Enhancing Esthetics with a Fixed Prosthesis Utilizing an Innovative Pontic Design and Periodontal Plastic Surgery

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ABSTRACT

During the past two decades, significant advancements with the integration of periodontal plastic surgery into esthetic restorative dental procedures have received increased attention. While ovate pontics have traditionally been used as a restorative design following augmentation procedures to enhance esthetics, an alternate E-pontic design aims to predictably support and maintain the gingival architecture between a single missing anterior tooth adjacent to a natural tooth or an implant that is in harmony with the lip line and face. In addition, the E-pontic design promotes the gingival facial tissue to coronally migrate over the pontic, creating a gingival sulcus. This article describes an innovative new technique and a pontic design that predictably will develop, support, and maintain the gingival architecture to provide a long-term esthetic and functional outcome.

CLINICAL SIGNIFICANCE

Over the past 14 years, it has been the author's observation that the E-pontic design and conservative surgical technique, when properly performed, will develop, support, and maintain the gingival architecture more predictably than any other pontic design observed. When the goal of tooth replacement is to achieve the optimal esthetic and functional outcome, the utilization of the E-pontic design for a fixed partial denture involving either natural teeth or implants is recommended.

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INTRODUCTION

The past two decades has seen significant advances with the integration of periodontics into esthetic dentistry with more awareness being given to the significance of the perio-restorative interface.[1,2] Restoration of lost hard and soft tissues of the periodontium has become a reality, and a combination of procedures has been used in a periodontal plastic surgery approach to restore these tissues to enhance the esthetic outcome. An adequate alveolar ridge is a prerequisite for esthetic and functionally optimal reconstruction of the soft tissue architecture for a fixed partial denture (FPD) or an implant restoration.

In the past, edentulous ridge defects have been managed restoratively through the various prosthodontic techniques by changing the location of the contact point, the dimensions of the embrasure space, and the use of pink ceramics to simulate replacement of lost tissue.[3,4] A more predictable solution to this problem is the augmentation of the alveolar ridge. Reconstructive periodontal plastic surgery procedures enable us to restore the hard and soft tissues of the alveolar ridge to their former dimensions and give the restorative dentist an opportunity to provide patients with a predictable esthetic and functional outcome. Alveolar ridge augmentation encompasses several different periodontal surgical procedures that attempt to recapture the

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original alveolar ridge dimensions. It provides solutions to challenging restorative problems in the anterior region, where edentulous ridge defects are common. If the restoration is to be esthetically successful, a natural soft tissue–pontic relationship must be developed on an adequate alveolar ridge.

In a retrospective study of partially edentulous patients, greater than 90% of patients with missing anterior teeth have varying degrees of alveolar ridge defects.[5] The most common causes of alveolar ridge deformities include developmental defects, advanced periodontal disease, and traumatic removal of teeth.[6]

There are numerous periodontal plastic surgery procedures available to esthetically reconstruct both the hard and soft tissue deficiencies.[7–14] Ridge and socket preservation is an effective and predictable procedure in limiting both horizontal and vertical bone loss in post-extraction sites. It is certainly a more conservative approach to prevent bone remodeling and subsequent ridge resorption and thereby negate or minimize the need for soft or hard tissue augmentation. Periodontal reconstructive procedures for both extraction sockets and the deformed edentulous ridge have evolved from the use of both hard and soft tissue grafts, barrier membranes, and recombinant growth factors.[15–32] Reconstruction of the interdental papilla is the most challenging and the least predictable of treatments. A review of the literature reveals little scientific data concerning the long-term success and predictability involving surgical and nonsurgical techniques for papilla reconstruction. Several surgical and nonsurgical approaches have been suggested to resolve the esthetic problem of interdental papilla that has been lost.[33–37] A nonsurgical approach may involve orthodontic tooth movement and sometimes in combination with apical positioning of the contact point through interproximal stripping, especially when adjacent triangulated teeth are involved, resulting in the closure and/or elimination of the open gingival embrasure space. The open gingival embrasure space can be addressed by restorative techniques as well.[38,39]

There has been a plethora of techniques in the literature describing how to provide immediate support and maintenance of the interproximal papilla and soft tissue architecture following tooth extraction.[40,41] This article addresses how to reestablish or maintain papilla height and the facial gingival tissue between a single or multiple missing teeth adjacent to a natural tooth or an implant by using a pontic design termed the E-pontic (Figures 1 and 2). The author learned about the E-pontic design (limited to the fabrication of a resin-bonded FPD) at Louisiana State University School of Dentistry.[42] This article demonstrates additional applications and techniques that the author has developed over the past 14 years with the E-pontic design.

