of the defect area.
✓ The expander should be able to withstand the external stimuli, it should not dislocate from its position.
✓ Cost effective and easy to handle for surgeons.
✓ It should be easy to adapt and easy to remove before and after surgical procedure.

Materials used in tissue expander

Materials which are widely used as tissue expanders in dentistry are silicon expander, Hydrogel expander, Hydroxyapatite and Chitosan. Hydroxyapatite and chitosan are hard tissue expander, while Silicon and Hydrogel are soft tissue expanders.

Hydroxyapatite

It is a hard tissue expander used for alveolar ridge augmentation. Its characteristics include,

- Easily carved and molded.
- Adequate mechanical properties to support a denture.
- Biocompatible and stable.
- Bond firmly with bone and soft tissue.
- Soft tissue healing after implant exposure.
- Resistance to infection.
- No adverse effect on the adjacent bone.
- Hydroxyapatite is extremely biocompatible in bone and in soft tissue, and it does not initiate any foreign body reaction in the host.

Hydrogel Expander

Before hydrogel expander, conventional expander were used which was introduced by NEUMAN in 1957, the expander body is covered with a silicone elastomer and an injection port was attached to the body for serial injection, though the expander exhibited some positive results, it was always accompanied with some discomfort to the patients like increase in frequency of hospital visit, expander perforation and cost of the treatment.

The above mentioned disadvantage of conventional expander lead to the rise of novel self-inflating expander by WEISE in the year 1993, which was made up of copolymer of methylmethacrylate and n-vinyl-pyrrolid this polymeric component, made the expander insoluble in aqueous solution. It is named as “hydrogel” as it has good affinity towards water and gels with it and the name is not related to any chemical formulation. It is made up of cross linked hydrogel co polymers of methylmethacrylate and n-vinyl pyrrolidi, which makes it hydrophilic, before implantation and the expander is referred as “xerogel”.

The hydrogel has 2 component, the polymer and aqueous component. The polymer component remains constant and the aqueous component varies and the expanders self-inflate through osmotic process.

Phases in Hydrogen Expander

There are 3 phase in hydrogel expander,

PHASE 1 (“Time switch”): In this phase there is usually a delay in the expansion of the expander, immediately after the placement. This phase last up to 2 weeks of implantation.

PHASE 2: It is the expansion phase, the expander gradually starts to expand, which is carefully controlled by the polymer reaction and also helps to prevent the inhibition of unwanted swelling.

PHASE 3: In this phase, completion of swelling is significant, the hydrogel turns inert & removed.

Comparison of silicone balloon expander and hydrogel expander

<table>
<thead>
<tr>
<th>Silicone Balloon Expander</th>
<th>Hydrogel Expander</th>
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<tbody>
<tr>
<td>It is soft and easy to adapt to the underlying tissues.</td>
<td>Hard in consistency, not adaptable to the underlying tissues.</td>
</tr>
<tr>
<td>Soft, sometimes hard to place in tissue pocket.</td>
<td>Hard, easy to push into its pocket.</td>
</tr>
<tr>
<td>Delayed expansion can sometimes take place after placement of the expander.</td>
<td>Immediate expansion, starts as soon as body fluids touch the hydrogel.</td>
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<tr>
<td>Presence of Filling port.</td>
<td>No filling port.</td>
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<tr>
<td>Periodic filling moments needed for expansion.</td>
<td>No periodic filling moment.</td>
</tr>
<tr>
<td>Expansion speed can be handled at the filling moments by the surgeon as its manual inflation.</td>
<td>Expansion speed cannot be influenced by the surgeon.</td>
</tr>
<tr>
<td>End volume can be handled by the filling.</td>
<td>More gradual expansion provided it is Enveloped.</td>
</tr>
<tr>
<td>Leakage of the expander can damage.</td>
<td>End volume pre-defined.</td>
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Classification of Expanders

Standard Expanders

The expanding volume ranges from, 50cc to 1000cc these expanders are manufactured in predetermined shapes which include the shapes like:

1. Cylindrical.
2. Rectangular.
3. Crescent.
4. Cupola

Cupola and cylindrical shape tissue expander are used for soft tissue expansion in dentistry, while circle and rectangular are used in breast and scar reconstruction procedures.

