Cohort Study

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Tent-pole technique for alveolar ridge width preservation with a compromised buccal plate: a prospective cohort study

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Objectives: The aim of this study was to assess the effectiveness of the tent-pole technique for alveolar ridge preservation of compromised alveolar socket following the surgical extraction of incurable single root premolars.

Materials and methods: This study was conducted on 12 patients who presented to the department of oral and maxillofacial surgery and had alveolar ridge preservation using tent-pole technique between August 2021 and February 2022. The alveolar ridge width was analyzed using cone beam computed tomography scans taken preoperative and 6 months postoperative. Statistical analysis was performed to assess the alveolar ridge width at different levels. The alveolar ridge width differences between periods were assessed with paired *t*-test. The comparison of alveolar ridge width loss according to jaw, sex, and different levels were done with unpaired *t*-test. The level of significance considered was 5% ($\alpha = 0.05$).

Results: The mean alveolar ridge width before surgery was 10.03 mm. After 6 months, the mean alveolar ridge width was 8.4 mm. The range of alveolar ridge width loss was between 0.6 and 3.22 mm with a mean of 1.63 (16.25%). There was no statistically significant difference in width loss between the maxilla and mandibular whether in males or females. Alveolar bone width loss was the greatest at W1 level (26.8%).

Conclusion: According to the results of this study, the authors conclude that the tent-pole technique could preserve the alveolar bone ridge width without bone graft materials.

Keywords: alveolar ridge preservation, compromised buccal plate, tenting screw, tent-pole

Introduction

Tooth extraction is one of the most common routine procedures in the dental clinic. Tooth extraction is followed by an inevitable bone resorption that leads to alveolar ridge reduction in the horizontal and vertical direction. The loss of the buccal plate due to periodontal disease, trauma, or as a complication of tooth extraction exacerbates the problem, which leads to greater bone resorption, aesthetic and functional problems[1]. Traumatic extraction has also been associated with additional loss of bone[1].

Socket preservation (SP) is a well-documented technique in literature[1,2] for preserving bone quantity present at extraction when the socket is intact. Alveolar ridge preservation (ARP) is a more comprehensive term that also includes damaged extraction sockets[3].

HIGHLIGHTS

- The tent pole is an effective technique to preserve the alveolar bone ridge width after traumatic surgical extraction.
- Tent screws as a space-maintenance device can create and maintenance the space between the bone and surrounding soft tissues without bone graft materials.
- The use of the tent-pole technique for alveolar ridge preservation did not give the mechanical support at the coronal portion of the socket.

Different classifications have previously been proposed for extraction sockets based on several factors that include: number of bone walls, gingival biotype, presence or absence of hard and soft tissue in buccal aspect and dimensions of the septal bone in molar sockets[4–7]. Bone defect type II in Elian's classification[4] referred to a situation where there is buccal bone loss without soft tissue loss. Several techniques have been suggested for management of bone defect type II that involve alveolar ridge preservation, guided bone regeneration (GBR) and immediate implant placement[8–10]. The contraction of the soft tissue is the main problem which happens even when bone graft materials are applied[11], this requires using of space-maintenance tools such as titanium mesh, Ti-reinforced membrane, tent screw and bone blocks[11–13].

Tent-pole is a GBR technique that was used to reconstruct the alveolar ridge horizontally and vertically[13,14]. In 1994,

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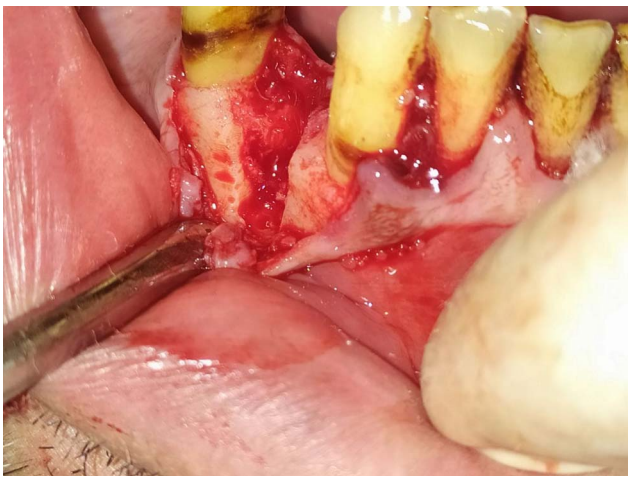

Figure 1. The compromised socket after surgical extraction.

