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Research Paper

Provisional restorations with ovate pontic preserve alveolar ridge after tooth extraction: A case series

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ABSTRACT

The aim of this case series was to evaluate whether provisional restorations with ovate pontic would preserve hard and soft tissue of alveolar ridge after tooth extraction. 11 patients (5 males and 6 females; aged: 20 to 54) were enrolled. After six months of using provisional restorations with ovate pontic, vertical bone loss at each level of measurements were significantly lower (p<0.01) than the value (0.38 mm) in reference. Papilla recessed and midfacial shrinkage was all less than 1 mm. The dimension of the ridge contour around the socket reduced mainly at 3 and 5 mm below the most coronal aspect of the gingival mucosa, which was 1.68 ± 0.48 mm and 1.61 ± 0.48 mm, respectively.

Key words: Ovate pontic, tooth extraction, hard and soft tissue, alveolar ridge.

INTRODUCTION

After tooth extraction, the alveolar ridge undergoes evident reduction in both vertical and horizontal directions. The healing process of the extraction socket and the related changes of respective hard and soft tissues following tooth removal has become a well-investigated research field. Alveolar ridge resorption has been widely described in the literature as mainly occurring during the first 3 months after tooth extraction and particularly, involving the buccal bone wall of the socket, resulting in the loss of as much as 50% of the buccal wall (Van der Weijden et al., 2009; Sanz et al., 2012). Based on the evidence of review (Tan et al., 2012; Hammerle et al., 2012), the vertical dimensional reduction on the buccal side amounted to 1.24 mm after 6 months, whereas the horizontal dimensional reduction on the buccal side was greater, amounting to 3.8 mm after 6 to 7 months. Besides, the interproximal papilla also recedes after tooth extraction. The poor esthetic appearance caused by the "black triangle," especially in the maxillary anterior region has been a concern for both patients and professionals (Carnio and Carnio, 2018). Hence, many techniques have been widely used for alveolar ridge preservation to counteract changes in soft tissue and hard tissue that follow tooth extraction. Various surgical reconstructions can be performed with different levels of risk and predictability.

The ovate pontic design was first used to maintain or enhance the soft tissue contours (Dylina, 1999), especially the interproximal papilla of fixed partial dentures (Korman, 2015; Spear, 1999). It was recommended that using a pontic with ideal shape and relatively smooth surface, right after tooth extraction could maintain the height of soft tissue, especially the height of interproximal papillae, as long as the underlying bone on adjacent teeth was adequate. One option involves placing a temporary bridge with an ovate pontic at the time of extraction to support the proximal papillae, the facial soft tissue, and the healing gingival tissue (Taleghani et al., 2008). However, no reports that examined the change of bone volume were identified in the literature. Hence, it is still unknown whether the maintenance of ridge prolife brought by ovate pontic was attributed to reduced bone loss or better soft tissue healing. There is also lack of overall assessment of the volume and shape of the alveolar ridge and hard/soft tissue after using a provisional restoration with ovate pontic. Hence, the objective of this clinical trial was to test the hypothesis that a provisional restoration with ovate pontic would promote

socket healing after tooth extraction and to preserve hard and soft tissues of the alveolar ridge.

MATERIALS AND METHODS

This study was carried out to evaluate soft tissue and bone healing after tooth extraction for 6 months. The provisional restorations that modified Maryland bridge or fixed partial bridge with ovate pontic were used for post-extractive socket preservation.

The protocol was approved by the Ethics Committee of XXX (hiden from the reviewer). The enrollment of patients took place between August, 2014 and November, 2015. The subjects recruited included patients presented to the clinics of the department of Prosthodontics of our hospital. They were included in the treatment plan for maxillary anterior tooth extraction for any clinical indications. Subjects aged between 18 and 60 years old who met the inclusion and exclusion criteria were included in this study. All patients were informed and consent signed. Inclusion criteria were as follows: 1) presence of a single failing tooth in upper central incisors; 2) Unable or unwilling to immediate post-extractive implant due to any reason; 3) Ideal soft tissue level/contour at the facial aspect of the failing tooth in perfect harmony with the surrounding teeth; 4) Thick gingival biotype. Exclusion criteria were as follows: 1) Systemic conditions which impact wound healing, like uncontrolled diabetes; 2) Pregnancy or lactation; 3) Untreated periodontitis or poor oral hygiene; 4) Addiction to alcohol or cigarettes (> 10 cigarettes/day); 5) Lack of intact facial wall after tooth extraction.

