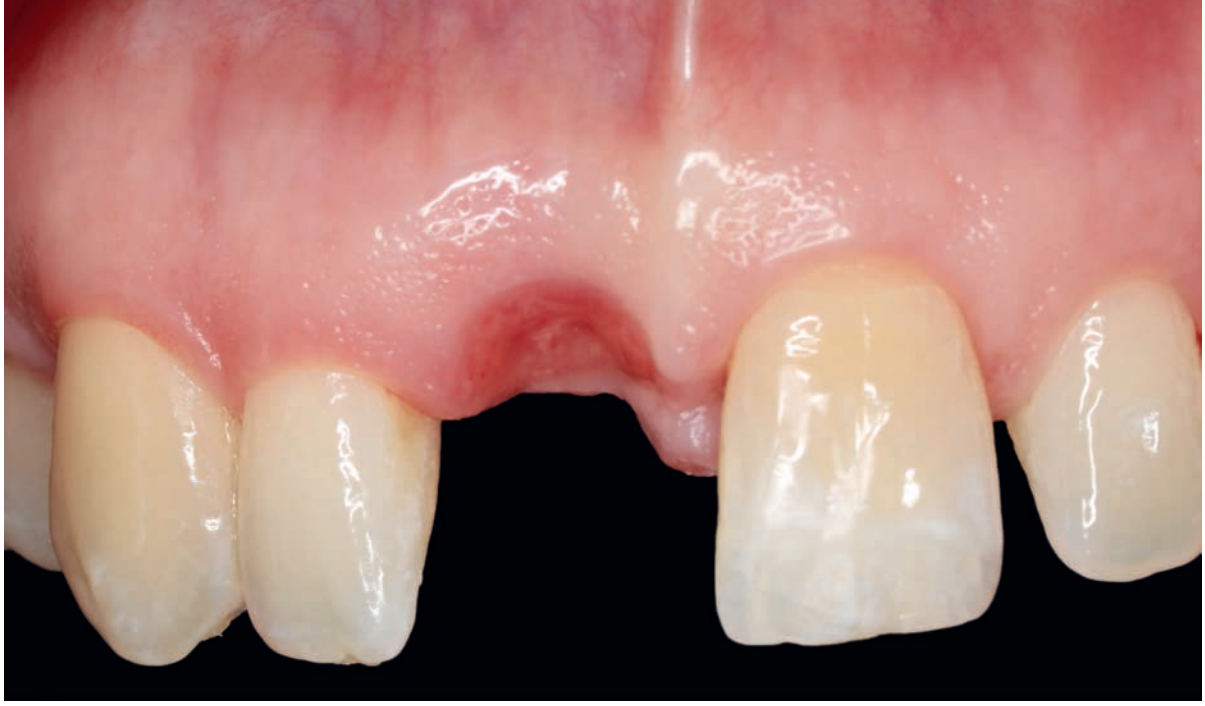
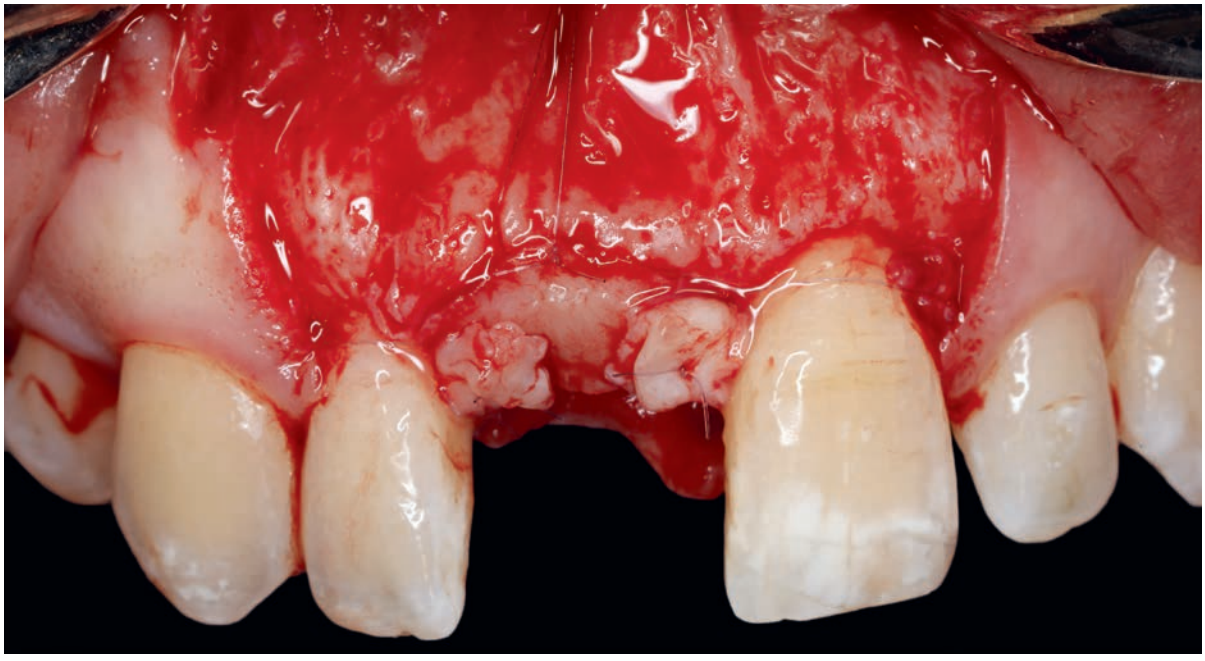
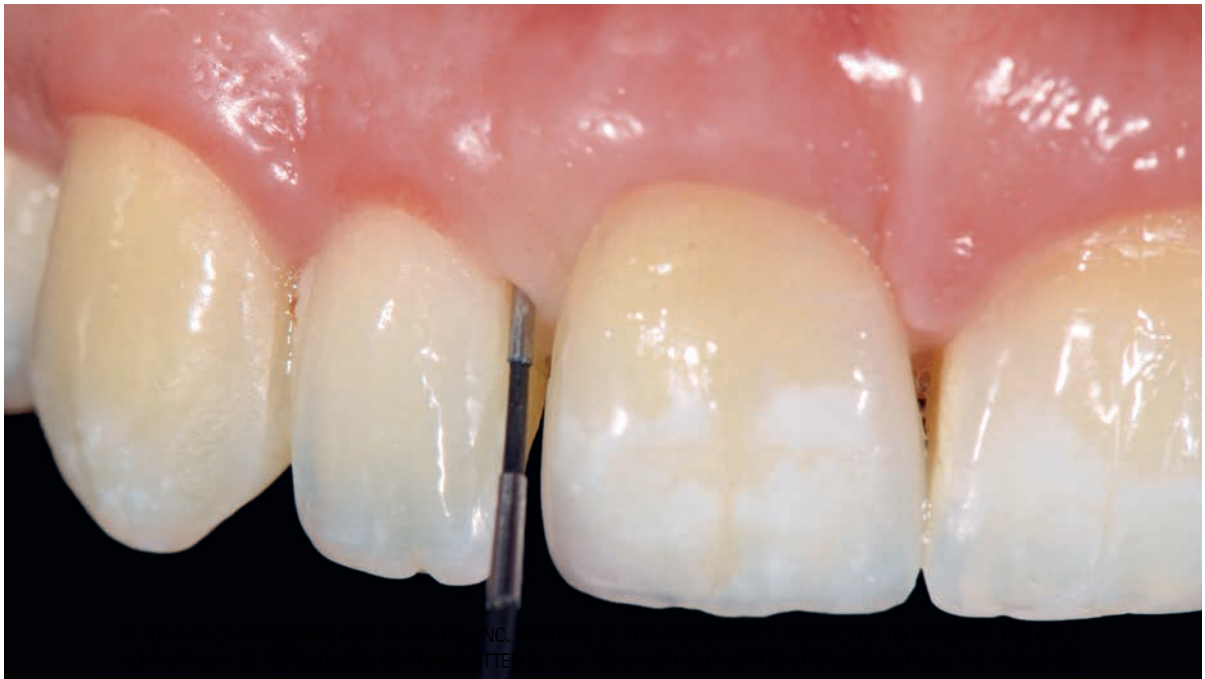






