



## A Review on Intraoral Soft Tissue Expanders: A Novel Technique for Tissue Augmentation Prior to Treating Ridge Defects

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 27 Nov 2023	<p><i>Periodontitis, is a complex infectious disease resulting in destruction of tooth supporting structures, which gradually may result in bone loss. Common complications of ridge augmentation procedures are soft tissue dehiscence and attaining a tension free primary closure after grafting. Soft tissue expanders provide a novel alternative to invasive, tedious methods of soft tissue augmentation by gradually increasing the volume and thickness of soft tissues, before ridge augmentation. This is a short review article on the available soft tissue expanders and their benefits on achieving a proper ridge morphology.</i></p>
CC License CC-BY-NC-SA 4.0	<p><b>Keywords:</b> Ridge Augmentation, Tissue Expanders, Osmed® expanders, Hydrogel expanders, Intraoral soft tissue expanders.</p>

### 1. Introduction

Periodontitis is a complex inflammatory disease resulting in destruction of the tooth supporting tissues with progressive attachment loss and bone loss.<sup>1\*</sup> In order to achieve adequate dimension of the alveolar ridge, various techniques such as horizontal or vertical ridge augmentation, guided bone regeneration, onlay grafting, distraction osteogenesis, etc. have been previously suggested but are often associated with complications such as soft tissue agape and difficulty in attaining tension free primary closure over the grafted area.<sup>2\*</sup>

Tissue expansion is defined as, “The ability of a living tissue such as skin, mucous membrane to accommodate a slowly enlarging mass beneath it by increasing its surface area”.<sup>3\*</sup>

Intra-oral soft tissue expanders improve the overlying mucosal volume prior to ridge augmentation by being placed (as a device) in the sub/ supra-periosteal pouch that shows successive spatial expansion resulting in greater soft tissue dimensions by mechanotherapy.<sup>4\*</sup>

### History

The idea of tissue expansion was first advocated by **CHARLES NEUMANN** in 1957, who successfully reconstructed an external ear, using an inflatable silicon rubber placed underlying the derma.<sup>5\*</sup> In 1982, **ERIC AUSTAD** and **ROSE** introduced self-inflating tissue expanders.<sup>6\*</sup> In 1993, **WEISE** introduced, the novel self-inflating osmotically active soft tissue expanders made up of co- polymers of hydrogel, where the expansion occurs through the osmotic gradient.<sup>7\*</sup> In 1999, came the first commercially available self-inflatable osmotic expander, introduced and manufactured by Osmed® (Ilmenau, Germany).<sup>4\*</sup>

### Requisites Of A Soft Tissue Expander

1. An ideal soft tissue expander should not be toxic to the adjacent tissues, hence, should be made up of an inert material.<sup>4\*</sup>

2. Patient discomfort and risk of tissue perforation can be lowered by a gradual, slow and short expansion process.<sup>4\*</sup>
3. To evade expander displacement during tissue expansion, an expander should be facilitated with an option of adherence to the tissues.<sup>4\*</sup>
4. Even distribution of pressure to the underlying structures is required to minimise local peak pressure.<sup>4\*</sup>
5. The expander, with its elements, should be distinguished easily in the surgical field during its placement and removal.<sup>4\*</sup>
6. According to Mazzoli R et al, soft tissue expanders should be immune to infection, extrusion or inflator complications and should require minimal intervention, manipulation or revision.<sup>8\*</sup>

### **Types Of Soft Tissue Expanders**

Based on their mechanism, soft tissue expanders can be classified as:

- 1) **Traditional soft tissue expanders:** Introduced by Neumann in 1957, these are **silicone rubber expanders**, which can be inflated manually with successive injections through an external valve penetrating the skin. The process of expansion is rather sporadic, leading to periods of pressure that often results in tissue hypoxia and associated drawbacks such as expander perforation, tissue contamination/necrosis and treatment failures. Successive inflations prolong the duration of treatment up to several months and also add to cost of the treatment. <sup>4\*</sup>
- 2) **Self-inflating soft tissue expanders:** These are **hydrogel expanders** surrounded by selectively permeable silicon membrane without any external valve.<sup>6\*</sup> Hydrogel is a three-dimensional(3D) network of cross-linked hydrophilic polymers, undergoing anisotropic expansion in an aqueous media without dissolving in it. [<sup>2\*,9\*,10\*,11\*</sup>] Whereas, the semipermeable silicon membrane prevents rapid expansion of the expander. [<sup>12\*</sup>]

**Hydrogel Expanders** consist of 2 components, namely, the constant **polymer** component and the variable **aqueous** component which enlarges as the expander self-inflates via the osmotic process. [<sup>13\*</sup>]

### **Phases Of Hydrogel Expanders: [7\*]**

**PHASE 1(“Time switch”):** In this phase, the expander exhibits a delayed expansion that can last up to 2 weeks after implantation.

