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The Use of Silicone Foley Catheter as Tissue Expander for Intraoral Alveolar Defect

Ali Sh. Zayed [1]

Mohammed Oday Falih [2]

[1,2] Department of Maxillofacial Surgery, Alwasity Teaching Hospital, Baghdad, Iraq.

CORRESPONDING AUTHOR:
Mohammed Oday Falih, Department of Maxillofacial Surgery, Alwasity Teaching Hospital, Baghdad, Iraq.
Email: mohammedfalih1987@gmail.com

Abstract:

Background: Soft tissue expansion is a common procedure in reconstructive and cosmetic surgery. This technique has several advantages in the head and neck area it provides tissue with similar color, texture, thickness, and no need for the donor site. In recent year's intraoral mucosal expansion used to allow sufficient volume to receive bone graft and direct closure in tension free manners.

Objectives: Our study aimed to evaluate the use of Silicone Foley Catheters as tissue expanders (intraorally in the management of alveolar ridges deficiency).

Methodology: Six patients with alveolar ridge deficiencies were included in this study. The patients' ages ranged from 18 to 37. Between September 2019 and January 2022, the study was done in the Oral and Maxillofacial Surgery Department at Alwasity Teaching Hospital. Silicone Foley Catheter with normal saline inflating material used as tissue expansion to form new oral mucosa.

Results: For all cases, expansion was continuous between 4 to 6 weeks depending on the needed volume for bone graft, then the iliac bone grafting procedure was performed simultaneously during the removal of the Foley catheter. All patients followed up for 18 months, and we revealed sufficient bone available vertically and horizontally.

Conclusion: Silicone Foley Catheters are a simple, available, low cost device, with the simple surgical application used effectively in the area with soft and hard tissue deficiencies to reconstruct the oral cavity.

Keywords: silicon Foley catheter, tissue expansion, alveolar defect, reconstruction surgery, bone graft.

INTRODUCTION

Teeth extractions, trauma, cysts, and congenital anomalies can all cause alveolar deformities. Alveolar ridge deficiencies are divided into three groups by Seibert: Class I: buccolingual (horizontal) defect with normal ridge height; Class II: apico-coronal (vertical) defect; Class III: horizontal and vertical bone loss combined [(1)].

With the widespread use of implant therapy and rising esthetic and functional demands from patients, the repair of alveolar ridge defects has become a basic requirement for implant insertion and survival, necessitating both hard and soft tissue reconstruction [(2)].

A successful bone graft requires primary soft tissue closure during the healing phase. It is difficult

to produce sufficient flap advancement in a severely atrophic alveolar ridge if an excessive amount of bone is grafted; Excessive flap advancement from a periosteal releasing incision can impede periosteum healing and result in insufficient vascularity, which can affect bone formation. Furthermore, excessive flap advancement might result in vestibular height loss and mucogingival junction displacement. It is difficult to achieve simultaneous bone grafting and soft tissue coverage in bigger defects; therefore, soft tissue must be handled before bone grafting to improve the success rate of ridge augmentation treatments [3].

Many tissue expansion devices are used in almost all areas of the body from scalp to feet.

Aims of the Study

Our study aimed to evaluate the use of Silicone Foley Catheters as tissue expanders (intraorally in the management of alveolar ridges deficiency).

METHODOLOGY

This study was conducted in the Oral and Maxillofacial Surgery Department at Al-Wasity Teaching Hospital, between September 2019 and January 2022, the study involved 6 patients; 3 male and 3 female with ages ranging between 18-37 years. All patients were informed of the study's goals, the associated complications, the possible outcomes, and provided written informed consent in advance. The inclusion criteria were severely atrophic alveolar ridges classified as Seibert Class II and III to restore the vertical height of alveolar ridges defect, benign tumor excision and patients who will be available for follow-up were a candidate for this study. Patients with uncontrolled diabetes, usage of bisphosphonate medicines, heavy smokers, and a history of radiation therapy in the head and neck region were excluded. In our study, Silicone Foley Catheter was inserted intraorally at the alveolar ridge defect as a tissue expander for oral mucosa in the first surgical procedure to stretch oral mucosa and allow a new mucosa to form. While, The second surgical procedure was performed after obtaining satisfactory tissue expansion, and an autogenous iliac bone graft was harvested to correct the alveolar ridge deficiency (Fig 1).