The anatomical shape of the E-pontic will predictably support and maintain the facial gingival margin and interdental papillae over an acceptable alveolar ridge (Figure 3). The E-pontic design fulfills the prerequisites for maintaining a healthy periodontium and its ability to achieve a predictable long-term esthetic and functional result. The emergence profile of this pontic design that is similar to that of a natural tooth ensures that no palatal gap forms which could potentially cause phonetic problems. Trapping of food particles does not occur because of its unique adaptive design to the

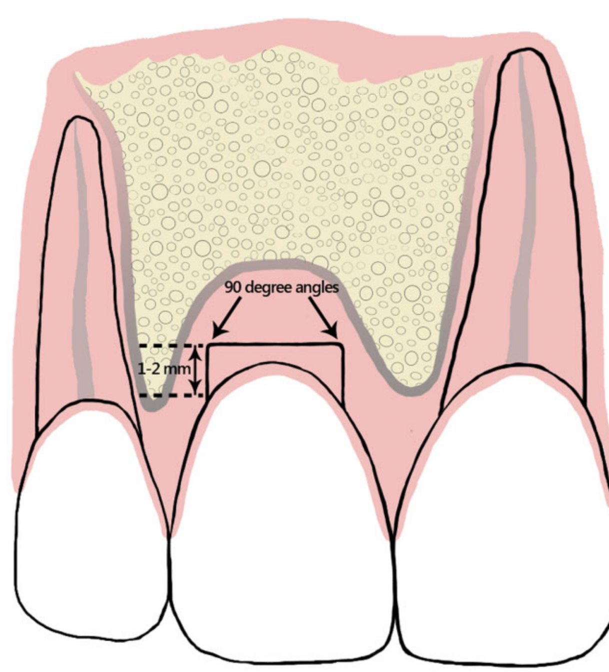

FIGURE 1. Illustration of the E-pontic. Facial view.

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pontic recipient site. However, like the ovate pontic, there are esthetic and functional limitations with the E-pontic when there is an alveolar ridge defect with apico-coronal loss of tissue and/or a combination of buccolingual and apico-coronal loss of tissue, resulting in a significant loss of normal height and width. In this case, reconstructive plastic surgical procedures of the alveolar ridge are required to prepare for a suitable pontic recipient site.

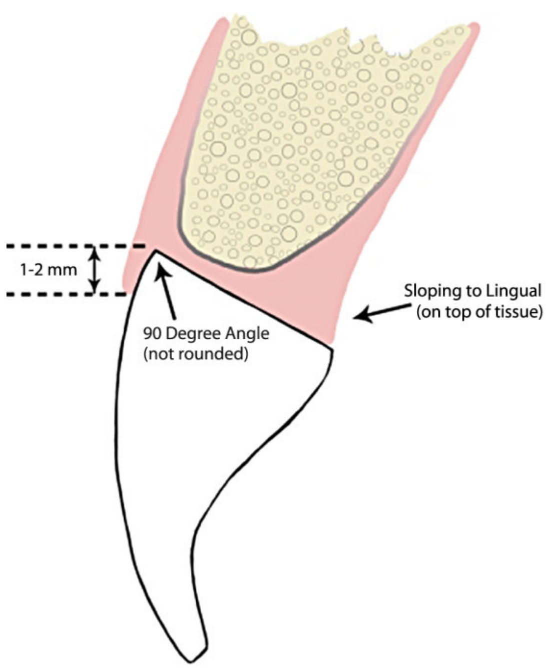

FIGURE 2. Illustration of the E-pontic. Sagittal view.

Technique and Procedure in the Fabrication and Utilization of the E-Pontic

This technique will describe the fabrication for either a single or multiple pontic FPD with a natural tooth or with an implant.

1. Determine the amount of tissue thickness over the edentulous ridge by osseous sounding the alveolar crest with a periodontal probe or endodontic file. At least 2 mm of soft tissue over the alveolar bone is necessary to create the site; 3–5 mm of soft tissue coverage is ideal.
2. At the tooth preparation and impression appointment, the pontic site does not have to be anatomically developed by the provisional at this stage because the site will begin anatomical development at the delivery appointment. However, it is important to have the appropriate amount of mature tissue on the facial aspect of the ridge to embed the pontic.
3. The master models are fabricated and mounted on a semi-adjustable articulator with a facebow and an appropriate centric relation or maximum intercuspation position registration.
4. In the laboratory setting, the clinician sculpts the approximate outline and predetermined tissue depth on the solid and sectioned master models.

FIGURE 3. A, A preoperative view of a six-unit fixed partial denture with pontics in the maxillary right and left central incisor position displaying poor esthetics. B, A 3.5-year postoperative view. The E-pontic mimics the emergence angles and soft tissue profile of a natural tooth and illustrates the stability of the periodontal-restorative interface with this innovative design.

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The ceramist will then proceed with the fabrication of the framework.