For the first visit, all subjects were evaluated clinically and their medical histories recorded. Initial situation were recorded by photograph and impressions taken using a polyether material (Impregum, 3M ESPE, Seefeld, Germany). Bone volumes were analyzed using CBCT scan (CRANEX 3D; Soredex, Tuusula, Finland). Before tooth-extraction surgery, provisional prostheses, such as Maryland bridges or fixed partial bridges, were manufactured by technicians. The pontic was designed as oval form. In order to preserve the original emergence profile after tooth extraction, the pontic will be completely 'sunk' into the wound for about 3 mm depths.

A prophylactic antibiotic therapy was prescribed (2 g of amoxicillin or 600 mg clindamycin if allergic to penicillin) for each patient 1 h before the intervention. All surgical procedures were performed by experienced clinicians. The mouths of patients were rinsed with 0.2% chlorhexidine mouthwash prior to the intervention. Local anesthesia was administered using articaine hydrochloride with epinephrine 1:100000 (Orabloc, Pierrel, Milan, Italy). Teeth were removed using a flapless approach with as minimal trauma as possible in an attempt to preserve the facial alveolar bone. Sockets were then thoroughly debrided using a curette to ensure complete removal of granulation tissue. The facial walls were visually evaluated using a periodontal probe, to make ensure they were intact after tooth extraction. The provisional restoration was placed right after tooth extraction. Provisional restorations were not in contact with the opposite dentition, both in the static and dynamic occlusion.

Patients were evaluated for provisional prostheses survival and complications one, three and six months following tooth-extraction surgery. Complications included biologic (abscess and fistula), and technical (adhesion failure of Maryland bridge, loss of retention of the crown, and fracture of prostheses).

CBCT scans were performed before teeth extraction and 6 months after socket preservation procedures. The data was reported as Digital Imaging and Communication in Medicine (DICOM) and opened using Amira software version 5.2.1 (Visage Imaging Inc., Carlsbad, CA). A superimposition of the pre- and post-operative DICOM data was performed on unchanged anatomical areas and manually checked for a complete match. The most apical point of the pre- extraction socket (the most apical point of the root apex) was defined in the baseline image. A vertical reference line was drawn in the centre of the tooth socket, and horizontal reference line drawn perpendicular to the vertical line, crossing the apical reference point. The horizontal ridge width was measured at three levels localized 1, 3, and 5 mm below the most coronal aspect of the bone crest, parallel to the horizontal reference line, named Level A, B and C, respectively (Figure 1). The vertical dimension was also measured at the level between the buccal and lingual wall peaks, parallel to the vertical reference line, and named level D. Bone loss was calculated for each value, corresponding to the difference between pre- and post-operative measurements.

Soft tissue dimensions were measured immediately following the failing tooth was extracted and after 1, 3, and 6 months. A polyether impression for each patient was taken to make study casts. Casts were then optically 3D laser scanned (D-250, 3Shape A/S, Copenhagen, Denmark) and the data saved as STL files and imported into the reverse engineering software (Geomagic Cotroll, 2015; Cary, NC, USA). Besides, intraoral photographs were also taken at every visit. 3D model data and photographs were used for measurement of soft tissue dimensions (1, 3, and 6 months with respect to the pre-operative status) by means of the following parameters:

1) **Papilla reduction:** Where the top of the mesial or distal papilla level was measured on photographs using the incisal level of adjacent unrelated tooth as primary standard;
2) **Midfacial recession:** Midfacial mucosa level was measured on photographs using the incisal level of adjacent unrelated tooth as primary standard;
3) **Ridge contour reduction:** Horizontal dimension of mucosa was measured on 3D model data of study casts at

