Abutment-Supported Papilla: A Combined Surgical and Prosthetic Approach to Papilla Reformation

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Restoration of lost interdental papilla remains one of the most challenging goals for clinicians. When a single tooth is replaced with an implant, the papilla between the tooth and the implant can often be maintained or predictably reconstructed as long as the periodontal attachment and bone of the adjacent tooth is preserved. However, if the periodontal support is compromised on the neighboring natural tooth, the papilla will often be deficient or missing. This article presents a multidisciplinary treatment approach to regenerate the interdental papilla between an implant and a periodontally compromised tooth using surgical procedures and a customized abutment. Specifically, an abutment with modified subgingival contours is used to enhance support of the surgically reformed papilla. Int J Periodontics Restorative Dent 2016;36:665–671. doi: 10.11607/prd.2817

The interdental papilla is extremely important in anterior esthetics and must be considered when replacing teeth with implants. While replication and replacement of a missing tooth structure with a natural-appearing implant-supported prosthesis is predictable, regeneration of lost interdental papillae is often difficult. The black triangle that presents when soft tissue does not completely fill the interproximal space is unsightly and can be devastating for patients. Restoration of lost interdental papilla remains one of the most challenging and least predictable goals for clinicians.

In the natural dentition, papillae are supported by interdental alveolar crestal bone, a network of gingival connective tissue fibers, and a long junctional epithelial attachment. The quality or thickness of the tissues (ie, the periodontal biotype) also influences the fullness of the interdental papillae.1–4 When a single tooth is replaced with an implant-supported crown, the papilla between the tooth and the implant can often be maintained or predictably restored as long as the periodontal attachment and bone of the adjacent tooth is preserved at a normal level.5 However, if the periodontal support is compromised by bone and periodontal attachment loss, the papilla will often be deficient or missing.
Critical dimensions of the interproximal space between natural teeth that are conducive to complete papilla fill have been described. Tarnow et al found that the papilla completely fills the interdental space when the vertical distance between the contact point and the height of the interproximal bone crest is ≤ 5 mm, while the papilla was less likely to fill the space when the distance is > 5 mm. Cho et al found that the presence of a full interdental papilla was also influenced by the horizontal distance between teeth and that as the interdental space increased, the vertical distance from contact point to bone crest was less of an influence on the presence of papillae. In other words, when the horizontal distance increased beyond a certain dimension, papilla were not full even if the distance from contact to bone was ≤ 5 mm. Martegani et al found that the horizontal distance between natural teeth is important, suggesting that interdental spaces > 2.4 mm result in a higher likelihood of black triangles. When an implant is used to replace a missing single tooth between natural teeth, the critical dimensions for papillae are similar to those for adjacent natural teeth. Grunder concluded that for single-tooth implants the presence of the papilla is determined by the interproximal bone level on the neighboring natural tooth and not by the bone level adjacent to the implant.

The black triangle problem presents around a single-tooth implant when the adjacent tooth has lost bone and periodontal attachment. Most approaches to correct lost or deficient interdental papilla have been surgical, which is understandable given that the goal is to increase the volume of living tissue. In fact, a number of different surgical techniques have been proposed to preserve, restore, and regenerate the interdental papilla, including papilla preservation procedures, hard and/or soft tissue augmentation, guided tissue regeneration, injections, microsurgical approaches, and modified suturing techniques. However, the role of prosthetic contours in forming and supporting the interdental papilla has been recognized and must be considered as part of a multidisciplinary treatment approach. Some authors have suggested that immediate placement of a provisional restoration promotes papilla formation and support. The amount of papilla fill is strongly related to the level of bone on the adjacent tooth. A few authors have suggested that modification of the subgingival implant abutment contour will allow for tissue space while also supporting the interdental papilla.

This article presents a multidisciplinary treatment approach to replace a missing single tooth and severe loss of the interdental papilla using modification of the subgingival abutment contours to shape and enhance papilla reformation.

**Materials and methods**

**Case presentation**

A healthy 25-year-old woman presented for an evaluation of her implant replacing the maxillary left lateral incisor. Clinical examination revealed that the gingival margin was asymmetrical, with apical displacement of the facial marginal tissue at the implant (Fig 1a). In addition, the mesial papilla of the implant was lost. Upon probing, a 6-mm pocket was found on the facial aspect and gentle pressure of the area revealed purulent exudate. The patient also reported a history of several unsuccessful bone graft procedures around the implant. The mesiodistal space of the site was 10 mm, whereas the contralateral space was 6.5 mm.

Since the patient desired a fixed and esthetic reconstruction, the clinical plan was to remove the implant, regenerate the alveolar defect, and place an implant to support a fixed prosthetic restoration that would restore form and esthetics.

**Surgical phases**

**Implant removal**

The implant was removed 2 months prior to the regenerative surgical procedure (Fig 1b). A full-thickness flap was elevated, and a round bur was used to remove bone around the implant followed by application of a countertorque device to remove the implant. The site was allowed to heal for 2 months. Healing was uneventful.