5. The ceramist completes the sculpting of the pontic site based on the final contours and outline form of the pontic on the solid and sectioned master models. It is important to instruct the ceramist to create 90-degree line angles facially and interproximally when sculpting the model at a predetermined depth (Figure 4). The E-pontic is then adapted to the sculpted pontic site on the model. The sharp line angles that are formed between the tissue side and the 90-degree walls of the pontic are critically important components of the E-pontic design for developing and stabilizing the gingival tissue. This pontic design has a flat surface on the tissue side of the pontic which resembles the anatomical cross-section of a tooth at the cementoenamel junction (Figure 5). The E-pontic creates a predictably stable gingival framework that mimics the gingival architecture around a natural tooth (Figure 6). The pontic is subgingival on the facial and interproximal aspects, gradually sloping up to the lingual, where it is positioned on top of the tissue (Figure 7). The flat tissue surface of the pontic enables the dental floss to make contact with all its surfaces, allowing the patient to easily floss underneath it. The E-pontic design is biocompatible with no evidence of ulcerations, blood extravasation, and any degree of food impaction underneath it.

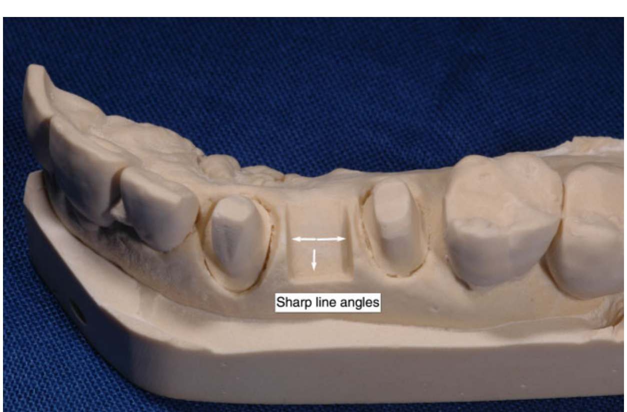

FIGURE 4. The clinician sculpts the approximate outline and predetermined tissue depth on the solid model. Then the ceramist completes the sculpting of the pontic site based on the final contours and outline form of the pontic on both the solid and sectioned models.

6. At the delivery appointment, a color transfer applicator is applied to the tissue surface side of the pontic and then imprinted onto the pontic tissue site while seating the FPD. The tissue imprint represents the gingival outline of the pontic and acts as a guide for electrosurgical or laser surgical contouring of the tissue (Figure 8A). The pontic site is surgically sculpted incrementally until the prosthesis is *almost* fully seated. The sculpting depth is primarily at the facial and interproximal line angles and minimal sculpting as you move lingually along the pontic tissue site. Compression of the pontic site in the mid-lingual portion, along with deeper sculpting depth at the facial gingival margin and interproximal line angles, is enough to ensure complete seating of the pontic and abutment crowns. The patient is then instructed to close down on a cotton roll for approximately 10 minutes with the prosthesis in place until blanching abates (Figure 8B). The goal is to visually identify blanching of the tissue around the pontic site to ensure that tissue compression is taking place facially and laterally. This process literally begins to squeeze the tissue into the predetermined interproximal space to achieve the desired tissue volume and papilla height, promoting coronal migration of the facial gingival tissue over the pontic (Figure 8B,C). If too much tissue is surgically removed and blanching does not occur while seating the prosthesis, there will not be enough tissue compression to achieve sufficient tissue volume and papilla height in the gingival embrasure space. The depth of the pontic is dictated by the amount of tissue over bone and the amount of tissue compression needed to create an adequate volume of interproximal tissue in the predetermined gingival embrasure space.[43] A 2-month and 17-month postoperative view of a posterior FPD illustrates how the predetermined gingival embrasure space fills completely with interdental tissue. The flat pontic design with its sharp 90-degree line angles promotes the facial gingival tissue to coronally migrate over the