Submitted February 13, 2023;
accepted April 20, 2023.

Istvan A. Urban, DMD, MD, PhD
Leonardo Mancini, DDS, PhD
Hom-Lay Wang, DDS, MS, PhD
Lorenzo Tavelli, DDS, MS, PhD

The "Iceberg" Connective Tissue Graft Technique for Peri-implant Papilla Augmentation Following Interproximal Bone Reconstruction

Implants with deficient papillae and black triangles are common findings. The treatment of these esthetic complications is considered to be challenging with limited predictability. Therefore, the present report aims to describe a novel technique for papilla augmentation: the "iceberg" connective tissue graft (iCTG) after extraction and interproximal bone reconstruction in the anterior region. A 35-year-old patient presented with a hopeless tooth with interproximal clinical attachment loss extending to the apical third of the adjacent tooth. Interproximal bone reconstruction was performed through alveolar ridge preservation by directly applying recombinant human platelet-derived growth factor-BB (rhPDGF-BB) to the exposed root surface of the adjacent tooth. A mixture of autogenous bone chips (obtained from the ramus) and bovine bone xenograft particles (previously mixed with the growth factor) was also used. The patient was able to return for implant therapy only 2 years later, at which time an incomplete regeneration of the interproximal bone was observed. Therefore, to compensate the interproximal deficiency, the iCTG approach was utilized, involving a double layer of CTG with different origins. Two small grafts from the tuberosity were sutured to the mesial and distal ends of a wider CTG harvested from the palate, aiming to gain additional volume at the interproximal sites. The composite graft was then sutured on top of the implant platform, and the flap was then released and closed by primary intention. After conditioning the peri-implant tissues, the case was finalized with a satisfactory outcome. The described iCTG could be an effective approach for reconstructing peri-implant papillae following interproximal bone reconstruction. *Int J Periodontics Restorative Dent 2024;44:511–519. doi: 10.11607/prd.6731*

Keywords: *alveolar ridge augmentation, biologic mediator, connective tissue graft, dental implant therapy, platelet-derived growth factor*

Hopeless teeth are often characterized by interproximal clinical attachment loss at the adjacent dentition, which inevitably increases the complexity of implant therapy, especially in the esthetic zone.[1,2] Without proper management of the hard and soft tissue components after the extraction of hopeless dentition, dental implants often have suboptimal esthetic outcomes. These outcomes can be related to the midfacial level of the peri-implant soft tissue margin alone[3] or to the interproximal soft tissue.[3–6] Unfortunately, implants with deficient papillae and black triangles

are common findings.[3–6] It should be noted that both clinician and patient standards for implants have significantly increased in the last decade. Even a small peri-implant papilla deficiency in the anterior region can be considered a compromised clinical outcome.