**Vertical ridge augmentation**

The patient was premedicated with 2 g amoxicillin 1 hour before surgery. The patient rinsed with 0.12% chlorhexidine solution (Peridex, 3M...
ESPE) for 1 minute immediately prior to surgery. The skin surrounding the surgical site was disinfected with 0.12% chlorhexidine solution, and a sterile surgical drape was applied to minimize the potential contamination from extraoral sources.

A full-thickness midcrestal incision was made in the keratinized gingiva on the alveolar crest. Two divergent vertical incisions were made at the mesial line angle of the left central incisor and the distal line angle of the canine to achieve adequate surgical access. Periodontal elevators were used to reflect a full-thickness flap beyond the mucogingival junction and at least 5 mm beyond the bone defect.

When the flap was reflected, a periodontal and vertical ridge combination defect was evident (Fig 1c). A 4-mm vertical bone deficiency was measured from the most apical portion of the bony defect to a line connecting the interproximal bone height between the neighboring teeth. The mesial interproximal bone of the central incisor was resorbed about 2 mm (Fig 1d). A small round bur was used to prepare the recipient bony bed with multiple decorticalization holes to expose the medullary space and promote bleeding. Autogenous bone was then harvested from the right ascending ramus and particulated in a bone mill (R. Quétin Bone-Mill, Roswitha Quétin Dental Products). An appropriate size titanium-reinforced expanded polytetrafluoroethylene membrane (e-PTFE-TR) (Gore-Tex, W.L. Gore & Associates) was selected and trimmed with consideration given to graft volume. The membrane was fixed first on the palatal side using multiple titanium pins (Frios Membrane Tacks, Dentsply). The autogenous bone was then applied and packed exactly to the planned height and width of the ridge (Fig 1e). The membrane was folded over and completely secured with additional titanium pins on the facial surface (Fig 1f). The flap was mobilized to permit tension-free primary closure. A periosteal releasing incision connecting the two vertical incisions was performed to achieve elasticity of the flap. The flap was sutured in two layers. First, horizontal mattress sutures (Gore-Tex CV-5 Suture, W.L. Gore & Associates) were placed 4 mm from the incision line. Single interrupted sutures with the same e-PTFE suture were then placed to close the edges of the flap, leaving a connective tissue layer at least 4 mm thick between the membrane and the oral epithelium. This connective tissue–to–connective tissue contact provides an intimate tissue closure that serves as a barrier, preventing postoperative exposure of the membrane. Vertical incisions were closed with single interrupted sutures. The single interrupted sutures were removed 14 days postsurgery, and mattress sutures were removed after 3 weeks.

Amoxicillin 500 mg was administered three times a day for 1 week following the surgery. In addition, an anti-inflammatory medication, 50 mg diclofenac (Voltaren XR, Novartis Pharmaceuticals) was prescribed three times a day for 1 week following the surgery. Chemical plaque control using 0.12% chlorhexidine solution was used daily from 24 hours postsurgery until the time of suture removal.

Postoperative swelling was remarkable and reached its maximum at 48 hours postprocedure. Swelling gradually subsided but was still visible at 1 week and disappeared completely after 10 days. Postoperative discomfort was mostly associated with tension from the swelling, and pain was negligible. No other symptoms occurred in the postsurgical period.

A fixed bonded bridge was used to avoid postsurgical trauma and pressure on the surgical site.

**Implant placement and soft tissue grafting**

After 6 months of uneventful healing, the area was explored employing the same full-thickness flap design. Upon reopening of the surgical site and removing the membrane, the tissue beneath appeared healthy, with a healthy periosteal layer between the soft tissue and the bone. A complete, 4-mm vertical augmentation was observed (Fig 1g). A standard-diameter Brånemark TiUnite implant (Nobel Biocare) was placed using a prefabricated surgical guide (Fig 1h).

Despite the successful augmentation, there was still loss of interdental bone on the mesial and some unsupported regenerated bone around the distal neck of the implant. This area was not repaired with additional bone grafting. A collagen membrane (Bio-Gide, Geistlich) was used empirically to prevent resorption of the newly formed bone.
Patient presenting with failing implant at the site of the maxillary left lateral incisor. Note that the mesial interdental papilla was lost and the marginal gingiva was asymmetrical. Purulent exudate was present on gentle pressure of the area. Bone was missing on the facial and the palatal side. (b) Labial view of the area 2 months after implant removal, with a fixed bonded provisional bridge in place. (c, d) Two months after implant removal, a full-thickness flap was raised. In addition to the vertical ridge deficiency, interdental bone loss was evident on the distal side of the left central incisor.

Labial view of the autogenous particulated bone graft and e-PTFE-TR membrane in place. (f) The e-PTFE-TR membrane in place. (g, h) The dental implant was placed into newly formed bone using a surgical stent. Note that there is still loss of interdental bone and corresponding unsupported regenerated bone present around the distal neck of the implant. (i, j) PCTG was performed to enhance the soft tissue architecture. Amelogenin (Emdogain) was used on the denuded root before the CTG was applied. (k) Labial view on the day the implant was uncovered. Note the improved soft tissue architecture. (l) Labial view of the soft tissue after provisionalization. Even though the papilla and the gingival symmetry had improved, there was still a lack of full papillary contour.
Additional soft tissue grafting was performed to enhance the soft tissue architecture. After careful root planning, enamel matrix derivative (EMD) (Emodogain, Straumann) was applied to the denuded root surface. A thick piece of connective tissue was harvested for a free connective tissue graft (CTG) and then secured interdentally in an inverted position to cover the denuded proximal root surface for a papillary connective tissue graft (PCTG) of the left central incisor with a 6-0 resorbable monofilament suture (PDS-II, Ethicon) (Fig 1i). An additional suture was then used on the buccal side of the CTG to stabilize it in an optimal position. The flap was advanced and sutured the same way as in the bone regenerative surgery to achieve good primary closure above the CTG (Fig 1j).