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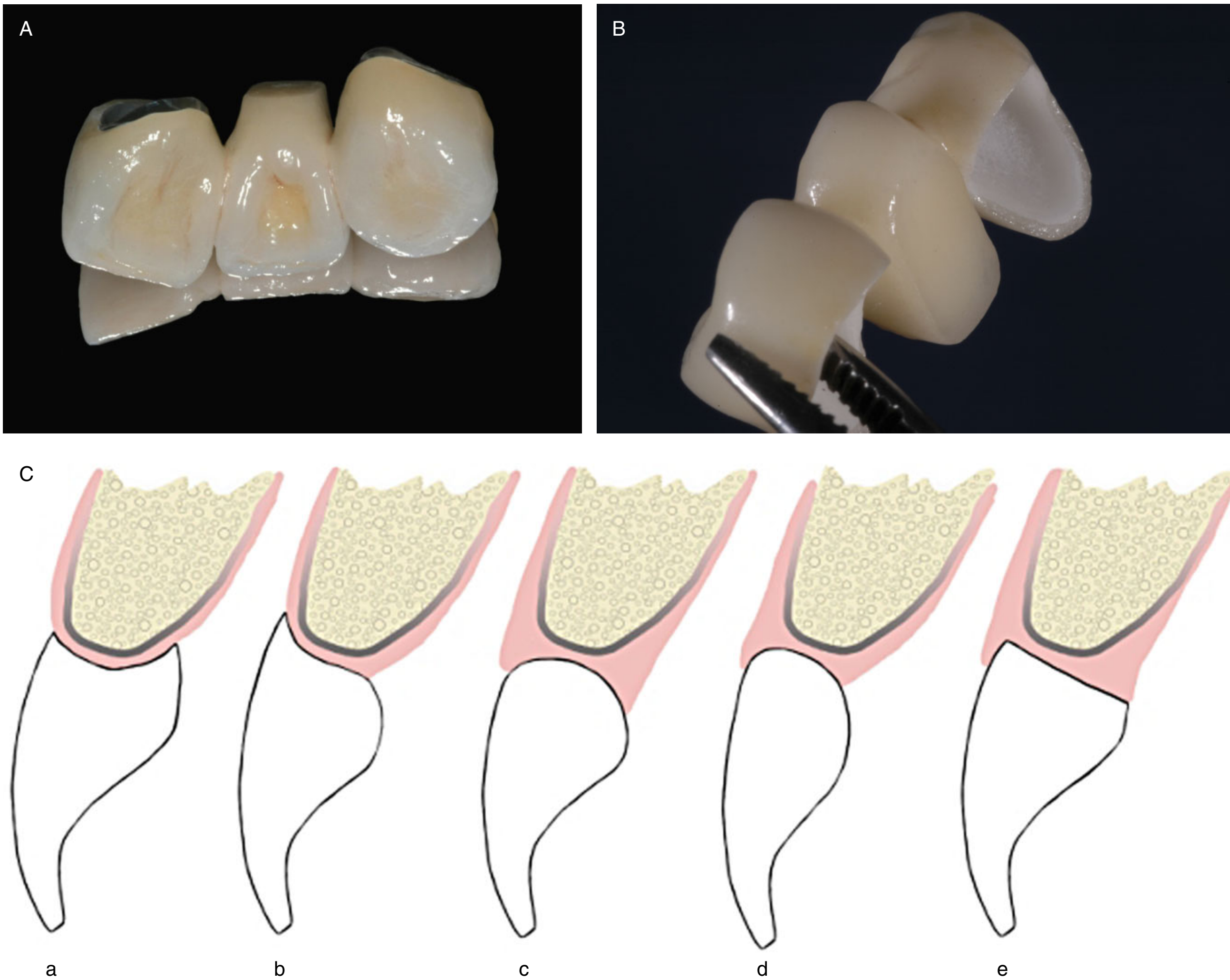

FIGURE 5. A and B, Note the anatomical shape and sharp 90-degree line angles of the E-pontic design. It has a flat design on the tissue surface that resembles the anatomical cross-section of an anterior tooth at the CEJ. C, Classification of pontic designs: (A) ridge lap, (B) modified ridge lap, (C) ovate, (D) modified ovate, and (E) E-pontic.

E-pontic, creating a well-defined gingival architecture mimicking the scalloped facial gingival tissue of the adjacent natural tooth abutments (Figure 9).

A removable partial denture with an E-pontic design may also be used as a provisional restoration when the adjacent teeth do not need to be restored. A removable E-pontic design can predictably preserve and develop an immediate extraction site when considering a staged approach with implant placement. It acts as a tissue scaffold for development and support of the gingival architecture prior to implant placement (Figure 10).

CASE PRESENTATION

Age at initial presentation: 66 years.

Initial presentation: April 2005.

Initiated treatment: June 2009.

Medical history: noncontributory.

Dental history: the patient presented with a chief concern of esthetic complaints regarding her maxillary anterior and posterior restorations in the esthetic zone.

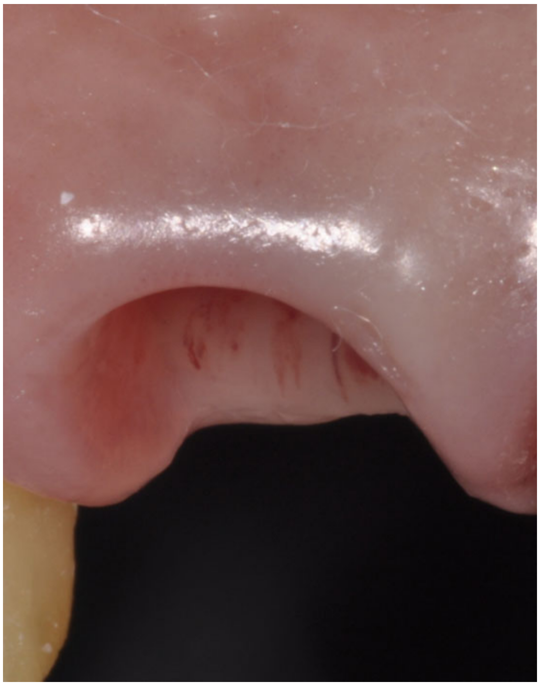

FIGURE 6. Illustrates a stable gingival architectural framework developed by the E-pontic.