Fugazzotto[15] used a Titanium screw with mixture of freeze-dried bone and tricalcium phosphate to augment the alveolar ridge horizontally. The author assumed that the using of titanium

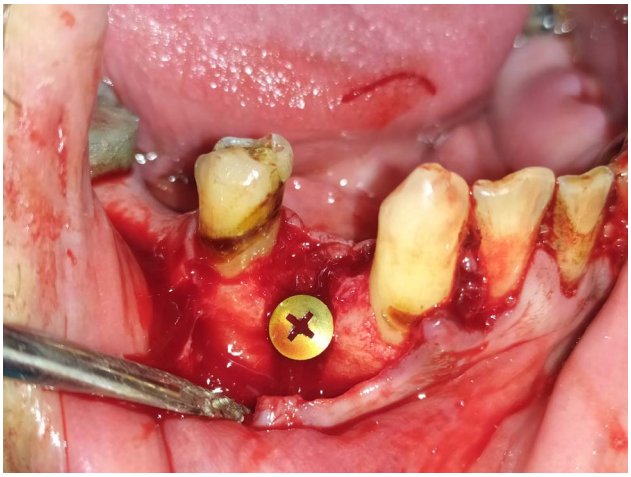

Figure 2. Insertion of a titanium tenting screw into the socket obliquely.

screw prevented the collapse of the regenerative materials. Lee *et al*[11]. used titanium screws with allograft that placed around titanium screws to augment the alveolar ridge vertically.

More studies confirmed the effectiveness of tent-pole technique with different graft materials for bone regeneration[13,14].

The aim of this study was to assess the effectiveness of the tent-pole technique for alveolar ridge preservation. The specific aim of the study was to evaluate the alveolar ridge width changes after the surgical extraction of incurable single root premolars leading to an alveolar socket with a compromised buccal plate using special titanium tent screw without any graft materials or barrier elements.

Materials and methods

This study was approved by the Ethics Committee (Ethical Permission No. 2964 on 13-7-2021) and was conducted in accordance with the Declaration of Helsinki for human studies. The patients were informed about the details of the surgery, and all of the subjects gave their written informed consent for inclusion prior to the study. This work is fully compliant with the STROCSS 2021 criteria[16]. This research was registered at Research Registry under the identifying number: researchregistry9096.

This study was done on 12 patients who had reported to the outpatient section of the department of oral and maxillofacial surgery, faculty of dentistry between August 2021 and February 2022.

To be included in the study sample, patients had to be medically healthy and over 18 years old (men and women), with no systemic diseases, with good oral hygiene, and patients who had an incurable single root premolar that required full removal of buccal plate for extraction (Bone defect type II in Elian's classification). Patients excluded were heavy smokers and those having compromised systemic diseases.

Surgical procedure

All surgical procedures were performed by the same surgeon. A local anaesthetic solution was used by infiltration with 2% lidocaine and 1:100 000 epinephrine for all surgical operations. sulcular incision followed by two vertical releasing incisions were done. A full-thickness mucoperiosteal flap was raised up. The buccal plate was completely removed to extract the tooth. The remaining root was extracted with an elevator. The residual lesions were then removed with a bone curette and the socket was then rinsed with sterile saline (Fig. 1). The screw bed was prepared according to the manufacturer's instructions using its own kit (MCT Tenting Screw Kit; MCT Inc). A special titanium screw (Tenting Screw; MCT Inc) with a broad head (8 mm in diameter) was placed into the socket obliquely (Fig. 2). The screw that used in our study were only threaded at the bottom section of the

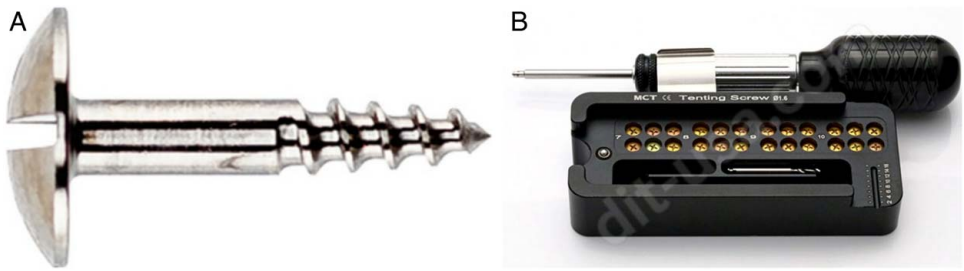

Figure 3. (A) Design of the screws used for alveolar ridge preservation. (B) The kit used to prepare the screw bed.