Surgical Technique

- **First surgical procedure: Foley catheter insertion.**

- All patients operated under general anesthesia with oral or nasal intubation (Fig 2a).
- Local anesthesia is used to infiltrate the surgical site.
- Two vertical incisions on the proximal and distal sides of the defect, followed by subperiosteally dissection and tunneling between the incisions.
- Silicone Foley Catheter (Rüsch, Teleflex Medical, india) 12FR or14fr was inserted from the mesial vertical incision and continuous through the tunnel that was made (Fig 2b), then the tip or bladder opening of the catheter exits from the distal vertical incision.
- 0.75 to 1.25 ml of normal saline was used to inflate the Foley and to obtain the primary stability of the catheter over the alveolar defect without pressure. Silk suture was used to fix the catheter in position, and then the remaining of the Foley was turned around the patient's head and fixed with a bandage (Fig 2c).
- Antibiotics (ceftriaxone 1g iv)was started 1 h before surgery and continued for 5 days, Ibuprofen (200 mg tab) and 0.2% chlorhexidine mouthwash were prescribed.

Postoperative follow up 1 ml of normal saline is used to inflate the Foley catheter every 7 days, this process continuously depends on the needed volume for the bone graft. Pain, blanching, and tightness of tissue over the Foley catheter are clinical indicators that guide the rate of expansion.

- **Second surgical procedure: removal of Foley catheter and augmentation of the alveolar defect with bone graft**

- all patients operated under general anesthesia, with oral or nasal intubation.
- local anesthesia infiltrated at the surgical site
- crestal incision over the alveolar defect was performed, then the previous two vertical incisions were combined with crestal incision.
- Full thickness mucogingival dissection was performed to expose the alveolar defect and the Foley catheter removed.
- Bone graft harvested from iliac bone for all cases to restore the vertical and horizontal defects at the recipient site.
- Primary closure of the surgical site with silk 0/3 suture in tension free manner.
- Postoperatively, an antibiotic(ceftriaxone 1g iv) was started 1 h before surgery and continued for 7 days, analgesia (ibuprofen 400 mg tab) and 0.2 % chlorhexidine mouthwash was prescribed.

RESULTS

In our research, six patients (3 male and 3 female) were treated by intraoral Foley catheter as tissue expanders to treated alveolar ridges deficiency. The patient's age ranged between 18-37 years. All patients were partially edentulous, two of them were presented with only vertical ridge deficiency were classified as Seibert Class II, while the other four patients presented with severe ridge deficiencies (vertical and horizontal ride deficiency), which were classified as Seibert Class III.

Three cases were located in the posterior mandible with severe ridge deficiencies (Class III), while the other three cases were located in the maxilla (two cases in the posterior maxilla with only vertical ridge deficiency (Class II) and one case in the anterior maxilla with severe deficiencies' (Class III).

The defect site in about all cases occurred as a result of excision of benign cysts or tumors, only one case of anterior maxilla which was a result of previous trauma. All cases presented with soft tissue scar and fibrosis as a result of full thickness flap elevation and periosteal releasing incision. In addition, two patients with a history of previous bone grafts failure.

The use of a Foley catheter as a tissue expander allowed the expansion of both oral mucosa and underlying periosteum in all cases. We did not find any signs of infection after the primary surgical procedure(Foley catheter insertion and second surgical procedure(Foley removal and bone graft augmentation), only one case in the posterior mandible after the second surgical procedure wound dehiscence was occurred and treated by refreshing wound edges and re-suturing (Table 1).

In all cases, the Verbal Rating Scale (VRS) was used to assess pain after inflation Foley catheter every week. The VRS is a set of descriptors that describe various levels of pain severity. Patients were asked to choose the best adjective to describe their suffering (Table 2). There are five categories (0-4) on this scale, ranging from no pain to excruciating pain. We found the pain score for all patients fell within category 1 (mild pain). Foley catheter expansion was continuous between 4 to 6 weeks depending on the needed volume for bone graft, then bone grafting procedure was performed simultaneously during the removal of the Foley catheter.

All patients followed up for 18 months, and we revealed sufficient bone available vertically and horizontally.