On the other hand, it is well known that papilla augmentation and, overall, interproximal clinical attachment level gain is clinically challenging at teeth and implant sites. In natural dentition, it has been advocated that the interproximal soft tissue position, and thus the architecture of the papillae, is impacted by various factors, such as the distance from the bone crest to the interproximal contact point, the distance between cementoenamel junction to the alveolar crest, the probing depth of the adjacent teeth, the soft tissue thickness, the fibrous or edematous nature of the tissues, the tooth location, and the history of previous nonsurgical/surgical procedures.[7–9] In particular, Tarnow et al[9] demonstrated that the papilla was present in 98% of cases when the distance between the bone crest and the contact point was ≤ 5 mm; this incidence dropped to 56% and 27% when the distance from the bone crest to the contact point was 6 and 7 mm, respectively.

Therefore, it is logical to assume that implant rehabilitation after extraction of hopeless teeth in the anterior region, characterized by interproximal attachment loss, should combine hard and soft tissue reconstruction at the implant site in order to establish the interproximal bone height necessary for supporting an adequate papilla architecture.[1,10]

The objective of the present report is to describe a novel technique for papilla augmentation, known as the "iceberg" connective tissue graft (iCTG), after extraction and alveolar ridge reconstruction in the anterior region.

Clinical Presentation

This manuscript adheres to the guidelines for CARE guidelines for case reports. The present manuscript depicts a novel combined hard and soft tissue augmentation approach for the management an extraction site with interproximal bone loss in the anterior zone.

A healthy 35-year-old woman presented at the Urban Regeneration Institute (Budapest, Hungary) in December 2018 with severe loss of the interdental papilla in the maxillary right central and lateral incisors. The central incisor was considered hopeless due to advanced periodontal disease, with severe loss of the buccal and palatal bone plates, class III mobility, and interproximal clinical attachment loss extending up the apical third of the tooth (Fig 1). In particular, 9-mm probing depths were observed at the midbuccal and midpalatal aspects of the tooth, and a 10-mm probing depth was found at its distal aspect. The patient's main concern was the final esthetic outcome of the implant therapy.