Figure 4. The screw was positioned 2 mm outside the socket contour.

screw; having a smooth shaft to prevent integration (Fig. 3). The screw's head was positioned 2 mm outside the socket contour (Fig. 4). No bone graft material or barrier membrane was used. The flap was sutured using 3-0 silk sutures. Patients were given amoxicillin/clavulanate 875/125 mg, twice a day for 5 days, and potassium diclofenac .50 mg as needed. Sutures removal was done after 1 week. All screws were removed after 6 months.

Radiographic evaluation

Radiographic comparison was done using cone beam computed tomography scan to evaluate the horizontal alveolar ridge width before the procedure and 6 months after extraction. Cone beam computed tomography images were analyzed using three-dimensional imaging software.

The horizontal alveolar ridge width was measured using the measurement tool at the mid position, at a distance of 1, 3, 5, 7 mm from the top of lingual/palatal plate (Fig. 5).

Statistical analysis

Statistical analysis was conducted using SPSS version 22 (SPSS Inc.). Descriptive statistics included the mean and standard deviations to assess the horizontal alveolar ridge width. Normality and hetereoskedasticity of continuous data were assessed with Shapiro–Wilk and Levene's test. The horizontal alveolar ridge width differences between periods were assessed with a paired *t*-test. The comparison of alveolar ridge width loss according to jaw, sex, and different levels were done with an unpaired *t*-test. The level of significance considered was 5% ($\alpha = 0.05$).