DISCUSSION

Many surgical techniques were used to reconstruct the severely atrophic alveolar bone, like vertical and horizontal bone augmentation with on lay bone graft or potentially GBR to allow rehabilitation of oral cavity, restore functions, and esthetic. The reconstruction of large alveolar defects with bone graft is difficult to achieve with tension-free closure [3]. today soft tissue expansion is increasingly used before the reconstruction procedure to overcome the soft tissue deficiency and allow primary coverage of bone grafting in a tension free manner.

So, in 1957, Neumann utilized a rubber balloon to expand skin in the temporooccipital area to reconstruct a traumatic ear, which was the first report of tissue expander use [4]. Austad and Rose [5] produced the first self-inflating tissue expander made of hypertonic, saturated saline in 1982, but it was never used because the fluid escaped from its shell, it raised the risk of skin necrosis. Self-inflating tissue expanders were created by Osmed (Ilmenau, Germany) in 1999, providing a new option for tissue expansion. The expanders are made of a solid material that absorbs the surrounding tissue fluid and grows in size over 6–8 weeks, such as hydrogel, vinyl pyrrolidone, or methyl methacrylate [6].

We employed a Silicone Foley Catheter as a tissue expander in our research. Silicone coating on the latex has a smooth surface with a degree of flexibility, making insertion easy with less irritation to the soft tissue. Also has some properties such as biocompatibility, rigidity, mechanical strength, and elasticity that decrease tissue inflammation [7].

In our study, a Foley catheter was inflated every week by 1 ml of normal saline that allows steady, slow, continuous, and effective growth of soft tissue by controlling stretching of oral mucosa and the formation of new mucosa that can be used to reconstruct the defect. If rapid expansion was applied the high pressure and force to oral mucosa and periosteum will compromise blood supply and to lead tissue necrosis and may lead to alveolar bone resorption. In all cases, we gain a sufficient tissue expansion that provides an adequate bed to receive bone graft and allow primary closure in tension free manners. We will discuss some points that affect our result.

- **Infections**

There are a few problems with latex catheters like their poor biocompatibility and susceptibility to infections [8]. As a result, several coatings have been applied to the surface of latex catheters to alleviate the issues associated with latex. This includes biocidal coatings such as silver coating or silicone [9]. The coating material has several advantages including being more biocompatible, resistant to bacterial colonization, and infection [7]. No serious infections were observed in all treated cases. In our technique, only the ballooning part of the catheter is passed subperiosteally while all the remaining parts are outside the oral cavity. Also, copious daily irrigation of the surgical site reduces the risk of debris accumulation and bacterial colonization. All these factors contributed to reducing the possibility of infections.

- **Expansion process and side effects**

In our study, the Silicone Foley Catheter was inflated by injection of 1 ml of normal saline every week that allows gradual mucosal membrane expansion in a controlled manner that reduces the possibility of damage to underlying tissue and compromises blood supply. While osmotic hydrogel tissue expansion absorbs water or biological fluids, resulting in a volume rise. This uncontrolled expansion leads to tissue perforations or necrosis [10].

- **Cost and availability**

In our study, the materials that are used are available and low cost when compare with other tissue expander devices such as osmed tissue expander are unavailable and high cost, which makes the procedure more expensive [9].

- **Pain**

According Verbal Rating Scale, which has low error rates [11]. All patient complain of slight pain (categories 1) and the peak of pain intensity occur within the first eight hrs. After inflation of Foley catheter.

- **Social consideration and interference with oral function**

The major drawback of the Silicone Foley Catheter is the extra oral extension that interference with the social and esthetic considerations especially in females and interference with oral function (eating, speech, and lip competence).

CONCLUSION

T The Silicone Foley Catheter is a simple, available, low cost device, used effectively in the area with soft and hard tissue deficiencies to expand soft tissue to achieved tension-free primary closure after bone graft augmentation. Also has a low risk of infection, less morbidity, less pain, and not compromised blood supply in the area of defect during the expansion periods.