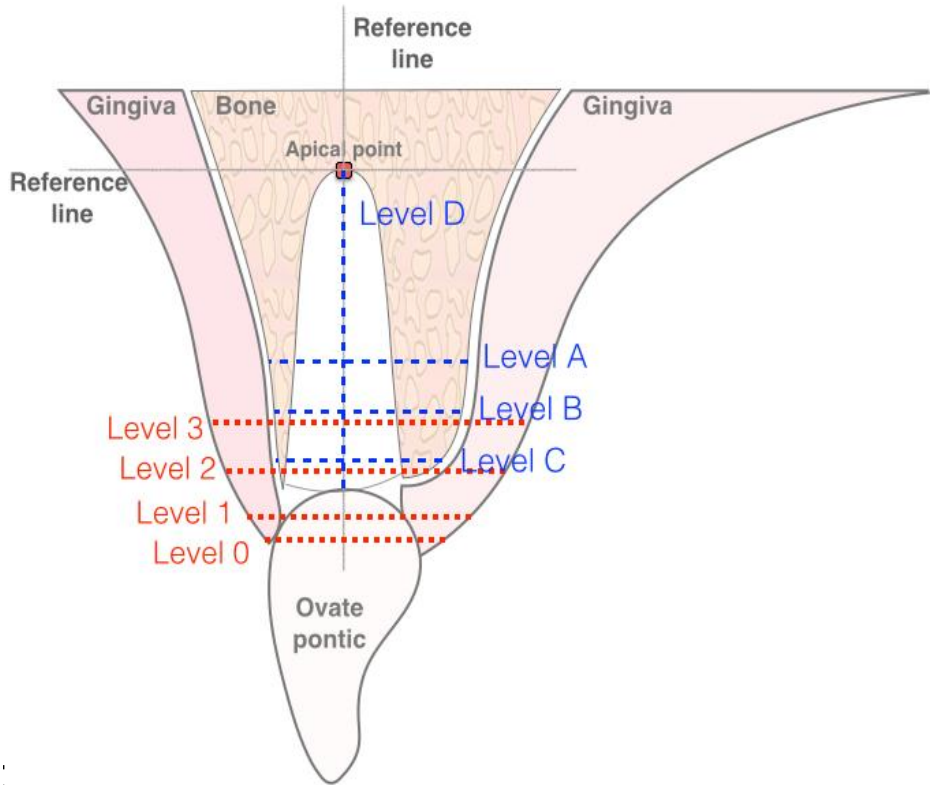

Figure 1: Vertical and horizontal volumetric change measurements of bone loss and ridge contour.

Table 1: Types of provisional restoration and complications of patients.

Variable		Number of case
Types of provisional restoration	Maryland bridges	9
	Fixed partial bridges	2
Complications	Mechanical complications	2
	Adhesion failure	1

four levels, localized 0, 1, 3, and 5 mm below the most coronal aspect of the gingival mucosa, named Levels 0, 1, 2 and 3, respectively (Figure 1).

All data analysis was performed according to a pre-established analysis plan. The differences of means at patient level for continuous outcomes (horizontal and vertical ridge profile changes and bone volume changes) and values of soft tissue and ridge profile between different levels were tested for statistical significance with one-way analysis of variance (*post-hoc* analysis using the Tukey method). Bone loss against the values in reference was compared by t-tests. All statistical comparisons were conducted at significance level of 0.05.

RESULTS

A total of 11 patients (5 males, 6 females; age range from 20 to 54) were consecutively enrolled in the trial. Following tooth removal and provisional restoration insertion, healing for all patients was uneventful with minimal swelling and inflammation and no signs of post-operative infection. Table 1 shows the treatment types and complications, while Figure 2 shows representative clinical findings described.