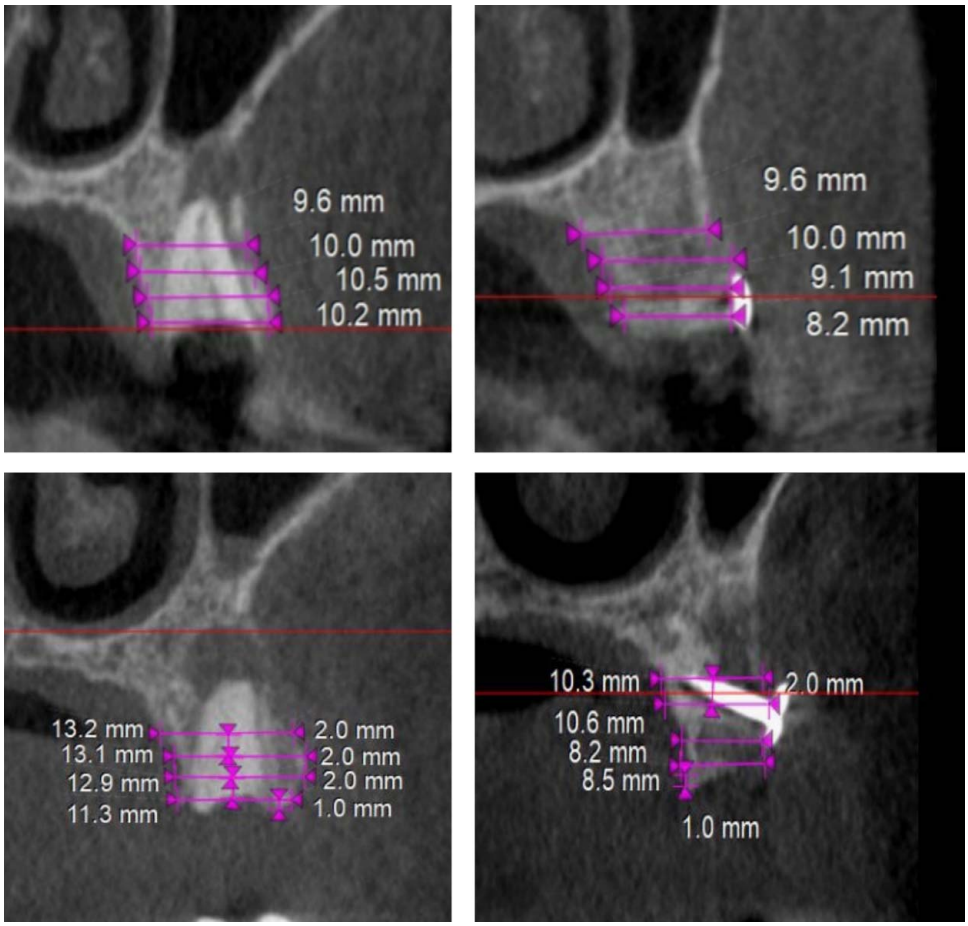

Figure 5. The radiographic measurements of the alveolar ridge width before surgery and after alveolar ridge preservation using tenting screw.

Table 1

The descriptive statistics of radiographic variables

	Before surgery	After 6 months	Width loss
Mean	10.03	8.4	1.63 (16.25%)
SD	1.1007	0.65	0.71
Max	12.65	9.4	3.22
Min	8.125	7.4	0.6

Max, maximum; Min, minimum.

Results

Patient characteristics

This study was done on 12 patients (six males, six females) with an average age 43.64 years (range, 29–54 years).

Radiographic analysis

The alveolar ridge width before surgery ranged from 8.125 to 12.65 mm with mean 10.03 ± 1.1 mm. The alveolar ridge width after 6 months ranged from 7.4 to 9.4 mm with mean 8.4 ± 0.65 mm. The width loss ranged from 0.6 to 3.22 mm with mean 1.63 ± 0.71 mm (Table 1).

There was no statistically significant difference in width loss between the maxilla and mandibular (Table 2), whether in males or females (Table 3).

Alveolar bone width loss was the greatest at W1 level (26.8%) (Table 4). We noted statistically significant differences in width loss at W1 level with W5 and W7 levels. There was no statistically significant difference in width loss at W1 level with W3 level. There was no statistically significant difference in width loss between W3, W5, and W7 levels (Table 5).

Discussion

Teeth extraction follows significant resorption in the alveolar bone, especially in the horizontal direction, which represents a challenge for clinicians to rehabilitate the area with dental implants[1]. Schropp *et al.*[17] reported that 30% of the alveolar bone width is lost within three months after the extraction and 50% of the alveolar bone width within the first year after the extraction.

The significant resorption of intact buccal plates is a prevalent occurrence subsequent to tooth removal due to tooth extraction that decreases the blood supply to the adjacent tissues. This leads to increasing the osteoclastic activity[18,19]. Furthermore, the reflection of full-thickness flaps (in cases of surgical extraction and immediate implant placement) disrupts the blood supply to the buccal bone wall[19]. The resorption is often greater at buccal aspect due to the limited thickness of the buccal wall in comparison with the lingual/palatal wall. The greater part of the buccal plate is composed of bundle bone which is quickly resorbed[18,20]. The partial or complete loss of buccal plate represents a riskier condition for the volume of resorption.

ARP procedures aim to reduce the alveolar bone resorption that follows tooth extraction and to decrease the necessity for bone augmentation procedures prior to dental implant placement[21]. Several techniques have been proposed to preserve the vertical and horizontal dimensions, including socket grafting[22], uses of barrier membranes[23], partial extraction[24], and immediate or early implant placement[10,25,26]. A systematic review showed that alveolar ridge preservation technique significantly decreased the loss of bone width by 2.37 mm (range, 1–3.5 mm) compared with the normal socket healing, which is consistent with our results (1.63 mm)[1].

Socket grafting with different biomaterials have been well documented in the literature including autogenous, allograft, xenograft, alloplastic, platelet concentrates, and growth factors with varying results. Although most of biomaterials were able to preserve the external contour of the alveolar ridge and to limit the resorption after tooth extraction, the remnants of the grafts are often interposed with the healing process, and the newly formed tissue has less quality and quantity[27–29]. Despite the benefits of the barrier membrane, there are several drawbacks associated with their use including high cost, difficulty of stabilization, unpredictable resorption, and the potential presence of chemical residues that can elicit undesirable inflammatory responses[30].