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Tables and figures:

Figure (1): A: alveolar ridge defect. B: make two vertical incisions and tunnel between them. C: silicone foley catheter inserted from mesial incision and fixation by suture then inflated by normal saline (first surgical procedure). D: after obtaining expansion for oral mucosa three-sided flap was done (second surgical procedure) to remove the silicone foley catheter. E: autogenous bone graft harvested and fixed to reconstruct alveolar ridge defect. F: closure of the surgical site with silk 0/3 suture in a tension-free manner.

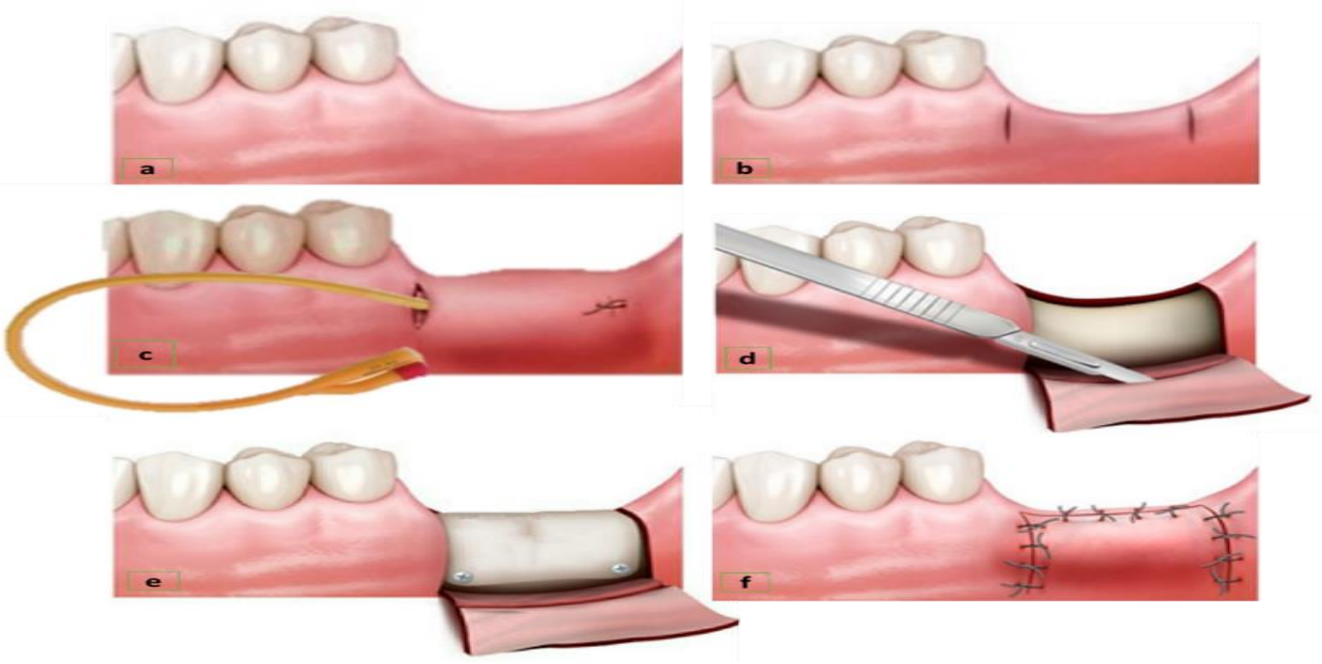

Figure (2): A: oral intubation also showing the defect site. B: Foley catheter insertion as a tissue expansion. C: finally Foley catheter turned around the head and inflate with 1 ml normal saline to obtain primary stability.

Table (1): Defect site, Expansion periods, Final size of inflatable Foley catheter, and Complications.

Patients sex/age	Defect site	Expansion periods	Final size (ml)	Complications
Male/34 y	Post. mandible	4 weeks	4.75 ml	No
Female/18 y	Post. maxilla	4 weeks	4.9 ml	No
Female/37 y	Post. mandible	6 weeks	7 ml	Wound dehiscence
Male/22 y	Ant. maxilla	6 weeks	7.25 ml	No
Male/29 y	Post. maxilla	4 weeks	4.75 ml	No
Female/33 y	Post. mandible	5 weeks	6.1 ml	No

Table (2): Verbal Rating Scale (VRS) chart.

No pain	○
Mild pain	○
Moderate pain	○
Severe pain	○
Very severe pain	○