**Cupola Expander:** Used for completely edentulous region.

**Cylindrical Expander:** Used when one or two teeth missing in a quadrant, edentulous arch and front region of the jaw.

**Custom Built Tissue Expander**

As the name indicates it is made with specific measurements of the defect for an individual patient usually indicated in patients with congenital abnormalities, trauma, alopecia, burns and vascular deformities.

**Differential Expander**

The differential expander is mainly used for esthetic reasons, where the expander is used for expansion of one area of the body compared to other area of the body. The main advantage of the expander is that the thickness and the elasticity of the expander can be adjusted and it is indicated in plastic surgeries like ear, breast and nose reconstruction surgeries.

**Anatomical Expander**

Anatomical expanders are mainly used in the field of breast reconstructions to produce a mimicking breast shape and proportions. After the expansion of the skin, envelope is expanded to desired size, the expander is replaced by the implant. It is indicated for cases like hypoplasia and tissue defects, scar revision surgery and reconstruction of breast.

**Commerical Names of Tissue Expander**

Osmed Self Inflating Tissue Expander

- Mentor tissue expander
- Cui brand tissue expander

**Physiology of Tissue Expansion**

Tissue expansion was initially performed by orthopedic surgeons in the year 1900s. Tissue expansion is a combination of Creep and Biological stretch. In “Creep”, when a constant force is applied to stretch the skin, it continues to extend. In “Biological stretch”, the skin or any other tissue enlarges whenever a force is applied. In tissue expansion, the tissue is stretched without affecting the quality of the original tissue. Basically the skin consist of 3 layers namely:

- The epidermis
- The dermis
- The subcutaneous layer

When the therapeutic tissue expander is placed in the defect area the changes observed are more similar to the normal physiological expansion as evident during pregnancy. After the expander is being placed, a thick fibrous capsule is found on the outer surfaces of tissue expanders within a short span of days. The fiber capsule become more thick within 2 to 2.5 months of expansion and it is composed of elongated fibroblasts and a few myofibroblasts. The newly formed fibroblasts are made up of very active rough endoplasmic reticulum with prominent cisternae, and many of these cells have numerous vesicles filled with electron-dense material.

**Indications of tissue expander**

**In medicine**

- Reconstruction of Traumatic scar in aesthetic region of face.
- Reconstruction in head and neck area defects.
- Breast augmentation procedure after mastectomy.
- Burns.
- Congenital anophthalmos.
- Immunotherapy and vaccination.
- Cardiac application.
- Wound healing applications.

**In Dentistry**

- Bone regeneration procedures.
- Onlay grafting procedure.
- Augmentation of resorbed edentulous ridges.
- In craniofacial clefts correction procedures.
- Correction of Alveolar ridge deficiencies.
- For placement of dental Implant.

**Contraindications**

- Systemic disease.
- Psychological problems.
- Active infections.
- Clinically persistent malignancy.
When And Why A Tissue Expander In Periodontics?

Tissue expander is mainly advised for reconstructive surgical procedures, which are used to restore or improve defective, damaged or missing structures. During an implant surgery, when there is no sufficient bone present to place an implant, bone augmentation procedure is advised, but one main disadvantage in bone augmentation procedure is, difficult to provide a tension free tissue closure which leads to dehiscence. But for predictable bone regeneration primary wound closure is a must in those type of cases, tissue expansion with tissue expander along with bone augmentation procedure can be an option which can be considered in the treatment planning.

Surgical Guidelines for Placement of an Expander

Patient selection: Proper patient selection and treatment plan should be made before the placement of a tissue expander, patient should be psychologically stable for tissue expander application, to which the results are highly appreciated.

