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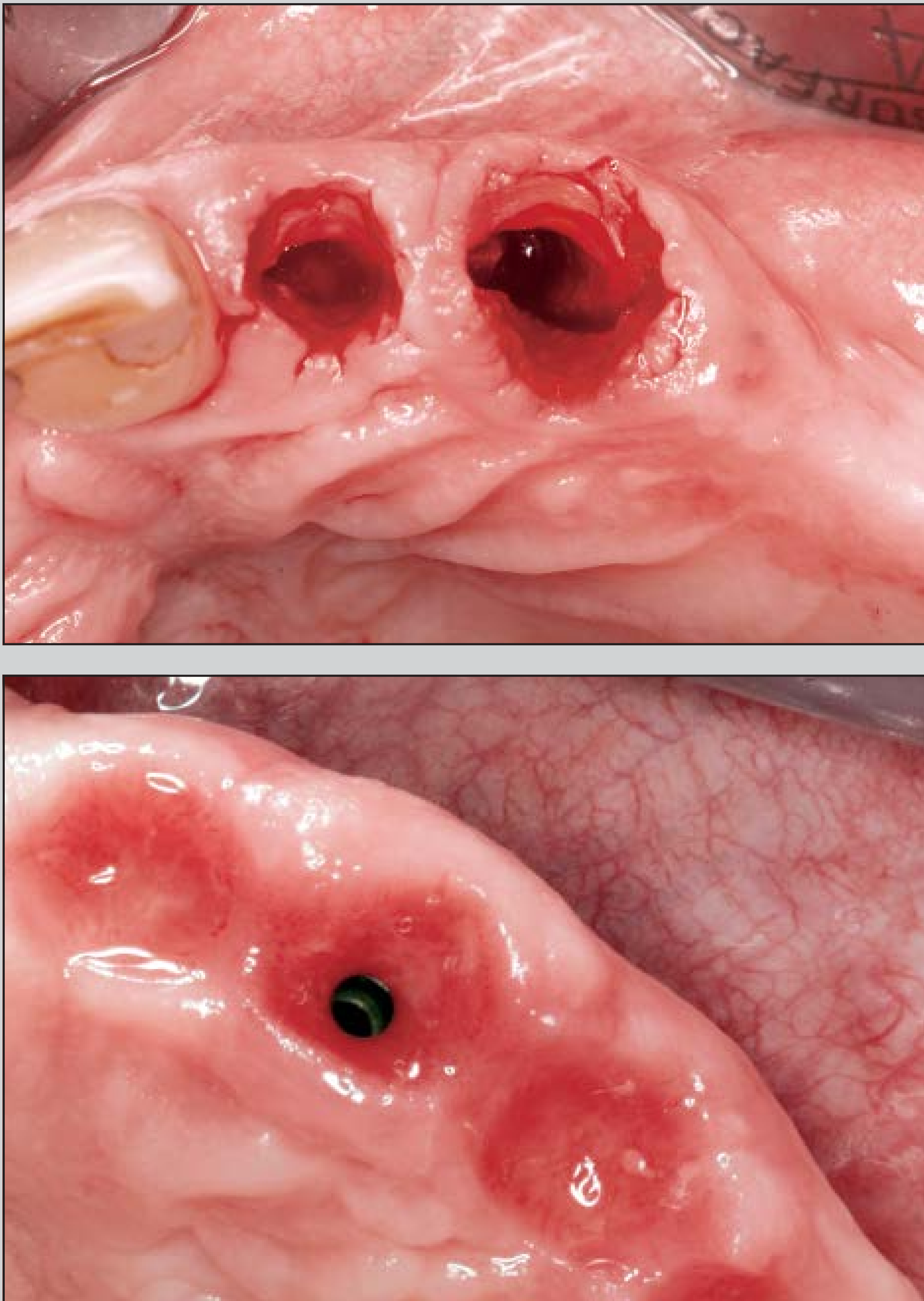