Bone volume changes were evaluated by a blinded outcome assessor on CBCT data (Table 2 and Figure 3). After 6 months, the most reduction in horizontal bone volume which was 2.28 ± 0.53 mm was in Level A. In Levels

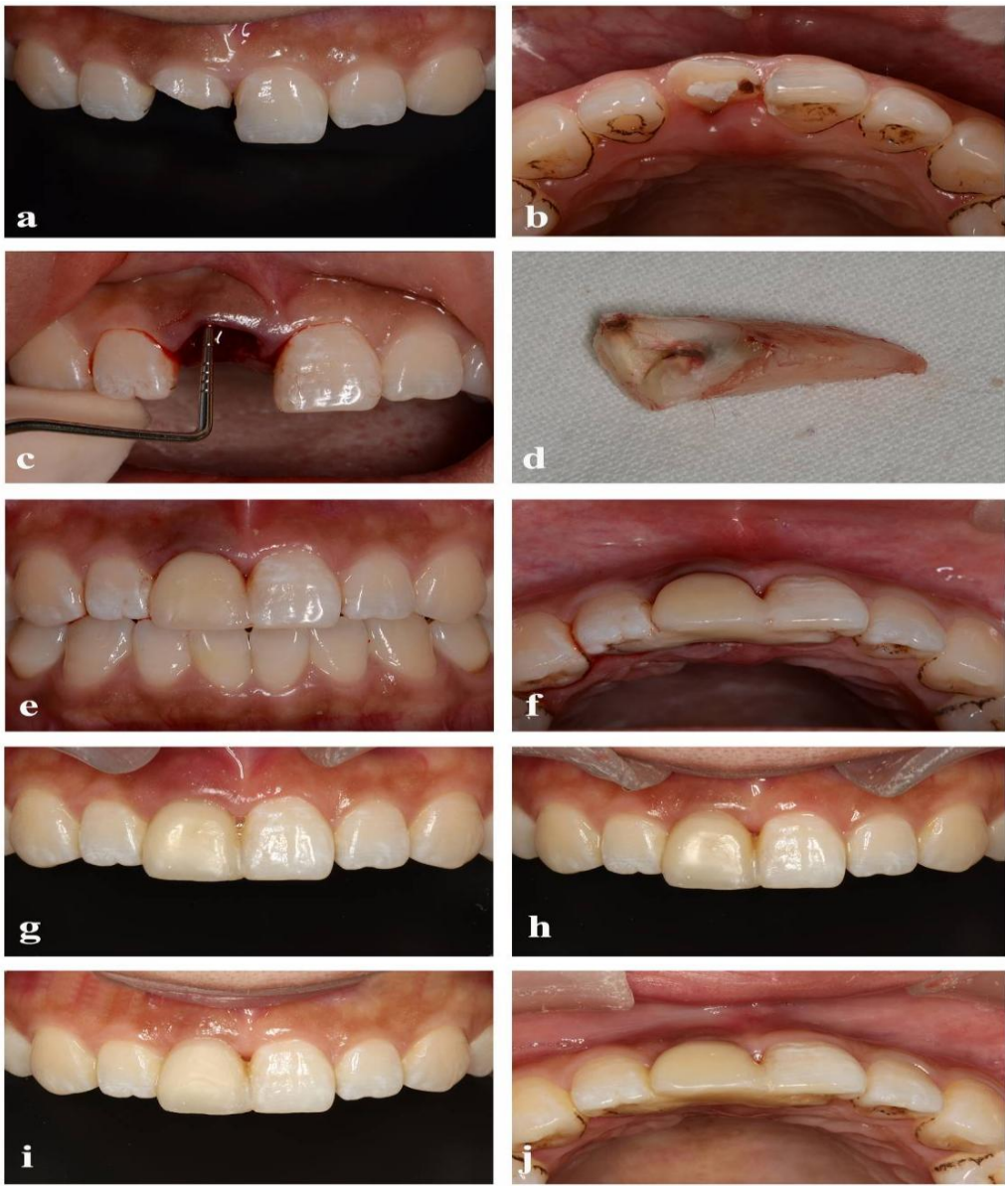

Figure 2: (a) Treatment sequence of a representative patient; (b) Tooth number 8 was fractured; (c) Occlusal view of tooth number 8 before treatment; (d) Right after tooth extraction, note that bucal bone was intact; (e) The extracted tooth; (f) Provisional restorative was *in situ* after tooth extraction; (g) Occlusal view of post-extraction socket with provisional restoration; (h) Clinical view at 1 month after tooth extraction; (i) Clinical view at 3 months after tooth extraction; (j) Clinical view at 6 months after tooth extraction; (k) Occlusal view of ridge contour at 6 months after tooth extraction.