Selecting the right and suitable shape of the expander: The defect to be corrected should be completely evaluated before the surgery, like its exact dimension, location, presence of any important nerves or glands adjacent to the defect area. Depending upon the defect site, anatomical boundaries, the shape of the expander is selected.

Implantation of the Expander

Under local anesthetic solution a small incision is made from the defect site, the depth of the incision should be of 3mm wide, a tunnel preparation is made to insert the expander in the defect area (where the incision is made from attached gingival margin to the distal to the level of the bone). In order to form a passage on the lateral part of the defect site a smaller incision is usually advised so that it reduces the risk of failure and dehiscence. So after the initial incision and tunnel being prepared without elevation of the periodontium the expander is placed inside the pouch with a bone fixation screw to further provide a good stability to the expander, wound is then sutured using monofilament suture.

Expansion of the Expander

Depending upon the defect, the tissue expander is selected, different shapes of tissue expander have different initial volume of swelling, so the duration being primarily dependent on the expander usually take total of 40 to 60 days to inflate, the inflation of the expander is by kinetic action, where the swelling is caused by absorption of water and diffusion across the hydrogel.

Use of Soft Tissue Expander for Alveolar Ridge Augmentation

The tissue expander for alveolar ridge augmentation is usually available in arch shape and in two designs one with the external port and another without the port. The inflatable tissue expander is not suitable to maxilla when compared to mandible because of the inelastic property of the palatal mucosa. So when tissue expander is placed in the palatal mucosa it leads to the rolling of the mucogingival junction, usually submucosal vestibuloplasty is done for maxillary ridge augmentation which is mainly indicated for edentulous maxillary arch.

Surgical Technique in Maxilla

After administration of local anesthesia, Z–plasty incision is made, this aids in the surgical access, then a dissection is made, the depth of the dissection should be superior to the outward curvature of the maxilla, the zygoma buttress and inferior to the dissection site to the mucogingival junction. All these incision and dissection leads to submucosal tunnel formation, after the completion of the submucosal tunnel preparation. The muscle and the connective tissue overlying the periosteum is removed, sutures are given, then a customized interim surgical splint is prepared, and placed over the sutured area, where it is left for first 48 hours, later it is removed and irrigated, the splint should be worn nearly for 8 to 10 weeks until the prosthesis is fabricated.

Surgical Technique in Mandible

A 8mm bilateral vertical cuspid incision given buccal to the residual keratinized mucosa or a single transverse incision can be given in the labial sulcus, by a sub periosteal dissection, the mucoperiosteum of the mandible is elevated from left 3rd molar to the right 3rd molar, transversely from the mylohyoid ridge to the buccal aspects of labiobuccal sulcus.

Placement of the Expander
The expander should be carefully placed in the center and in buccolingual direction on the residual portion of the jaw, and the expander is carefully sutured in the retromolar pad region with the resorbable suture, so that it helps the expander to stay in position. In case of expander with port, the expander is cautiously placed in center across the midline in buccolingual direction on the residual bone of the jaw and sutured. A small vertical incision is made in the midline so that the port can be placed outside. Later expander is removed after 40 to 60 days, the saline is aspirated through the port, after the removal of the soft tissue expander. A wide fibrous tissue is formed around the expander above the residual ridge, the fibrous ring should not be removed as it helps in development of blood supply and formation of new periosteum, then the hydroxyl crystals are injected and sutured with a resorbable sutures. A resilient lining of temporary prosthesis is placed in the ridge after 3 weeks, after removal of soft tissue expander.

Placement of soft tissue expander for dental implants

The need for dental implant arises, when there is loss of tooth, the most common reason for the loss of tooth is either periodontal or endodontical problem, loss of tooth usually leads to esthetically unappealing to the patient, the average bone loss after tooth extraction ranges to a minimum of 1.5–2 mm (vertical) and 40%–50% (horizontal) which take place after a span of 6months of extraction or tooth loss.