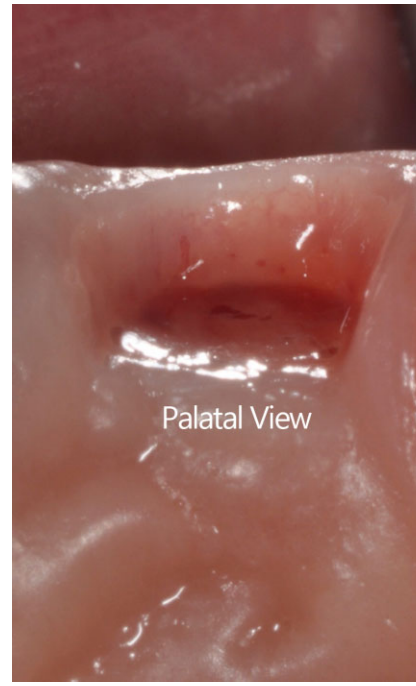

FIGURE 7. The E-pontic is subgingival on the facial and interproximal aspects gradually sloping to the lingual where it is positioned on top of the tissue.

She was very self-conscious about her front teeth when she smiled (Figure 11). Her treatment goal was to improve upon the esthetics of her maxillary teeth in the esthetic zone with the most predictable treatment plan. She has a history of trauma primarily to her maxillary central incisors that necessitated endodontic therapy when she was in her teens. Eleven years ago, an anterior maxillary six-unit FPD was fabricated, replacing both central incisors because of endodontic failure. Implant therapy was not presented to the patient as an option for initial replacement of her central incisors.

A comprehensive exam included evaluation of the patient's dentofacial, functional, biomechanical, and periodontal risk levels to formulate a treatment plan and treatment sequence. The dentofacial risks were high while the periodontal and functional risk assessments were low for this patient. The biomechanical risks were uncertain. She presented with a sound periodontium, physiologic occlusion, and healthy temporomandibular joints.

To assess the health of the FPD abutments and to appropriately evaluate the interproximal papilla height and the free gingival margin on the alveolar ridge, the FPD was removed. Following the loss of both central incisors 11 years ago, a degree of resorption and flattening of the osseous crest with a subsequent vertical loss of the papillary height had expectedly occurred[40,44] (Figure 12). Fortunately, the vertical tissue height over the edentulous ridge was found to be esthetically acceptable when comparing with the adjacent papillary height (Figure 13). The FPD abutments were found to be structurally sound with no evidence of recurrent caries. Facial and interproximal osseous sounding around both abutments and adjacent teeth indicated adequate bone levels to support both the facial gingival tissue and interproximal papilla. The bone levels on the abutment teeth adjacent to the edentulous space will determine the papilla height.[44] Osseous sounding of the edentulous site in the central incisor position was 3 mm. The mobility patterns of all the abutments were within normal limits with periodontal probe readings within normal limits.