The Pontic-Shield: Partial Extraction Therapy for Ridge Preservation and Pontic Site Development

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Augmentive ridge preservation techniques aim to manage the postextraction ridge. The partial extraction of teeth may better preserve the ridge form by maintaining the bundle bone–periodontal ligament apparatus. Root submergence has been demonstrated to retain the periodontal tissues and preserve the ridge beneath dentures or fixed prostheses. The socket-shield technique entails preparing a tooth root section simultaneous to immediate implant placement and has demonstrated histologic and clinical results contributory to esthetic implant treatment. A retrospective 10-patient case series treating 14 partial extraction sites demonstrates how a modification of the socket-shield technique can successfully develop pontic sites and preserve the ridge. Int J Periodontics Restorative Dent 2016;36:417–423. doi: 10.11607/prd.2651

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Resorption of the alveolar ridge commences immediately postextraction, is more pronounced on the buccal aspect, plateaus after 3 months of healing, and may result in as much as 56% loss of the residual ridge.[1] This loss occurs as a result of the destruction of the bundle bone–periodontal ligament (BB–PDL) complex following the removal of a tooth and leads to resorption of the buccofacial ridge contour.[2] Positioning a pontic restoration at a missing tooth site requires residual ridge tissue bulk and a positive contour to create esthetic harmony between the restoration and the alveolar ridge. It is a well-established concept that to ideally or even adequately restore an edentulous or partially dentate patient in most instances requires management of these extraction sites either to prevent tissue loss or to augment the already collapsed tissues.[3,4] These may be divided into pre–ridge collapse interventions, namely ridge preservation techniques, and post–ridge collapse interventions, namely bone augmentation, soft tissue augmentation, or a combination thereof.[3–6]

To maintain this tissue complex the tooth root, its ligament fibers, its vascular supply, and its attachment to bone need to be retained.[7] The root submergence concept has been demonstrated with success in the development of pontic sites.[8]

Table 1 Tabulated methodologies and outcomes of the pontic-shields (n = 14) in the 10 patients

Patients (no.)	Socket-shield(s) (no.)	Socket-closure technique	Healing	Complications	Further treatment needed
4	5	Buccal flap advancement	Complete	–	–
1	3	No flap closure	Incomplete healing in all 3 sockets	Exposure of the shield	Exposure of the shields requiring surgical closure
1	1	Placement of cytoplast membrane	Complete with wider band of attached gingiva	–	–
2	3	Socket-seal technique	Complete healing, took longer	–	–
2	2	Zuchelli free gingival graft closure with buccal and palatal pouch	Complete healing with excellent soft tissue contours	–	–

An infection-free tooth root, whether endodontically treated or with a vital pulp, may when submerged support the ridge architecture to develop a pontic site.[9] The technique, however, is contraindicated by endodontic apical pathology. Successful endodontic treatment would first be needed, or the root would need extraction and an alternative ridge management applied.

The socket-shield technique, in addition to its application as a buccofacial ridge preservation technique at immediate implant placement, overcomes this limitation and provides the clinician with an alternative method to submerge the buccofacial tooth root section, retain the vital periodontal tissues buccofacial to the root, and develop a pontic site with little or no collapse in a buccopalatal dimension.[7] This report presents a case series of 14 sites in 10 patients treated with a modification of the technique, the pontic-shield.

Materials and methods

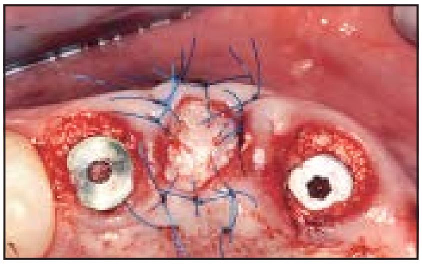
Ten adult patients of either gender, free of contributory medical conditions, presented for restorative implant therapy. Neither smoking nor apical pathology contraindicated treatment. Pontic sites (n = 14) were developed in each patient by preparing a pontic-shield with adjunct augmentation materials within the extraction sockets. The sites were left to heal for a minimum of 90 days and the ridge at the pontic sites developed by moderate pontic pressure of an interim fixed partial denture (FPD) for an additional 90 days. Final restorations were placed once the sockets had fully healed without clinical evidence of pontic-shield exposure.