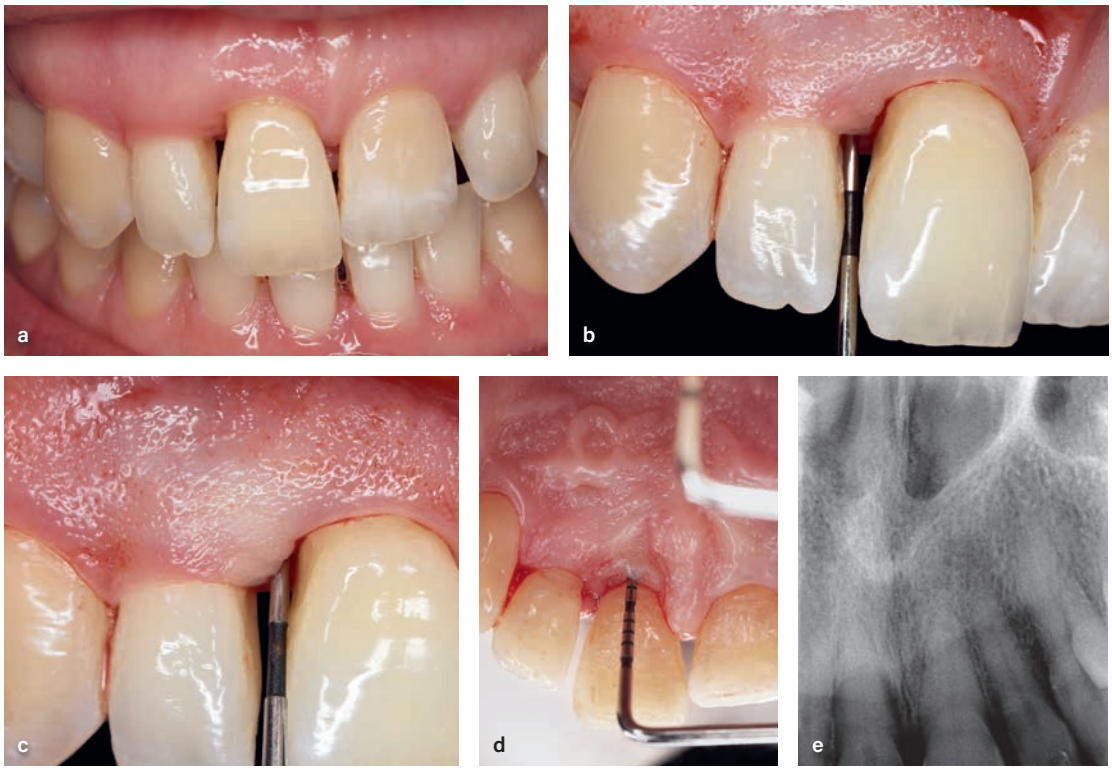
Case Management

Alveolar Ridge Preservation

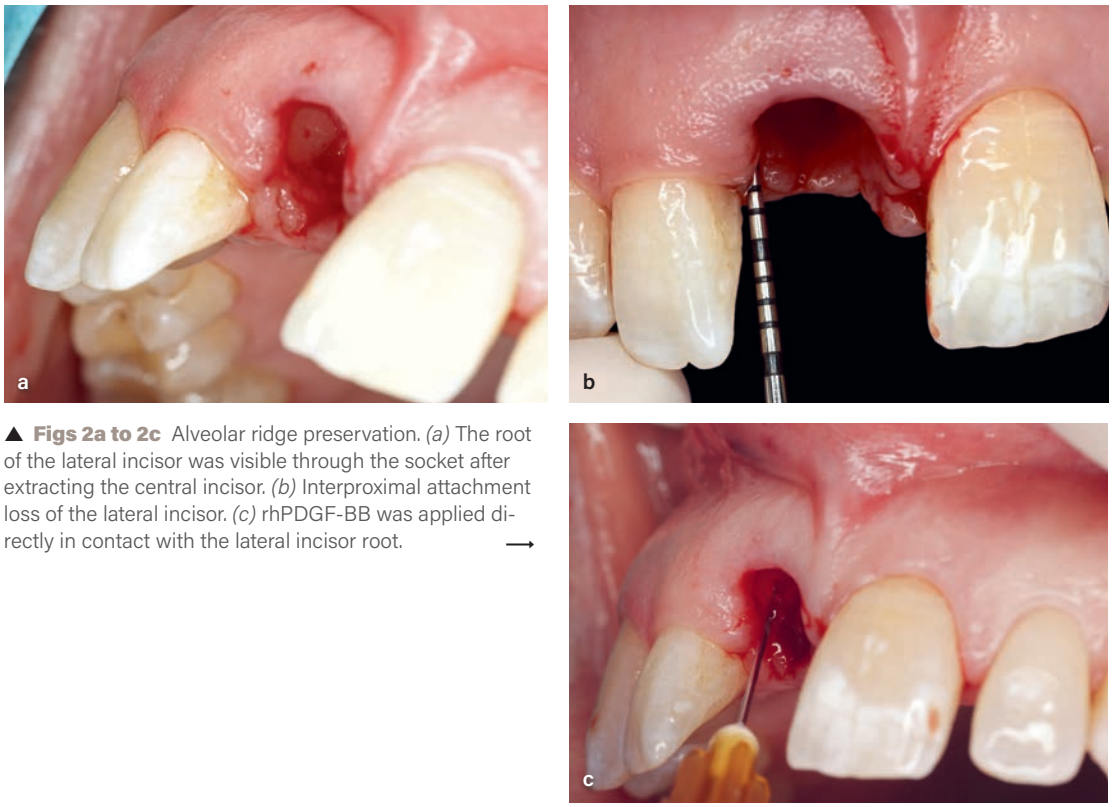
After local anesthesia, the central incisor was extracted with elevators and forceps. The root of the right lateral incisor was visible through the extraction socket due to the interproximal attachment loss (Figs 2a and 2b). After debridement of the extraction socket with curettes and rinsing with sterile saline, recombinant human platelet-derived growth factor-BB (rhPDGF-BB; GEM21, Geistlich) was directly applied to the exposed root surface of the lateral incisor through the socket (Fig 2c). Autogenous bone chips that were previously mixed with rhPDGF-BB were inserted into the extraction socket and pressed against the denuded root of the lateral incisor. The remaining socket areas were densely packed with a mixture of autogenous bone chips mixed with bovine bone xenograft particles (Bio-Oss, Geistlich) that had been previously mixed with rhPDGF-BB (Fig 2d). A collagen matrix (Mucograft Seal, Geistlich) was then placed over the bone graft material and sutured to the soft tissue (6/0 polypropylene, Resolon, Resorba) to seal the socket (Figs 2e and 2f).

Implant Placement and Simultaneous Soft Tissue Augmentation

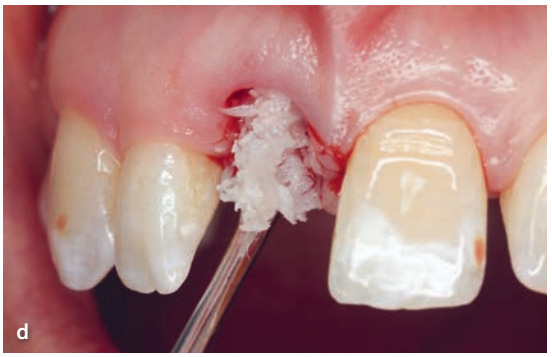
The patient was not able to come back to the office for 2 years due to personal reasons. At their

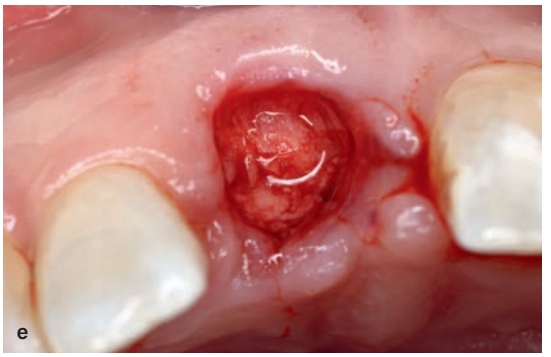


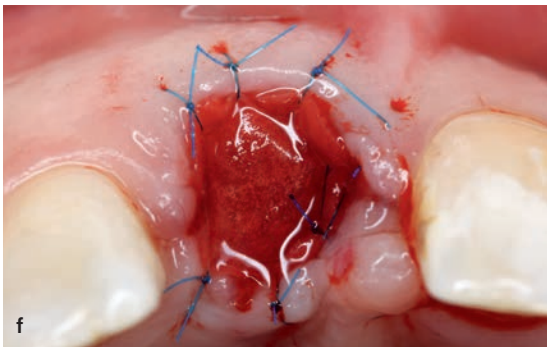
▲ **Fig 1** *(a to d)* Baseline clinical presentation of a hopeless maxillary central incisor planned for extraction and implant site development for future implant therapy. The interproximal attachment loss of the lateral incisor and black triangle between the right central and lateral incisors are visible. *(e)* Periapical radiograph at baseline.