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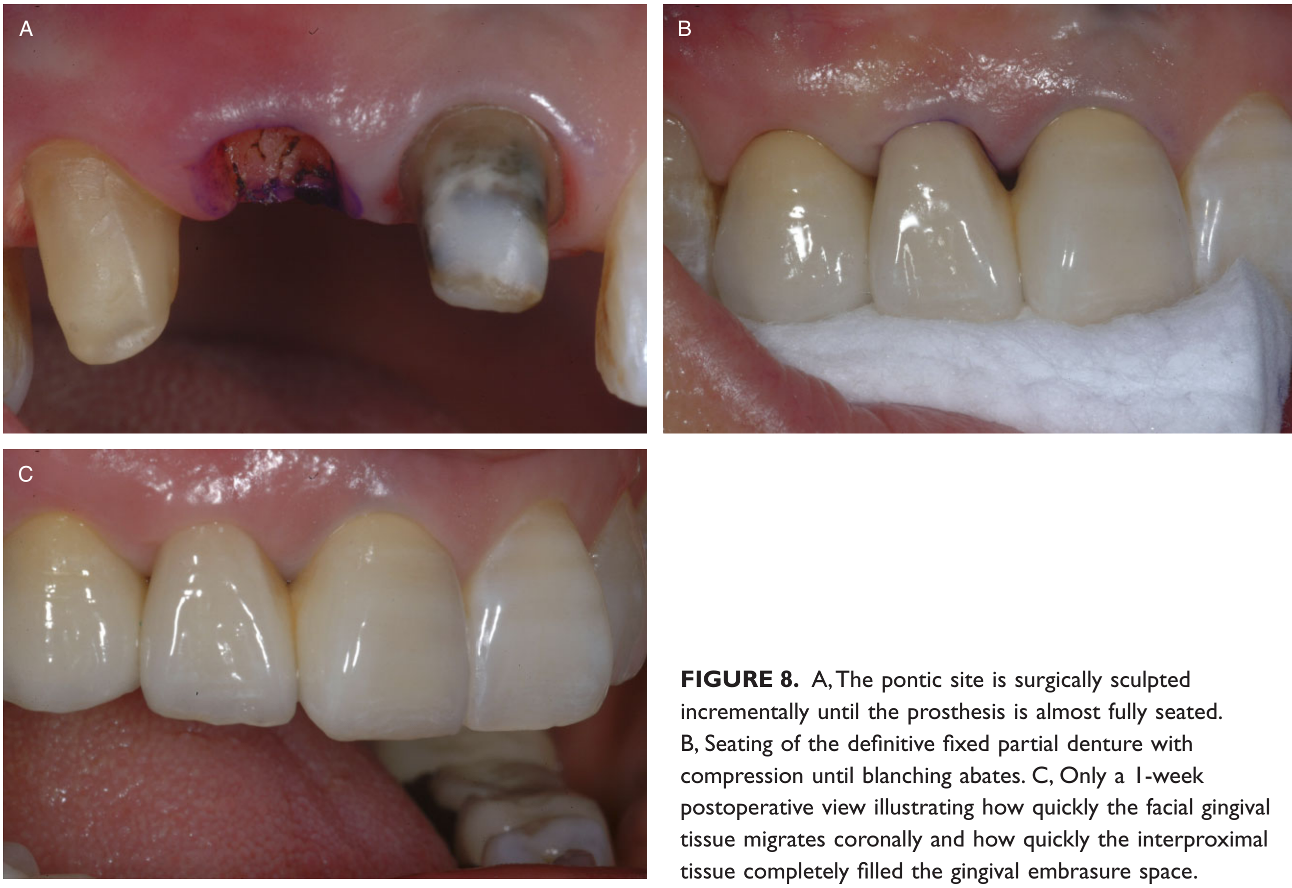

FIGURE 8. A, The pontic site is surgically sculpted incrementally until the prosthesis is almost fully seated. B, Seating of the definitive fixed partial denture with compression until blanching abates. C, Only a 1-week postoperative view illustrating how quickly the facial gingival tissue migrates coronally and how quickly the interproximal tissue completely filled the gingival embrasure space.

A treatment plan was formulated and presented to the patient based upon our diagnostic data and risk assessment in the four diagnostic categories previously mentioned. The cone beam computed tomograpy findings of the bony ridge defect would require extensive hard and soft tissue augmentation if implants were to be a treatment consideration. After reviewing with the patient the risks and benefits of adjacent implants versus adjacent pontics, she agreed to proceed with another FPD that would provide the most predictable esthetic outcome.

A connective tissue graft would predictably provide approximately 3 to 3.5 mm more interdental papilla between two central incisor pontics than interdental papilla between two central incisor implants.[43,44] The difference in the papillary height would dramatically impact the esthetic outcome for this patient. Also, the soft tissue augmentation would correct the facial ridge deficiency that would provide for an optimal emergence profile and enough tissue volume to ensure an adequate pontic/tissue adaptation to predictably develop, support, and maintain the interdental papilla and facial gingival tissue. Therefore, the decision to proceed with an FPD involving the same structurally sound abutments with two adjacent E-pontics would be the most appropriate treatment plan for this patient with regard to the most predictable esthetic outcome.

Soft tissue augmentation was completed to address the facial ridge deficiency. The periodontal plastic surgical approach used was a subepithelial connective tissue graft utilizing an interpositional technique. It was effective in achieving sufficient buccolingual width to address the facial ridge defect and preserve the existing gingival coloration and tissue characteristics.

A 6-week postoperative evaluation of the augmented pontic site adequately addressed the facial ridge deficiency. However, the interdental papillae were lost

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FIGURE 9. A, Seating a definitive three-unit fixed partial denture with surgical sculpting of the pontic site. B, A 2-month postoperative view illustrating a flat pontic design with its sharp 90-degree line angles promotes the facial gingival tissue to coronally migrate. C, A 17-month postoperative view illustrates the coronal migration of the facial gingival tissue along with predetermined complete fill of the gingival embrasure space.

adjacent to both lateral incisor abutments (Figure 14). A secondary graft was not a consideration because of how unpredictable it is to reconstruct the interdental papilla. According to van der Veldon, the papillae will regenerate over a period of 3 years as long as sufficient interproximal bone and teeth are present.[45] Therefore, a processed provisional bridge was fabricated with the understanding that it will be in place for a long period of time until sufficient papillary height is achieved to satisfy the esthetic outcome. The patient was accepting of this treatment approach.