The implant was left to heal for an additional 6 months (Fig 1k). At the time of exposure, a provisional implant crown was fabricated within a few weeks.

Fig 1p to 1w (p) Placement of final abutment. Note the level and improvement of the regenerated papilla at the mesial side of the implant. (q) Final all-ceramic crowns after cementation. (r) Labial view of the clinical result after 10 years of function. (s) Oblique view of the patient during smile. Note the volume of the regenerated papilla (arrow). (t) Periapical radiograph at uncovering. (u) Periapical radiograph after 1 year of loading. Note that the unsupported bony ledge resorbed. (v) Periapical radiograph after 8 years. A distance of 7 mm was measured between the contact and the level of the interdental bone. (w) Periapical radiograph after 10 years of function. Note that there was no more bone remodeling after the first year.
Restorative phase:
Customized abutment with convex subgingival contours

Two weeks after the implant exposure, a temporary implant crown was fabricated on a temporary abutment. The soft tissue architecture was greatly improved: the symmetry of the facial tissue between the contralateral sides had been reestablished, and the papillary height was also improved (Fig 1f).

After 12 months of provisionalization, the final impression was taken. The goal was to improve the papillary architecture by means of the form of the final abutment (Fig 1m). Hence, a zirconia final abutment was fabricated with a convex surface to further support and improve the regenerated interdental soft tissues (Figs 1n and 1o).

The papillary height increased to a symmetrical level with the contralateral papilla (Fig 1p). The patient received all-ceramic crowns from canine to canine (Fig 1q).

The distance from the contact point to the crestal bone was 7 mm, as measured on the periapical radiograph using Image J software (National Institutes of Health). The software was calibrated using the known interthread distance of the implant.

The patient was followed for 10 years after loading with good bone and soft tissue stability (Figs 1r and 1s). There was an increased remodeling of the crestal bone of about 2 mm in the first year, which stabilized for the remaining 9 years of follow-up without further bone loss (Figs 1t to 1w).

Discussion

Most reports in the literature advocate surgical reconstruction of the lost papilla. Techniques include papilla preservation procedures and modifications of this technique. A few reports use prosthesis contours to enhance papilla reformation.19,21,22

In a randomized controlled clinical trial to evaluate the effect of immediate provisionalization, De Rouck et al found that although delayed placement resulted in greater short-term loss of papilla, both immediate and delayed placement of crown contours offered similar papilla fill results after 12 months.27

This case demonstrates successful reformation of periodontal/peri-implant tissue contours, including reconstruction of lost interproximal papilla in a periodontally compromised dentition, using a combined surgical and prosthetic approach. In such challenging cases when the periodontal attachment and bone is lost from a tooth adjacent to an implant, a single-discipline approach (ie, surgical only) is unlikely to achieve full reconstruction of the papilla.

There is a biologic limit to papilla tissue height that is dictated by the level of periodontal attachment and bone support. Studies have shown that predictable papilla fill adjacent to a natural tooth is approximately 5 mm from the interdental bone height to the contact point.28 When the distance from the bone crest to the contact point is > 5 mm, achieving a full papilla is unlikely. In this case, 7 mm was measured from the contact point to the crest using imaging software (Image J, NIH) after delivering the final reconstruction (Fig 1v).

This case demonstrates a combined surgical reconstruction along with the use of a customized abutment with a subtle submarginal convex contour that confines the space available for the papilla. The PCTG technique used regenerated most of the recreated papilla, but a minor discrepancy still existed. Due to the increased mesiodistal space, a provisional implant abutment with a traditional form could not support the interdental soft tissues fully and a papilla-supporting abutment was created. This interdentally convex abutment applied pressure to the soft tissue acting as an internal ovate pontic. While this change was moderate compared with the changes achieved by the soft tissue graft, it had an impact and a full papilla was recreated.

In cases where there is a loss of the interdental bone, a convex contour abutment should be tested. The convex contours should be applied and its effects evaluated carefully by the restorative dentist during the provisional phase. Increased mesiodistal space in single-tooth gaps may require the use of this type of abutment to create more support for the papilla even if there is no loss of interdental bone.

Conclusions

This case report describes the use of a combination of soft tissue grafting and a prosthetic approach. Although this case had a poor prognosis for complete papillary fill, the papilla
not only was regenerated but was maintained for 10 years, supporting the techniques applied. The clinician should recognize that this result, however encouraging, requires a randomized, multicenter clinical trial to validate the effectiveness of this technique in routine clinical practice.

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References