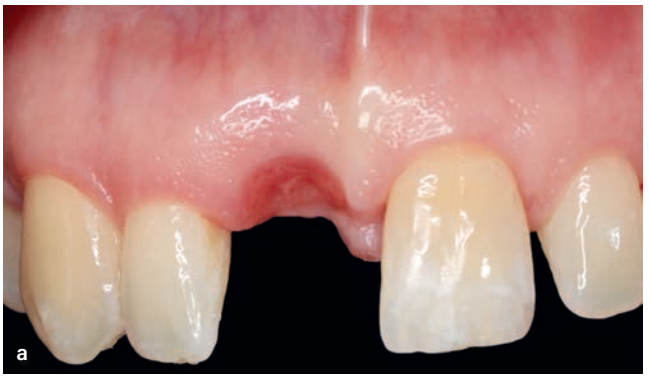
▲ **Figs 2a to 2c** Alveolar ridge preservation. *(a)* The root of the lateral incisor was visible through the socket after extracting the central incisor. *(b)* Interproximal attachment loss of the lateral incisor. *(c)* rhPDGF-BB was applied directly in contact with the lateral incisor root. ⟶



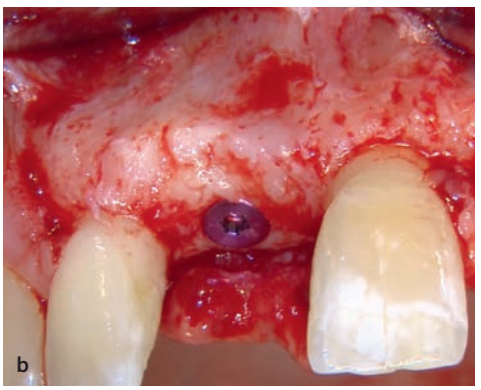


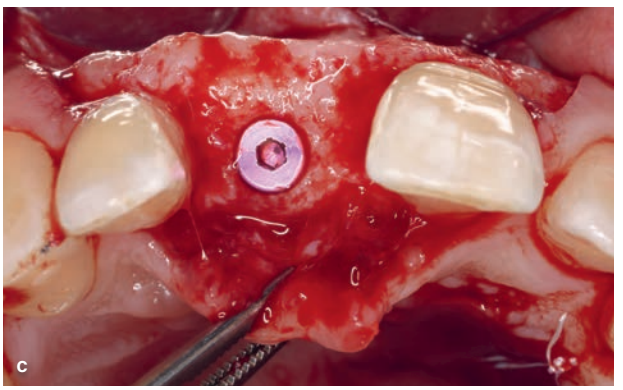


▲ **Figs 2d to 2f** *(d and e)* The bovine bone xenograft particles loaded with rhPDGF-BB were applied. *(f)* The collagen matrix was sutured to seal the socket.