Table 2: Horizontal and vertical bone volume changes (mm) after 6 months.

Variable	Level A	Level B	Level C	Level D
Mean	2.28	1.51	1.46	1.21
SD	0.53	0.30	0.41	0.26
95%CI	2.59-1.97	1.69-1.33	1.70-1.22	1.37-1.06

B and C the bone loss were 1.51 ± 0.30 mm and 1.46 ± 0.41 mm, respectively, and no statistically significant difference observed between these two levels (p = 0.75). All three levels' bone volume changes were significantly lower

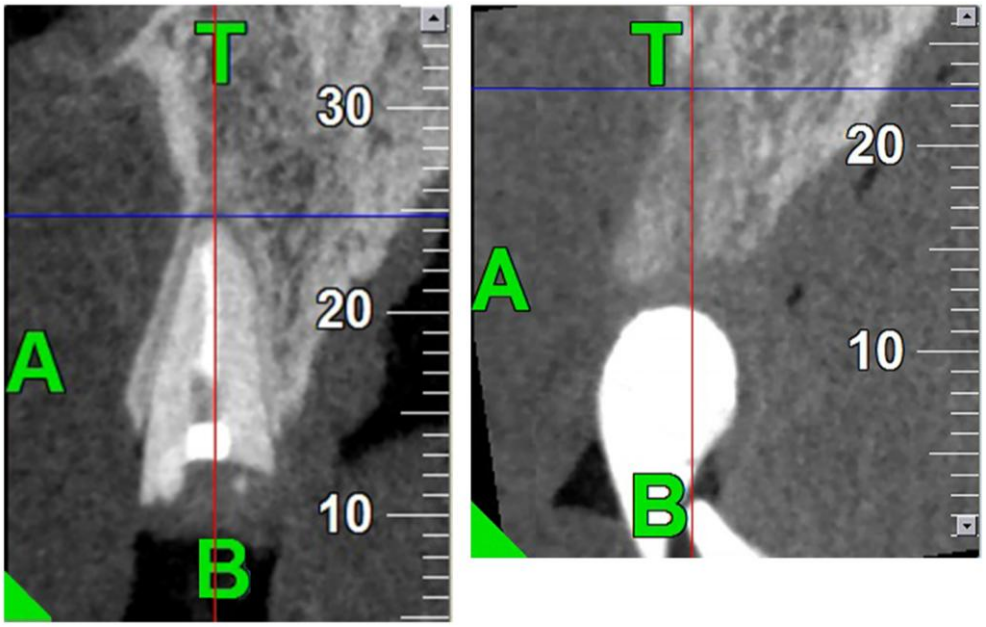

Figure 3: (a) CBCT scans before tooth extraction and (b) after 6 months with provisional restoration.

Table 3: The papilla reduction and midfacial recession (mean ± standard deviation, mm).

Range	Mesial papilla	Distal papilla	Midfacial
0-1 m	0.34±0.19	0.65±0.42	0.71±0.32
0-3 m	0.45±0.25	0.83±0.57	0.74±0.39
0-6 m	0.47±0.24	0.88±0.54	0.86±0.44

Table 4: Horizontal changes of ridge profile (Mean ± standard deviation, mm).