Use of soft tissue expander in dental implant

Advantages of Tissue Expander

a. Allows complete wound closure².

b. The recipient site resembles same texture color and consistency that of adjacent tissue³.

c. Short and sharp incision which leads to minimal tissue damage⁴.

d. Low risk of infection⁴.

e. Short surgical time⁴.

f. Reduced post-operative complications⁴.

Disadvantages of Tissue Expander

1. Frequent visit to the hospital¹⁰.

2. Possibilities of infections like tissue necrosis in case of overexpansion¹⁰.

3. In case of quick expansion it leads to hypoxia¹⁰.

DISCUSSION

Tissue expander was introduced into the field of medicine in the year 1982 by AUSTAD and ROSE, which was made up of silicon, in which sodium chloride is used to inflate the expander but due to certain disadvantages like tissue perfusion and hypoxia of the area exposed to expander and risk of rupture, certain modifications are made by K.G WEISE in the year 1993. He introduced a hydrogel expander, to overcome the drawbacks of silicon expander. This hydrogel expander provides a greater advantage compared to silicon expander. The main advantage of hydrogel is its hydrophilic property which cause gradual expansion of the expander.

In the field of medicine it used mainly for breast augmentation after masectomy, for renewing burn scar, alopecia, to correct any facial deformities thus STE is boon in the field of cosmetic surgery.

In periodontics soft tissue expander is used in procedures like expansion of alveolar ridge, before bone augmentation procedure and implants dentistry so that it can provide a tension free flap closure and avoid dehiscence².

D. Lew et al (1986)¹⁷ reviewed 10 patients with a posterior sub perioseal filling port for past 2 years as traditional method of expander caused damage to the inferior alveolar nerve. He concluded that the use of subperiosteal soft tissue expander with bilateral incision eliminated the dehiscence and minimize the trauma to the inferior alveolar nerve.

Dogankaner et al (2011)¹⁸ conducted a study, to evaluate the combined effect of STE and vertical ridge augmentation procedure in 12 patients at 24 sites which were implanted with STE. The result states that there was high vertical bone gain and good primary wound healing.

Christian mertens et al (2013)¹⁹ conducted a study which evaluated the use of soft tissue expander, prior to bone augmentation of atrophied alveolar ridge in 8 patients, where 11 intra oral implants were placed. The result of this study stated that only 2 patient had perforation. And they concluded that the use of STE before bone augmentation reduces the risk of soft tissue dehiscence and its overallcomplication.

Cvon ce et al (2013)²⁰ conducted a case study, where a 24 year old patient, who underwent a mandibular 1st molar extraction followed by a mandibular osteectomy. So prior to bone augmentation procedure, under local anesthesia a soft tissue expander was placed in defect area, after 21 days when the expander reached it maximum expanding capacity, the expander was removed, a retromolar autogenous bone...
was placed and placed in the defect site. He also concluded that, soft tissue under constant tension leads to formation of new cells and also in helps in tension free closure of the wound.

**Manohar laxmanoro et al (2014)** reviewed , the use of 2 distinct expander that is inflatable silicon balloon over or self-inflating osmotic tissue expander before vertical ridge augmentation, and he concluded that, STE is highly advantageous as the gain of more tissue is more and it aids in easy augmentation of ridge when compared to inflatable silicon balloon.

**CONCLUSION**

Tissue expansion is the future of dentistry, since it helps the patient to come out with adequate tissue coverage and good esthetics in defect area, with minimal hospital visit and discomfort. Wide knowledge about tissue regeneration is necessary for intra oral clinical application of tissue expander. A good surgeon can achieve increased surfacearea of the tissue by mechanical creep and biological stretch, which are used for resurfacing the defect. It improves the quality and quantity of soft tissue and facilitates primary wound closure & reduces the incidence of wound dehiscence and exposure of bone grafts. The only thing should be kept in surgeon mind is proper placement and control of degree of inflation of the expander, there is also study going on the use of “smart hydrogel”, this smart hydrogel is used in drug delivery, tissue engineering and possess a very good biocompatible property. Thus tissue expander is going to play an important role in future dentistry.

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