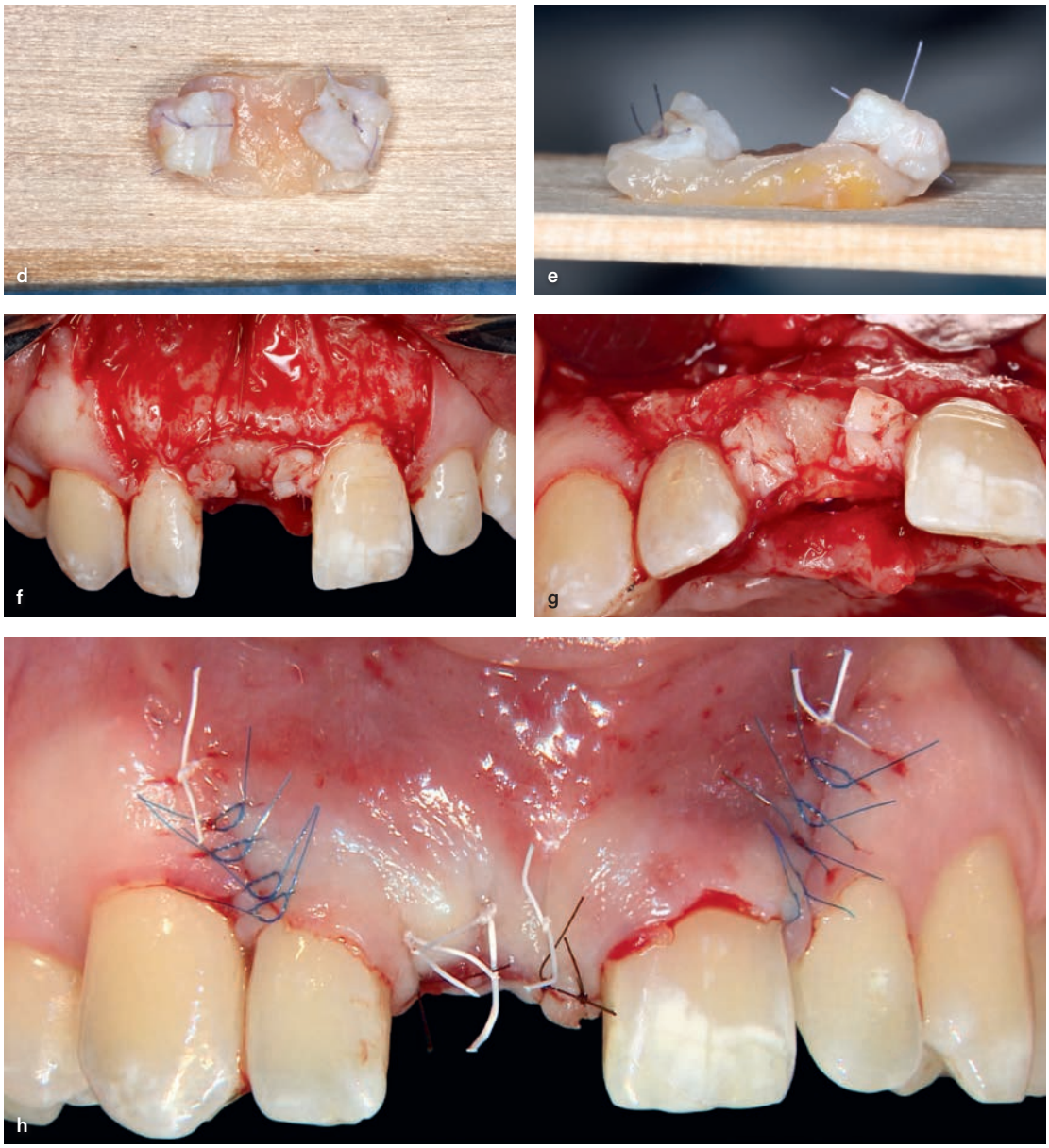


◀ **Figs 3a to 3c** Implant placement and simultaneous vertical soft tissue augmentation with the iCTG technique. *(a)* Preoperative view. *(b and c)* Implant placement. Note the interproximal bone regeneration that was obtained. →





return, an implant (NobelParalell CC, Nobel Biocare) was placed, fully guided, with concomitant soft tissue augmentation using the iCTG approach (see Fig 3). Although a substantial interproximal bone regeneration was achieved, the bony peak was still slightly deficient (Figs 3a to 3c). To compensate for this deficiency, the iCTG approach was utilized, involving a double layer of connective



▲ **Figs 3d to 3h** *(d and e)* The wider CTG was obtained from the palate, while the two smaller pieces, which were folded and sutured to the extremities of the first graft, were derived from the maxillary tuberosity. *(f and g)* Vertical soft tissue augmentation with the iCTG technique. The iCTG was sutured to the recipient bed. *(h)* Flap closure.

tissue graft (CTG) with different origins. An epithelialized graft was harvested from the palate and extraorally deepithelialized to obtain a CTG from the most superficial layers of the palate. An additional autogenous CTG was obtained from the maxillary tuberosity. This graft was divided into two pieces, which were then sutured (6/0 polyglycolic acid) to the distal ends of the wider CTG from the palate (Figs 3d and 3e). The goal of this novel iCTG approach was to provide additional soft tissue volume at the interproximal areas. The composite graft was then sutured on top of the implant platform, using the periosteum and the papillae of the adjacent teeth as anchorage points (Figs 3f and 3g). The buccal flap was then released and coronally advanced to completely cover the graft, aiming to promote primary closure healing (Fig 3h). A Maryland bridge cemented on the two neighboring teeth was used as a temporary restoration.

▲ **Fig 4** Final esthetic outcome 13 months after iCTG augmentation. *(a to c)* Clinical view. The interproximal attachment level gain can be seen at the lateral incisor, and complete papilla reconstruction was obtained between the lateral incisor and the implant. *(d)* Final periapical radiograph. *(e)* Final facial view of the interproximal soft tissue/papilla gain.

The implant was uncovered 4 months after iCTG augmentation, using an X-shaped mini flap design to further support the tissue height. Two incisions (forming an X) were made slightly more palatal than the position of the cover screw. The anterior, mesial, and distal portions of the flap were pushed towards the papillae and towards the buccal aspect as well. After 6 months of soft tissue conditioning with temporary crowns, the case was completed with a permanent, implant-supported restoration (Fig 4).

Discussion

The present manuscript aimed to describe a novel approach for papilla augmentation at implant sites following alveolar ridge preservation and interproximal bone reconstruction. Missing papillae have been a common concern in implant dentistry. Previous attempts to reconstruct papilla at implant sites have included the use of rotated pedicle flaps,[11,12] connective tissue platform augmentation,[4] hyaluronic acid injections,[13]

and combined hard and soft tissue augmentation.[5,6,10] Although papilla loss can be addressed with soft tissue grafting as the sole treatment method, more severe interproximal deficiencies may benefit from a combined approach in which the regenerated interproximal bone supports and improves the results of the soft tissue augmentation procedure.

In the present case, alveolar ridge preservation was performed with autogenous bone chips and bovine bone xenograft particles hydrated with rhPDGF-BB. It has been well-demonstrated that the growth factor promotes angiogenesis of the grafted site and induces periodontal regeneration by enhancing the chemotaxis of cells from the periodontal ligament.[14–17] The application of rhPDGF-BB has been reported as beneficial for periodontal regeneration, soft tissue grafting procedures, and alveolar ridge augmentation.[18–21] The present authors recently showed clinical evidence of periodontal regeneration in a periodontally compromised tooth adjacent to an edentulous site that received bone augmentation and implant placement.[10] Although more studies are necessary to support this speculation, it seems that the use of rhPDGF-BB, and overall biologic agents, can be beneficial when performing bone augmentation procedures around sites with periodontal attachment loss.[19,22]