Range	Level 0	Level 1	Level 2	Level 3
0-1 m	0.20±0.14	0.56±0.35	0.97±0.39	0.80±0.47
0-3 m	0.43±0.22	0.93±0.32	1.43±0.50	1.31±0.38
0-6 m	0.52±0.25	1.10±0.37	1.68±0.48	1.61±0.48

(p<0.01) than the value in reference, which was 0.38 mm. As for vertical bone loss, the change in Level D was 1.21 ± 0.26 mm. There is no significant difference compared with reference, which was 1.24 mm.

Table 3 depicted the papilla reduction and midfacial recession around the socket in relation to the pre-operative status. Mesial papilla attained a good number height at every time point (p<0.05), and there were no case demonstrating advanced mesial papilla reduction (1 mm) at the end of the study, while distal papilla recession (0.88 ± 0.57 mm) and midfacial shrinkage (0.86 ± 0.44 mm) were with no significant difference (p =0.91) after 6 months of healing. Table 4 and Figure 4 shows the dimensional changes of the ridge contour around the socket in relation to the pre-operative status. Reductions observed in Levels 2 and 3 in the dimensional changes of the ridge contour around the socket in relation to the preoperative status after 6 months were 1.68 ± 0.48 mm and 1.61 ± 0.48 mm respectively. The contour of soft tissue remained in the coronal zone (Levels 0 and 1).

DISCUSSION

The present study demonstrated substantial alterations in bone loss, soft tissue recession and the change of ridge prolife during the healing phase following upper central incisor extraction. It is remarkable given the fact that using

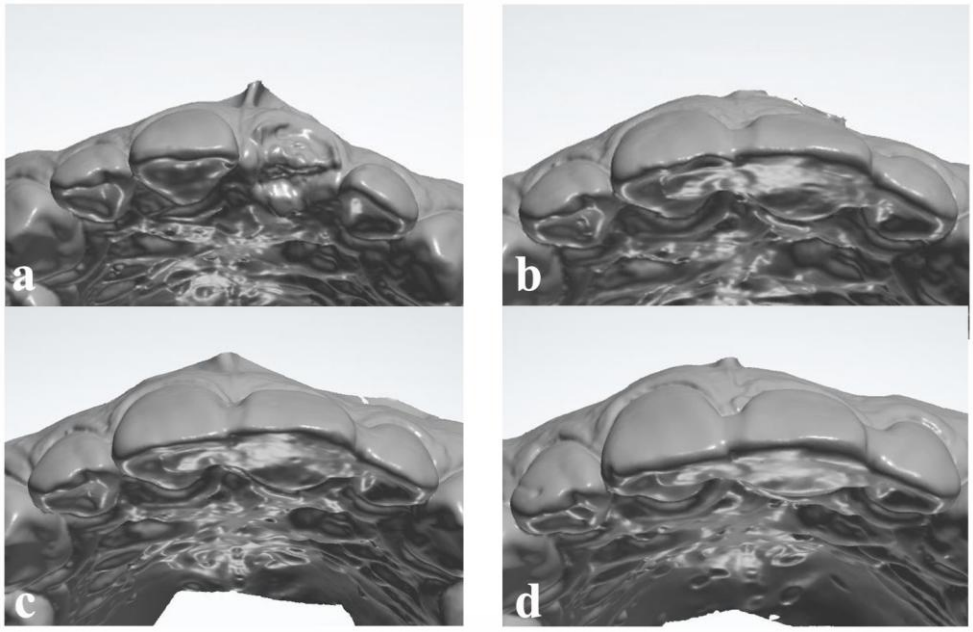

Figure 4: (a) Occlusal view of model scans: before tooth extraction, (b) 1 month with provisional restoration, (c) 3 months with provisional restoration and (d) 6 months with provisional restoration.

ovate pontic at post-extraction site would preserve alveolar ridge by maintaining soft tissue, especially the gingival papilla, and even reduce bone loss in the horizontal level.