Socket-shield technique

The first step was to prepare a socket-shield. The preparation of the socket-shields was standardized in its methodology and its instrumentation and was carried out by the same clinician. The tooth roots at desired pontic sites were sectioned along their long axes as far apical as possible in a mesiodistal direction with a long shank root resection bur (Komet Dental). This was intended to preserve the buccofacial half of the tooth root intact and undamaged. Periotomes were inserted between the palatal root section and alveolar socket wall to sever the PDL, and this section of root was then carefully delivered (with attached apical pathology, if present) so as not to disturb the facial root section. The remaining root section was then shaped and reduced coronally to 1 mm above the alveolar crest as well as thinned slightly and concaved by careful application in an apicocoronal direction using a long-shanked, large, round diamond bur (Komet Dental). The tooth socket apex was then curetted to remove any remnant of infection, and each facial root section was checked for immobility by applying a sharp probe to its surface. Once they were fully prepared, these root sections were thus the socket-shields.

Modifying the technique as a pontic-shield

All sockets were additionally grafted with a xenogeneic bone particulate (Gen-Os, Osteobiol). Closure of the



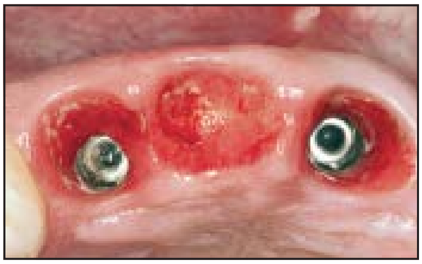


Fig 1 (left) *Socket-shields prepared at sites 12, 11, 21, and 23, with implants inserted immediately at 12, 21, and 23. The socket-shield at 11 with socket grafting and soft tissue closure thereafter completes preparation of the site as a pontic-shield.*

Fig 2 (right) *Immediate grafting of the postextraction socket at site 11 with xenogeneic bone particulate.*

Fig 3 (left) *CTG at the entrance to site 11.*

Fig 4 (right) *90 days of healing with an additional 90 days of pontic pressure developed an anatomical soft tissue frame to receive the final prosthesis. Note the total absence of buccopalatal collapse at site 11 due to the pontic-shield.*

sockets was achieved by buccal flap advancement (five socket sites), Zucchelli connective tissue graft (CTG) inserted into buccal and palatal pouches (two sites), cytoplast membrane (one site), and socket-seal technique (three sites). Three sites were initially managed without closure (Table 1). The following three cases are representative.

Case report 1

An adult male patient presented for treatment of a failing five-unit FPD. The prosthodontic treatment had been carried out several years prior and following several recementations the abutment teeth lacked adequate ferrules and proved unsuitable to support the restoration. The patient had lost tooth 22 (FDI) and the ridge collapse was evident (Fig 1). The abutment teeth were deemed nonrestorable and an implant-supported FPD was planned at sites 12, 21, and 23.

Use of the pontic-shield procedure was planned for sites 11 and 22. Apical pathology at site 11 precluded the use of the root-submergence technique. Tooth root 11 was then prepared as a pontic-shield. The socket was filled with a xenograft bone particulate and the entrance sealed by CTG placed within a buccal and palatal pouch (Figs 2 and 3). After 90 days of healing, an interim prosthesis was fixed to the neighboring implants and a pontic applied prolonged pressure for an additional 90 days to the ridge crest at site 11. The absence of buccopalatal collapse was evident, and an esthetic pontic site with pseudopapillae was successfully developed (Fig 4). At the 18-month follow up, the results had been maintained (Figs 5 and 6).