The need for bone augmentation at implant sites has been supported by several clinical studies, which have shown that a minimal thickness of buccal bone (ie, 1.5 to 2 mm) is necessary to prevent soft tissue dehiscence and peri-implant disease.[23–25] Additionally, a recent study conducted by the present authors demonstrated that buccal bone dehiscence is a risk indicator for developing esthetic complications with implants.[26] In particular, it was observed that for each millimeter increase in the distance between the implant platform and the crestal bone, the odds of developing a peri-implant soft tissue dehiscence increase by approximately 41%.[26] The bone augmentation procedure performed herein, prior to implant placement, had the goal of providing an adequate bone architecture and volume that could be maintained over time, as well as augmenting the interproximal bone levels. Then, with the regenerated bone serving as a "scaffold" to the peri-implant tissues, the novel iCTG soft tissue augmentation approach was performed. Aside from the main goal of reconstructing the interproximal soft tissue, the benefits of soft tissue grafting at implant sites include improved esthetics and color match with the adjacent tissues and higher marginal bone level stability over time.[27–29]

In the present case, although the denuded interproximal root was successfully regenerated, the missing bony peak was not fully reconstructed. The iCTG was developed to address this issue by providing additional vertical soft tissue thickness in areas where the peri-implant papilla lacks adequate support from an ideal bony peak. This was achieved by augmenting the peri-implant supracrestal tissue height and vertical papillae volume. By splitting a second graft from the maxillary tuberosity into two pieces and suturing them to the end of first graft, this approach also reduces the size of the autogenous graft, minimizing patient postoperative discomfort. It should also be highlighted that the maxillary tuberosity has been advocated as the preferred donor site for papilla augmentation procedure due to its composition, which is rich in fibrous connective tissue and tends to increase volume over time.[30]

Lastly, it should be mentioned that the described iCTG approach can be applied not only after alveolar ridge preservation but also in different case scenarios, including but not limited to: implant placement not requiring bone augmentation, implant placement after staged bone reconstruction, treatment of peri-implant soft tissue dehiscences, etc.

Clinical studies evaluating the performance of this novel approach, involving alveolar ridge augmentation and soft tissue augmentation using the iCTG, are needed to further evaluate the outcomes of this technique. Future studies should also explore the use of a single, thicker graft from the tuberosity and the application of soft tissue graft substitutes, such as xenogeneic collagen matrices or acellular dermal matrices, in combination with autogenous CTG or alone, for vertical soft tissue augmentation.

Conclusions

The present report presented the "iceberg" CTG approach for peri-implant papilla reconstruction after alveolar ridge reconstruction and implant placement in the anterior region.

Acknowledgments

The authors would like to thank Dr Andras Forster and Dr Janos Grosz for making the final restoration. The article was self-supported. All authors declare accountability for all aspects of the work. The authors declare no conflicts of interest.

Author contributions:
I.A.U.: surgical intervention, acquisition and interpretation of data, manuscript preparation and the initial draft, and final review of the work.
L.M. and L.T.: outcome interpretation, manuscript preparation and the initial draft, and final review of the work.
H.L.W.: outcome interpretation, critical review, and revision of the work.