The author's surgical protocol in the development of the E-pontic site is always at the delivery appointment of the definitive FPD. However, because the interdental papillae were lost postsurgically, it was decided to proceed with development of the E-pontic sites with a processed provisional E-pontic designed bridge that would be worn for an extended period of time until regeneration of the interdental papilla adjacent to the lateral incisors has occurred. A 3.2-year postoperative view reveals regeneration of the interdental papilla adjacent to the lateral incisors with the provisional bridge (Figure 15). The papilla height between the central incisor pontics is in harmony with the adjacent papilla heights between the lateral incisor and pontic. Removal of the provisional bridge reveals a well-defined gingival architecture and healthy pontic tissue receptor site without any evidence of inflammation or any degree of food entrapment as a result of its adaptive design (Figure 16). After 3 years of tissue development of the interdental papillae and pontic sites, a final impression was taken to fabricate a definitive FPD. At the delivery appointment, the definitive FPD was seated with a combination of surgical contouring and compression of the pontic sites to create a more apical position of the facial gingival margins at a predetermined level. This will optimize the length-to-width tooth proportion and esthetically improve the gingival levels (Figure 17). A 5-month

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FIGURE 10. A, A significant subgingival resorptive defect on the facial aspect of the maxillary left central incisor rendered a hopeless prognosis. B, Atraumatic extraction with socket preservation augmentation with demineralized freeze-dried bone allograft. C, A 4-month postoperative view illustrating the preservation of the papilla height and maintaining the same facial gingival height. D, Illustrating the removable E-pontic developing the pontic site. E, Illustrating a stable peri-implant tissue architecture 4 months after peri-implant tissue development with the provisional abutment and crown.

postoperative view of the definitive FPD reveals ideal papillary height and symmetry with complete tissue closure of the gingival embrasure space (Figure 18A–B). A 7-month postoperative view of the definitive FPD illustrates coronal migration of the facial gingival tissue over the pontics (Figure 18C–D). The postoperative X-ray illustrates the E-design with 6.5 mm of interdental tissue above bone between the E-pontics (Figure 19). It may take up to 1 year to predictably achieve complete development and stability of the peri-pontic gingival architecture. Continued coronal migration and draping of the tissue at the facial gingival line angles over the pontics will predictably occur during this time period.

FIGURE 11. A and B, The patient presents with esthetic concerns about her smile. Compromised anterior esthetics as a result of soft tissue gingival form and poor ceramics.

FIGURE 12. A preoperative X-ray illustrates resorption and flattening of the osseous crest following the loss of both central incisors 11 years ago.

FIGURE 13. The vertical tissue height over the edentulous ridge was found to be esthetically acceptable when comparing with the adjacent papillary height.

DISCUSSION

Poor anterior esthetics as a result of soft tissue gingival form can be significantly improved by periodontal surgical and prosthetic techniques that enable the clinician to alter and enhance the gingival architecture. Biologic and anatomical parameters that influence the presence of the interdental papilla and gingival facial height are important parameters that provide the clinician with a clear understanding and guidance to predictably manage the interdental and facial gingival tissue when a tooth is removed.[40] The facial bone level and gingival thickness will determine the height at which the facial gingival margin stabilizes.[46] The interdental volume of tissue is influenced by the level of the interproximal bone, biologic width, and the size and shape of the gingival embrasure space.[44,47–50] The interdental tissue volume is also influenced by whether or not the papilla is adjacent to a tooth, pontic, or an implant on either side of it.[43] Salama and colleagues provide a prognostic guide for interproximal soft tissue dimensions that can be utilized as an effective communicating tool with clinicians and laboratory technicians to achieve predictable esthetics.[43]

In the literature, Pontic form has been classified as sanitary, ridge lap, modified ridge lap, ovate, and

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FIGURE 14. A 6-week postoperative view of a soft tissue augmentation performed, which adequately addressed a facial ridge deficiency. However, the interdental papillae were lost adjacent to both lateral incisor abutments postsurgically.

FIGURE 15. A 3.2-year postoperative view reveals regeneration of the interdental papilla between the lateral incisors and pontics.

FIGURE 16. A 3.2-year postoperative view of a healthy pontic tissue site response with no entrapment of food particles during removal of the fixed partial denture.