**PHASE 2(“Expansion phase”):** This phase is marked by gradual expansion of the expander, which is thoroughly managed by the polymer reaction. Inhibition of any unwanted swelling can be done in this phase.

**PHASE 3:** This phase exhibits significant swelling of the expander, where hydrogel becomes inert & can be extracted.

Soft tissue expanders can also be classified as: [<sup>7\*</sup>]

- 1) **Standard expanders:** These are manufactured in pre-determined shapes and their expansion volume changes from 50cc to 1000cc. **Cylindrical and Cupola** are used for partially edentulous region including front jaw region and completely edentulous regions, respectively.
- 2) **Custom-Built tissue expanders:** These are designed according to the size of the defect in an individual and are indicated in patients with congenital abnormalities, trauma, alopecia, burns and vascular deformities.
- 3) **Differential Expanders:** mainly used for esthetic reasons and can be used in plastic surgeries of ear, breast and nose reconstruction.
- 4) **Anatomical Expanders:** can be used in cases of hypoplasia, tissue defects, scar revision surgeries and breast reconstruction.

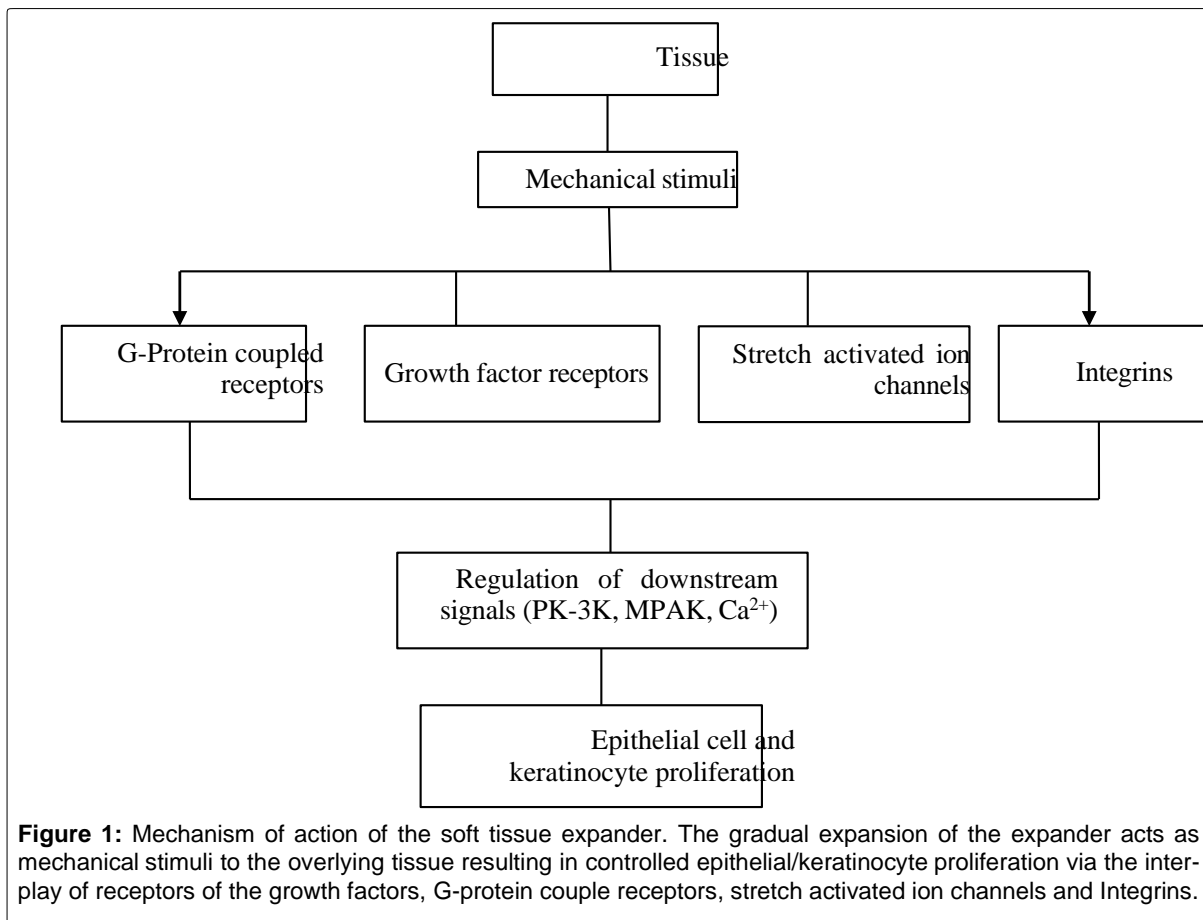
Based on the commercially available forms: [<sup>14\*</sup>]

- 1) **Osmed self-inflating tissue expander (Osmed GmbH, Germany):** Introduced by Osmed in 1999. It is a second-generation expander and is encompassed by a porous silicone shell to assure the supply of body fluid. Successive inflation of the expander occurs under a regulated condition which triggers the growth of accessory soft tissues.