Case report 2

An adult male patient presented for treatment with a partially edentulous anterior maxilla. The patient was a smoker, though the medical history was noncontributory. A FPD restored the edentulous space in the anterior maxilla with teeth 13, 11, and 22 as abutments. An implant-supported FPD was planned. However, the ridge at sites 12 and 21 had resorbed greatly and would require augmentation prior to implant placement. To prevent further collapse at site 11, ridge preservation was planned with the pontic-shield technique. Since an apical endodontic infection contraindicated the use of root submergence, the tooth was sectioned and a pontic-shield prepared. The socket was filled with a xenograft bone particulate and the socket entrance closed by the socket-seal technique as described by Landsberg.[10] A 2- to 3-mm-thick, circular free gingival graft was harvested from the palatal mucosa and transferred to the de-epithelialized socket entrance. Healing of the socket was, however, prolonged in comparison with the other cases (Table 1) to ensure complete resolution of the apical pathology at site 11. After 4 months of healing, the ridge preserved at site 11 allowed for bone augmentation at sites 12 and 21 that did not extend outside of the bony envelope.

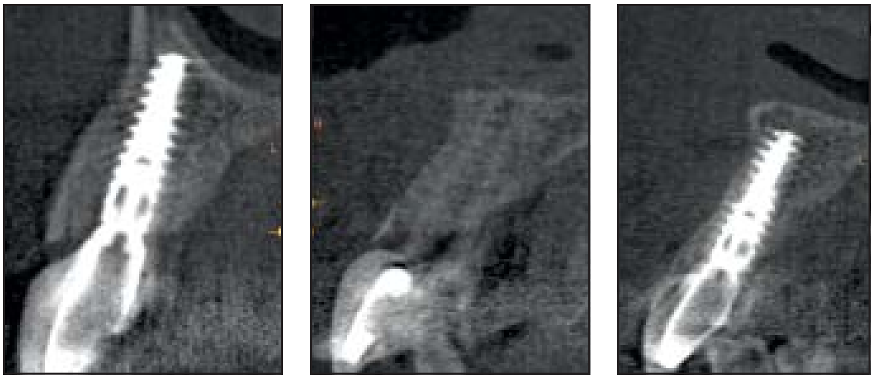


Fig 5 *Postoperative CBCT, sliced at site 11 of the healed pontic-shield.*

Fig 6 (right) *Oblique view of the anterior maxilla illustrating the lack of collapse at the 1-year follow-up.*

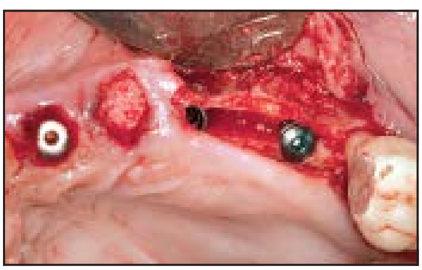


Fig 7 *Xenograft particulate placed within socket 23 (with sinus augmentation and ridge-split carried out in 24 to 26).*

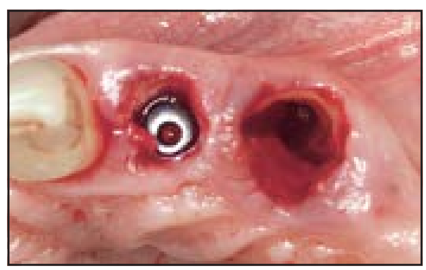


Fig 8 *Tooth 21 was planned for root submergence, 22 was immediately placed with a socket-shield, and tooth 23 was planned as a pontic-shield.*

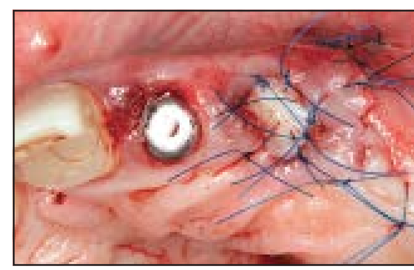


Fig 9 *Final closure of the pontic-shield at site 23 with CTG.*

Fig 10 *Note the absence of buccopalatal collapse at the pontic-shield site at 23, comparable with the adjacent partial extraction treatments.*