FIGURE 17. Seating of the definitive fixed partial denture with a combined surgical and compression technique of the pontic sites to create a more apical position of the facial gingival margins at a predetermined level.

modified ovate[23,51–55] (Figure 5). The sanitary pontic does not come into any form of contact with the ridge for the sole purpose of cleansibility and was not designed for esthetics. The ridge lap pontic design makes it difficult for both the patient and the clinician to keep the interface between the pontic and edentulous ridge cleansable. The modified ridge lap design allows for contact of the pontic on the buccal aspect of the underlying ridge. The contact position on the ridge allows for better cleansibility with improved esthetic design. The ovate pontic was designed to create an esthetic soft tissue-to-pontic relationship by giving the appearance of a natural tooth emerging from the gingiva. A modified ovate pontic was designed to make the pontic more cleansable compared with the ovate pontic and meeting all the esthetic requirements that other pontic designs may not meet.[56] In the author's opinion, the combination of the modified ovate pontic design being more labially positioned on the ridge, a narrower facial/lingual design, and having less contact on the soft tissue poses a concern with regard to long-term stability of the gingival architecture. The interproximal contours of a pontic design need to extend palatally past the contact point through the entire bucco-lingual width of the papillae for

FIGURE 18. A and B, A 5-month postoperative view reveals ideal papillary height and symmetry with complete tissue fill of the gingival embrasure space. C and D, A 7-month postoperative view of the definitive fixed partial denture illustrates coronal migration of the facial gingival tissue over the pontics.

predictable interproximal tissue support.[40] Inadequate support of the interdental papilla over time will invariably result in an unesthetic blunted papilla and increased risk for an open gingival embrasure space.

Traditionally, ovate pontics have been used as a restorative design following augmentation procedures to give the illusion of a gingival margin and a natural emergence profile for the pontic. An ovate pontic design to be used immediately after an extraction is very effective in supporting the gingival architecture and gives immediate esthetic results. However, it has been the author's observation that over a period of time, the ovate pontic situated on an acceptable alveolar ridge does not consistently maintain adequate support and stability of the interproximal papilla, resulting in blunted papillae and open gingival embrasure spaces. The facial gingival tissue associated with the ovate design frequently will tend to loose its intimate adaptation over time, creating a shadow that appears around the facial margin of the ovate that may compromise the esthetics. Traditionally, when a final impression is taken to fabricate a fixed prosthesis that includes a pontic site that has been surgically developed to accept an ovate pontic, a degree of unwanted soft tissue remodeling of the pontic site will frequently occur after the impression is taken. The pontic tissue site can become further distorted by the provisional restoration during the period of time when the definitive prosthesis is being fabricated in the laboratory. Even though the ceramist may sculpt the pontic tissue site on the master model to compensate for soft tissue distortion or rebound, the variable degree of soft tissue dimensional change occurs because the

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FIGURE 19. A postoperative X-ray illustrates the E-pontic design with 6.5 mm of interdental tissue above bone.

impression appointment on occasion leads to a poor pontic-to-tissue adaptation, resulting in a compromised esthetic outcome.

At the final impression appointment, it is not necessary to have the pontic tissue recipient site anatomically developed by the provisional pontic because the E-pontic design of the definitive FPD will begin anatomical tissue development of the site at the delivery appointment. The clinician is now able to intimately adapt the pontic directly to the tissue receptor site at the delivery appointment. Therefore, the clinician does not have to spend 6–12 months developing a pontic recipient site to work out the esthetic and functional components with a long-term provisional restoration[55] prior to the final impression appointment to fabricate the definitive FPD.

The author has consistently observed an interesting phenomenon over the past 14 years with coronal migration of the facial gingival tissue draping over the E-pontic regardless of the tissue biotype. The pontic/tissue interface intimately adapts without any palatal gap preventing food or saliva penetration.

The sharp line angles of the E-pontic design are responsible for a well-defined and stable gingival architecture. The lateral walls of this pontic design predictably support and stabilize the interdental papilla.

The author intentionally designed an E-pontic FPD with rounded line angles to observe if there would be any variation in the peri-pontic tissue response. The author consistently observed that the facial gingival tissue would not coronally migrate over the pontic regardless of thick or thin tissue biotype. The facial gingival margin and interdental papilla were both lacking a well-defined tissue architecture in comparison with a sharp line angle design. Without the sharp line angles, less than optimal esthetics would consistently result.

CONCLUSION

Historically, the ovate pontic design has been the gold standard in our dental profession for 33 years.

The author's observation has been that the E-pontic has a more predictable control of papilla shape and height and facial gingival position in comparison with the ovate, modified ovate, and other pontic designs.

The E-pontic requires half the depth of tissue and has complete control of shaping and guiding the predetermined amount of tissue interproximally for papilla height symmetry and facial gingival margin contour and height. It predictably develops, supports, and maintains the gingival architecture for the long term. The E-pontic method, when properly performed, will fulfill these expectations in a predictable manner.

When the goal of tooth replacement is to achieve the optimal esthetic and functional outcome, the utilization of the E-pontic design for an FPD, involving either natural teeth or implants, is recommended.

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