- 2) **Mentor tissue expander (Mentor Worldwide LLC, Minneapolis):** Dacron-reinforced base serves as a solid platform that facilitates directional inflation. Used in reconstruction of facial features like lips, nose and eyelids.
- 3) **CUITM Brand Tissue Expander (Allergan, California):** Comprising of a silicone elastomer casing, a remote injection dome and a patented fill valve, that provides high rate of inter-operative inflation. Gradual expansion occurs by injecting sterile saline solution intermittently until the desired dimensions are met.

**Mechanism of Soft Tissue Expansion: [4\*]**

It is an inter play of growth factors, cytoskeletal structures and proteinases and functions via the stretch induced signal transduction pathway. (Figure 1)



**Indications For Tissue Expanders:**

- 1) Bone regeneration procedures: To establish primary wound closure and prevent wound dehiscence during healing post vertical/ lateral hard tissue augmentation procedures. [4\*]
- 2) Onlay grafting procedures. [15\*]
- 3) Augmentation of resorbed edentulous ridges[15\*]
- 4) For placement of dental Implants. [15\*]
- 5) Plastic and reconstructive surgeries for congenital defects, anomalies and trauma (e.g. congenital nevi,etc)[8\*]
- 6) Cleft lip/cleft palate treatment. [16\*]
- 7) Scars And Contractures. [17\*]

**Contraindications For Tissue Expanders: [15\*]**

- 1) Systemic diseases.
- 2) Psychological problems.
- 3) Active infections.

- 4) Clinically persistent malignancy.

#### **Guidelines For Placement of An Intra-Oral Expander:**

- **Patient selection:** [19\*] Before implanting a tissue expander, a careful patient selection should be done along with a thorough treatment plan in place. Treatment by tissue expanders show better results in patients who are psychologically stable.
- **Expander size and design selection:** Exact dimension and location of the defect to be treated along with existence any vital nerves or glands around the defect area, should be thoroughly evaluated. Depending on the location of the defect and its anatomical considerations, the shape and design is selected. [20\*] Osmed® Germany accoutre different templates for various sizes of tissue expanders. [4\*]
- **Tunnel preparation:** A sub-periosteal or supra-periosteal tunnel is incised longer than the expander's dimensions with the dissection being at a distance to the expander. [2\*]
- **Fixation of the expander in the tunnel:** The flat end of the fixation screw helps in plugging the expander on the bone within the tunnel. Implanting these inflators within the tissue is a technique sensitive procedure as tunnel preparation and choosing the right expander requires not only precision and skill but also experience. The tunnel can be approximated by two layered wound closure by fine suturing. [2\*]
- **Removal of the expander:** The expander is implanted for approximately 20-60 days as per the location and size of the expander as well as the defect. [12\*] Treatment time is directly proportional to the size of the defect. [21\*]