Case report 3

An adult female patient presented with a failing dentition in the left maxilla. An implant-supported FPD was planned with strategic implant placement and pontic sites to be developed. A ridge split procedure with sinus augmentation was planned at sites 24 to 26 (Fig 7). Tooth 22 was prepared as a socket-shield at implant placement. Tooth 11, however, had a horizontal fracture contraindicating a socket-shield technique at placement. The tooth was removed and an implant immediately placed. Tooth 21 was free of apical pathology, and a pontic site was prepared by a root submergence technique, sealing the socket entrance by rotated palatal flap. Tooth 23 was prepared as a pontic-shield (Fig 8), the socket was filled with a xenograft bone particulate, and the site was closed (Fig 9). All sites were left to heal and the implants to osseointegrate for a minimum of 90 days, after which an interim FPD was fitted to the implants and the soft tissue developed with gradual pontic pressure for an additional 90 days. Both pontic sites at 21 and 23 were successfully sculpted to accommodate the final restoration, the ridge width was maintained, and the tissues were prevented from collapsing (Fig 10). There was no evidence of pathology or exposure of the pontic-shield.

Results

Of the 14 sites treated using the pontic-shield technique, noticeable ridge preservation quantified by subjective observation was achieved in all cases at the 12- and 18-month follow-ups. Assessment of the treatment outcomes as viewed from the occlusal and facial aspects demonstrated ridge preservation at all 14 sites using this partial extraction technique. In one patient, treatment was complicated by exposure of all 3 pontic-shields as a result of omitting soft tissue closure of the sites. Healing in this patient was prolonged and required buccal flap advancement for closure of the sites. An eventual positive outcome and ridge preservation was achieved. Healing was uneventful in all other patients (see Table 1). Results remained stable, and the pontic sites' tissues were healthy at the 18-month follow-up (Figs 5, 6, 11, and 12).

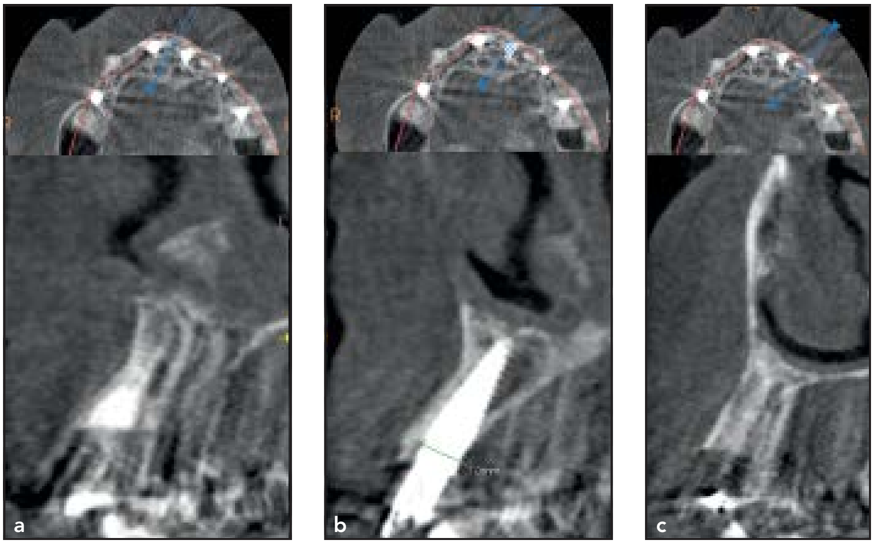


Fig 11 *CBCT slices of sites* (a) *21,* (b) *22, and* (c) *23 at the 1-year follow-up.*