Immediate or early implant placement with simultaneous GBR in an intact socket is a predictable approach and well documented in the literature[31]. Several advantages of immediate implantation including shorting treatment time, decreasing the morbidity associated with multiple surgeries, and increasing patient satisfaction with treatment[32]. However, immediate implant placement in a compromised socket is a complex, sensitive, and challenging procedure, in addition to difficulty with primary stabilization and risk for implant failure[33,34].

Tent-pole technique has been described for alveolar bone augmentation as a predictable and effective approach, which can provide a stability gain in horizontal and vertical bone

Table 2

Comparison of width loss between maxilla and mandible

Variable	Maxilla	Mandibular	*t*-test	*P*
Width loss				
Mean	1.62	1.64	0.048	0.962 (< 0.05) No statistically significant difference
SD	0.52	0.91		
N	7	5		

Table 3

Comparison of width loss according to sex

Variable	Male	Female	*t*-test	*P*
Width loss				
Mean	1.68	1.57	0.11	0.82 (< 0.05) No statistically significant difference
SD	0.89	0.55		
N	8	4		

Table 4

The descriptive statistics of width loss at different levels

Level	W1	W3	W5	W7
Mean	2.39	1.46	1.31	1.35
Percentage (%)	26.8	14.79	12.44	12.64
SD	1.19	1.18	0.75	0.81
Max	3.9	4.7	2.5	2.9
Min	0.1	0	0	0.6

Max, maximum; Min, minimum.

Table 5

Comparison of width loss at different levels

	Difference	*t*-test	*P*	
W1 and W3	0.93	− 2.009	0.06	No statistically significant difference
W1 and W5	1.08	− 3.16	0.009	Statistically significant difference
W1 and W7	1.04	− 2.43	0.03	Statistically significant difference
W3 and W5	0.15	− 0.57	0.57	No statistically significant difference
W3 and W7	0.11	− 0.4	0.69	No statistically significant difference
W5 and W7	0.04	0.23	0.82	No statistically significant difference

dimensions[13,14]. New bone formation in horizontal and vertical augmentation procedures can be explained by the primary closure, angiogenesis, space maintenance, stability principle of guided bone regeneration[35]. Tent screws are one of the space-maintenance devices, which can create and maintain the space between the bone and surrounding soft tissues[36,37]. Our study showed that the use of tent screw could preserve the alveolar ridge width in compromised socket without bone graft.

Several clinical studies have reported that the use of the tent-pole technique for horizontal augmentation did not provide the mechanical support at the coronal portion of the augmented site. Our study showed that the width loss at level 1 was the greatest (2.39 mm) while the width loss at other levels was less than 1.5 mm, which is consistent with the results of previous studies[36,37].

Importance of the study

This paper described the first study that used the tent-pole technique in alveolar ridge preservation procedures. Limitations of study are; (1) study sample was limited during the period of our research, (2) no control group, (3) no histological evaluation of the new formatted bone.

Conclusions

According to the results of this study, and within the limitations of our work, we conclude that the tent-pole technique could preserve the alveolar bone ridge width without bone graft. We recommend conducting studies that compare the described technique with other techniques that use bone graft materials. We also recommend studying the newly formed bone and evaluating it histologically.

Ethical approval

This study was approved by the Ethics Committee of Tishreen University, Syria (Ethical Permission No. 2964 on 13-7-2021) and was conducted in accordance with the Helsinki Declaration revised in 2013. The recommendations for strengthening the reporting of the observational studies in epidemiology (STROBE) were followed.

Consent

Written informed consent was obtained from the patient for publication of this study.

Sources of funding

None declared.

Author contribution

F.A.: conceptualization, methodology, data curation, investigation, writing. M.A.: conceptualization, methodology, investigation, supervision. Z.A.: conceptualization, writing.

Conflicts of interest disclosure

The authors declare no conflict of interest, financial or otherwise.

Research registration unique identifying number (UIN)

This research was registered at Research Registry under the identifying number: researchregistry9096. https://www.researchregistry.com/browse-the-registry#home/registration/details/64765b75ee245a00273aba0a.

Guarantor

Ziad Albash.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Provenance and peer review

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