#### **Advantages: [7\*]**

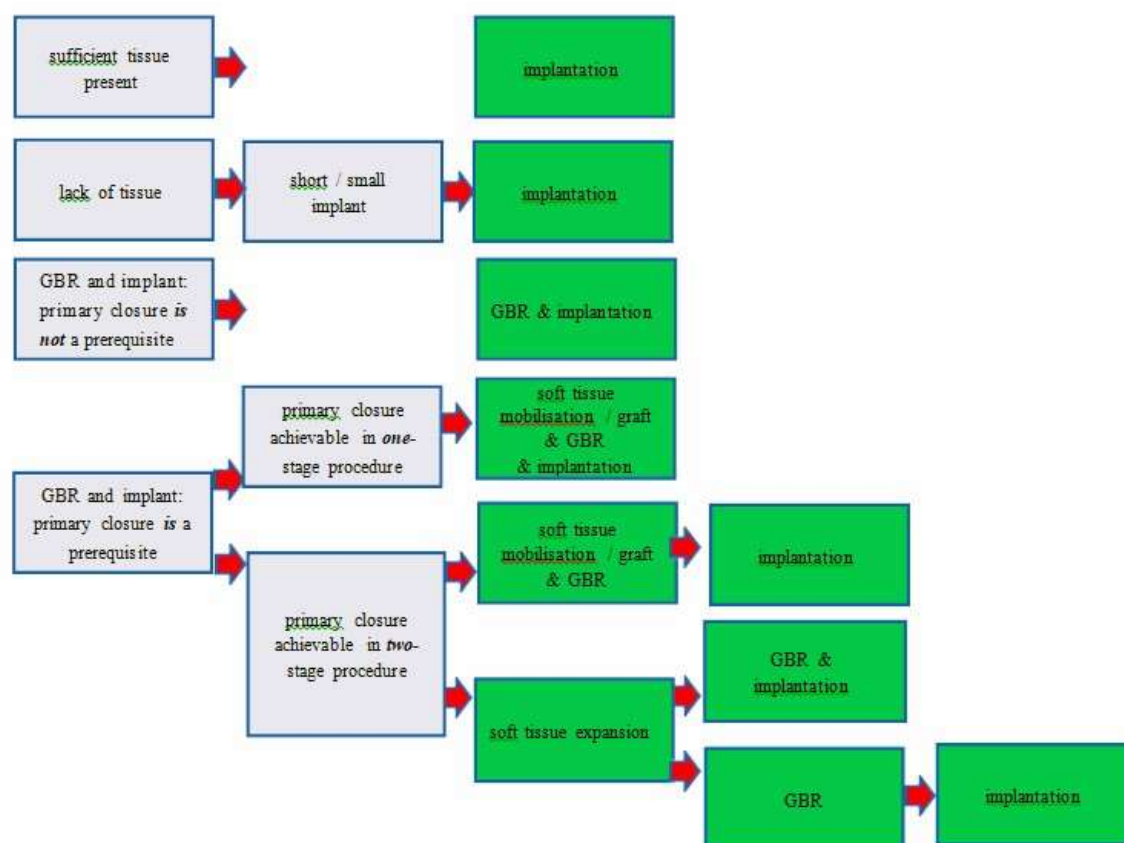
- 1) Allows primary wound closure.
- 2) Tissue at the recipient site is of similar texture, colour and consistency as that of the surrounding tissue.
- 3) Tissue trauma is minimised due to short, sharp incisions.
- 4) Lowered risk of infection.
- 5) Duration of the surgery is reduced.
- 6) Fewer post-operative complications.

#### **Disadvantages: [18\*]**

1. More number of visits to the hospital.
2. Risk of tissue necrosis in case of overexpansion.
3. Hypoxia can occur in cases of quick expansion.

#### **Use Of Soft Tissue Expanders For Implant Placement:**

Use of a soft tissue expander for implant placement, is a two-stage or three-stage procedure, where in, the initial phase is placement of the expander, second stage comprises of expander removal and inserting bone graft with/without implant, leading to the third stage where in, an implant is placed (if not placed in second stage). Limitations, conditions and procedures of the soft tissue expanders as indicated in the application of implant dentistry are shown in Figure 1.[20\*]



**Figure 1:** Decision tree for soft tissue expanders in Dental Implants.

#### Future Considerations:

The ultimate goal of every bone augmentation procedure is a ‘successful’ surgery, which is characterised with minimal patient discomfort, simple yet inexpensive procedure with minimal-to-no complications, in order to achieve sound bone structure in the defect areas. Hence, newer materials are needed, not only to facilitate greater tissue handling but also, to simplify this biological process. The Osmed expander, being isotropic swells identically in all directions. However, to achieve more soft tissue in one desired place with less bone resorption, there is a need for an expander which swells in a desired direction. An Intelligent hydrogel material, which is anisotropic, thus, giving surgeon the ability to control the direction, rate as well as the timing of expansion, is introduced by Oxford University Isis Innovation [22\*]. The so-called ‘smart hydrogels’ have properties such as drug delivery [23\*], bio-separation, biosensors and tissue engineering [24\*]. Sub periosteal injectable hydrogels have been proved as successful BMP-2 carriers for minimally invasive bone augmentation, in rats [25\*]. It will be challenging to design an expander which mimics natural soft tissue expansion and, in the meantime, acts as a carrier for bone growth factors to induce local bone formation.

#### 4. Conclusion

Use of soft tissue expanders is the future of dentistry, as it is a simple surgical procedure that not only improves the quantity but also the quality of soft tissue and facilitates primary wound closure reducing the incidence of tissue dehiscence and exposure of bone grafts. They help in achieving aesthetics in defect area with minimum patient discomfort and shorter operating time with minimal complications. Therefore, tissue expanders are expected to play an important part in intra-oral reconstruction in the future.

**Source of Support:** Nil.

**Conflict of Interest:** Nil.

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