An early clinical and histological study showed that increased pressure from smooth, polished, and glazed convex pontics in patients with excellent plaque control did not induce inflammation in the adjacent tissues (Tripodakis and Constandtinides, 1990). Tolboe et al. (1988) demonstrated that the mucosa under ovate pontics remained healthy when dental floss was regularly used. Generally, after tooth extraction and mechanical preparation of pontic sites, there was a progressive epithelialization of the wound that results in the formation of a stratified squamous epithelium typical of the gingival tissue (Certosimo et al., 1998). The time required for complete healing is variable and depends on various factors. In post-extraction sites conditioned with ovate pontics, as well as, in ovate pontic–prepared sites, a period of at least 3 months is needed for healing. In our study, we found that the change of ridge contour and gingival recession showed nearly 50% of 6-months change after 1 month and were mostly 85% after 3 months. The occurrence of papilla reduction and midfacial recession during 3 to 6 months almost maintained the same.

The sharp coronal bone edges of the extraction wound are rounded off which leads to vertical height loss of the alveolar bone. The alveolar bone is also narrowed in the horizontal direction, especially the buccal plate made up of bundle bone (Araujo et al., 2005). This may be partially due to the scar contraction of the soft tissue healing over this region. Using provisional restoration with ovate pontic after tooth extraction would give optimum sealing to the wound quickly. The sub-gingival length of pontic was about 3 mm, located right above the socket, providing full support to the soft tissue, thus, avoiding its contraction during healing time. That is why in our study, the reduction of ridge profile in Levels 0 and 1 (where the pontic supported) was 0.5 to 1 mm.

An animal study suggested that a distribution or reduction of mechanical stress could improve blood flow and decrease alveolar ridge resorption (Maruo et al., 2010; Yoshino et al., 2003). In a randomized controlled trial, after post-extraction socket preservation using epithelial connective tissue graft or porcine collagen matrix, the vertical bone loss after 5 months was about 1.47 or 1.60 mm, respectively (Meloni et al., 2015).

The area where ridge contour was mostly reduced, Levels 2 and 3 (3 to 5 mm below the most coronal aspect of the gingival mucosa) was consistent with the most horizontal bone-loss area (Level A: the most coronal level of bone measurement). In the area of Level A, the horizontal bone loss was 2.28 ± 0.53 mm, while the whole ridge contour changed about 1.6 mm, smaller than the former. Besides, the papilla reduction and midfacial recession after 6 months were also smaller than vertical bone loss being 1.21 ± 0.26 mm. It indicated that the volume of soft tissue was increased during healing time. The ovate pontic not only supported but also enhanced gingival healing. Controlled pressure provided by pontic enhances the interdental papilla and creates the illusion of pontic emerging from the soft tissue, providing a natural-looking (Kim et al., 2009).

A pilot human histological study suggested a provisional

FPD with an ovate-shaped pontic might be beneficial to the initial healing process during the interim phase of treatment (Orsini et al., 2006). Although the patients in our study all had optimum post-operative results, the inclusion and exclusion criteria were very important. We only enrolled patients with intact facial bone after tooth extraction that was also unable or unwilling for immediate implant. If more than 50% of the bone plate was missing, standard open-flap ridge preservation/augmentation (hard-tissue preservation) using current guided bone regeneration procedures was suggested (Jung et al., 2000; Brandam et al., 2015; Lee and Poon, 2017).

To the best of our knowledge, this was the first clinical series showing an overall assessment of the dimension and shape of the alveolar ridge and hard/soft tissue after using a provisional restoration with ovate pontic. We only evaluated the change of ridge profile, bone loss and gingival recession after 6 months, and compared them with earlier beliefs and findings by others (Tan et al., 2012). Hence, the results could be influenced by some factors, like patients selection, different situation after tooth extraction and different methods of measurement. The impact on hard and soft tissues of this treatment still needs to be elucidated in future studies.

Conclusion

Within the limitation of this clinical study, we observed that using provisional restoration with ovate pontic right after tooth extraction would preserve alveolar ridge by maintaining soft tissue, especially the gingival papilla, and even reduce bone loss in horizontal level. Implementing this technique into clinical practice provides dental professionals with an effective means of promoting proper gingival esthetics.

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