References

1. Urban IA, Barootchi S, Tavelli L, Wang HL. Inter-implant papilla reconstruction via a bone and soft tissue augmentation: A case report with a long-term follow-up. Int J Periodontics Restorative Dent 2021;41:169–175.
2. Rasperini G, Tavelli L, Barootchi S, et al. Interproximal attachment gain: The challenge of periodontal regeneration. J Periodontol 2021;92:931–946.
3. Zucchelli G, Tavelli L, Stefanini M, et al. Classification of facial peri-implant soft tissue dehiscence/deficiencies at single implant sites in the esthetic zone. J Periodontol 2019;90: 1116–1124.
4. Stefanini M, Marzadori M, Tavelli L, Bellone P, Zucchelli G. Peri-implant papillae reconstruction at an esthetically failing implant. Int J Periodontics Restorative Dent 2020;40:213–222.
5. Urban IA, Klokkevold PR, Takei HH. Abutment-supported papilla: A combined surgical and prosthetic approach to papilla reformation. Int J Periodontics Restorative Dent 2016;36:665–671.
6. Urban IA, Klokkevold PR, Takei HH. Papilla reformation at single-tooth implant sites adjacent to teeth with severely compromised periodontal support. Int J Periodontics Restorative Dent 2017;37:9–17.
7. Perez F, Martins Segalla JC, Ferreira PM, Pereira Lauris JR, Rabelo Ribeiro JG. Clinical and radiographic evaluation of factors influencing the presence or absence of interproximal gingival papillae. Int J Periodontics Restorative Dent 2012;32:e68–e74.
8. Chen MC, Liao YF, Chan CP, Ku YC, Pan WL, Tu YK. Factors influencing the presence of interproximal dental papillae between maxillary anterior teeth. J Periodontol 2010;81:318–324.
9. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. J Periodontol 1992;63:995–996.
10. Urban IA, Tattan M, Ravida A, Saleh MH, Tavelli L, Avila-Ortiz G. Simultaneous alveolar ridge augmentation and periodontal regenerative therapy leveraging recombinant human platelet-derived growth factor-BB (rhPDGF-BB): A case report. Int J Periodontics Restorative Dent 2022;42:577–585.
11. Tinti C, Benfenati SP. The ramp mattress suture: A new suturing technique combined with a surgical procedure to obtain papillae between implants in the buccal area. Int J Periodontics Restorative Dent 2002;22:63–69.
12. Palacci P, Nowzari H. Soft tissue enhancement around dental implants. Periodontol 2000 2008;47:113–132.
13. Becker W, Gabitov I, Stepanov M, Kois J, Smidt A, Becker BE. Minimally invasive treatment for papillae deficiencies in the esthetic zone: A pilot study. Clin Implant Dent Relat Res 2010;12:1–8.
14. Matsuda N, Lin WL, Kumar NM, Cho MI, Genco RJ. Mitogenic, chemotactic, and synthetic responses of rat periodontal ligament fibroblastic cells to polypeptide growth factors in vitro. J Periodontol 1992;63:515–525.
15. Cho MI, Lin WL, Genco RJ. Platelet-derived growth factor-modulated guided tissue regenerative therapy. J Periodontol 1995;66:522–530.
16. Dennison DK, Vallone DR, Pinero GJ, Rittman B, Caffesse RG. Differential effect of TGF-beta 1 and PDGF on proliferation of periodontal ligament cells and gingival fibroblasts. J Periodontol 1994;65:641–648.
17. Lynch SE, Williams RC, Polson AM, et al. A combination of platelet-derived and insulin-like growth factors enhances periodontal regeneration. J Clin Periodontol 1989;16:545–548.
18. Tavelli L, Ravida A, Barootchi S, Chambrone L, Giannobile WV. Recombinant human platelet-derived growth factor: A systematic review of clinical findings in oral regenerative procedures. JDR Clin Trans Res 2021;6:161–173.
19. Avila-Ortiz G, Ambruster J, Barootchi S, et al. American academy of periodontology best evidence consensus statement on the use of biologics in clinical practice. J Periodontol 2022;93:1763–1770.
20. Tavelli L, Chen CY, Barootchi S, Kim DM. Efficacy of biologics for the treatment of periodontal infrabony defects: An American Academy of Periodontology best evidence systematic review and network meta-analysis. J Periodontol 2022;93:1803–1826.
21. Suarez-Lopez Del Amo F, Monje A. Efficacy of biologics for alveolar ridge preservation/reconstruction and implant site development: An American Academy of Periodontology best evidence systematic review. J Periodontol 2022;93:1827–1847.
22. Urban IA, Tattan M, Ravida A, Saleh M, Tavelli L, Avila-Ortiz G. Simultaneous alveolar ridge augmentation and periodontal regenerative therapy leveraging recombinant human platelet-derived growth factor-BB (rhPDGF-BB): A case report. Int J Periodontics Restorative Dent 2022;42:577–585.
23. Sanz-Martin I, Regidor E, Navarro J, Sanz-Sanchez I, Sanz M, Ortiz-Vigon A. Factors associated with the presence of peri-implant buccal soft tissue dehiscences: A case-control study. J Periodontol 2020;91:1003–1010.
24. Monje A, Chappuis V, Monje F, et al. The critical peri-implant buccal bone wall thickness revisited: An experimental study in the beagle dog. Int J Oral Maxillofac Implants 2019;34:1328–1336.
25. Monje A, Galindo-Moreno P, Tozum TF, Suarez-Lopez del Amo F, Wang HL. Into the paradigm of local factors as contributors for peri-implant disease: Short communication. Int J Oral Maxillofac Implants 2016;31:288–292.
26. Tavelli L, Barootchi S, Majzoub J, et al. Prevalence and risk indicators of midfacial peri-implant soft tissue dehiscence at single site in the esthetic zone: A cross-sectional clinical and ultrasonographic study. J Periodontol 2022;93:857–866.

27. Jung RE, Holderegger C, Sailer I, Khraisat A, Suter A, Hammerle CH. The effect of all-ceramic and porcelain-fused-to-metal restorations on marginal peri-implant soft tissue color: A randomized controlled clinical trial. Int J Periodontics Restorative Dent 2008;28:357–365.
28. Mancini L, Barootchi S, Thoma DS, et al. The peri-implant mucosa color: A systematic appraisal of methods for its assessment and clinical significance. Clin Implant Dent Relat Res 2023;25:224–240.
29. Tavelli L, Barootchi S, Avila-Ortiz G, Urban IA, Giannobile WV, Wang HL. Peri-implant soft tissue phenotype modification and its impact on peri-implant health: A systematic review and network meta-analysis. J Periodontol 2021;92:21–44.
30. Tavelli L, Barootchi S, Greenwell H, Wang HL. Is a soft tissue graft harvested from the maxillary tuberosity the approach of choice in an isolated site? J Periodontol 2019;90:821–825.

Istvan A. Urban, DMD, MD, PhD
Urban Regeneration Institute, Budapest, Hungary; Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA; Department of Oral Medicine, Infection, and Immunity, Division of Periodontology, Harvard School of Dental Medicine, Boston, Massachusetts, USA.

Leonardo Mancini, DDS, PhD
Department of Oral Medicine, Infection, and Immunity, Division of Periodontology, Harvard School of Dental Medicine, Boston, Massachusetts, USA; Department of Life, Health and Environmental Sciences, University of L'Aquila, L'Aquila, Italy; Center for Clinical Research and Evidence Synthesis in Oral Tissue Regeneration (CRITERION), Ann Arbor, Michigan, USA.

Hom-Lay Wang, DDS, MS, PhD
Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA.

Lorenzo Tavelli, DDS, MS, PhD
Department of Oral Medicine, Infection, and Immunity, Division of Periodontology, Harvard School of Dental Medicine, Boston, Massachusetts, USA; Center for Clinical Research and Evidence Synthesis in Oral Tissue Regeneration (CRITERION), Ann Arbor, Michigan, USA.

Correspondence to:
Dr Istvan A. Urban, istvan@implant.hu