Fig 12 (right) *The healed pontic-shield at site 23 at the 1-year follow-up.*

Discussion

Following tooth extraction, the tissues resorb as a direct result of the destruction of the BB-PDL-tooth complex.[2] BB arises from a functionally loaded PDL and is lost following extraction, which results in an almost certain collapse of residual buccofacial tissues.[11] A healed ridge defect following tooth extraction may require extensive surgical intervention prior to definitive restorative treatment. This may involve guided bone regeneration (GBR) techniques using bone and/or bone substitute materials with a barrier membrane, bone block GBR procedures, ridge-split techniques, and so forth. All of these may provide hard tissue gains, though with limitations, and with the drawbacks of increased morbidity, technique sensitivity, increased costs, and difficulty of access to materials.[3] The soft tissue alterations are also a challenge, with loss of papillae, scarring from the ridge augmentation procedure, and so forth.[6] Root submergence was originally introduced as a technique to preserve alveolar ridge volume beneath removable full prostheses.[12,13] More than three decades ago, Malmgren et al reported successful bone regeneration around submerged tooth roots, that bone forms coronal to such submerged teeth, and that even new cementum and connective tissue may form coronally over submerged teeth.[8] Preserving the entire attachment apparatus for complete preservation of the alveolar ridge for pontic site development has been demonstrated.[9] This technique involves decoronation of the tooth at the bone crest or, preferably, 1 to 2 mm above the crest to

Table 2 Available case reports and literature reporting on the socket-shield technique

Year	Author(s)	Study
2015	Bäumer et al[14]	Animal histology of three cases of socket-shield with vertical fractures
2014[a]	Siormpas et al[17]	46 case series of the root-membrane technique with follow up from 2 to 5 years
2014	Holbrook[20]	Case report: Guided implant placement with socket-shield
2014[a]	Glocker et al[16]	3 case series of a modified socket-shield for delayed placement
2014[a]	Cherel and Etienne[19]	1 case report of modified socket-shield for papillae preservation
2013[a]	Kan and Rungcharassaeng[18]	1 case report of proximal socket-shield for papillae preservation
2013	Chen and Pan[15]	1 case report of socket-shield with immediate implant placement
2010	Hürzeler et al[7]	Original proof of principle report of animal histology following socket-shield and 1 clinical case report

[a]Not the actual socket-shield technique, but a version thereof.

preserve the supracrestal fibers with epithelial and connective tissue attachment.

Preservation of supracrestal fibers can better develop pontic sites by papillae preservation.[7,9] Root submergence can achieve this and is indicated in vital and nonvital tooth roots alike. However, periapical pathology contraindicates the use of submerged roots for developing pontic sites. Hürzeler et al were the first to report the socket-shield technique. Initially the procedure was applied to an immediate implant placement protocol, but its use in a far wider variety of applications and even in managing complications can be expected.[7] The histology from Hürzeler et al's first report of the socket-shield technique confirmed a retained attachment of the socket-shield to the buccal plate via a physiologic PDL free of any inflammatory response. The buccal plate crest showed an absence of osteoclastic activity—an absence of active remodeling. The coronal soft tissue demonstrated a physiologic junctional epithelium free of any inflammatory response that formed an attachment and junction at the newly formed cementum on the internal surface of the socket-shield. The working group of the original protocol later reported bone fill between the socket-shield and the implant.[14]

The pontic-shield should not be overprepared, since overthinning of the root may leave it unstable and flexure could lead to failure. Salama et al reported that root submergence for pontic site development may be left open to heal by secondary intention, but the pontic-shield must heal by surgical closure of the soft tissue.[9] The complications seen in this case series may be attributed to the sites not surgically receiving soft tissue closure. The best results were seen when the Zucchelli CTG was inserted into buccal and palatal pouches to close the socket entrance. It is thus recommended that these steps be reproduced in carrying out the pontic-shield technique.

A discussion on the topic of the socket-shield and pontic-shield would be incomplete without mention of the limitations. These partial extraction treatments are still very early in their application, and a review of the literature returns only eight publications to date of the socket-shield (Table 2). Also worth noting is an inconsistency in nomenclature. For clarification, Siormpas et al published a 5-year retrospective case series of immediate implant placement simultaneous to the root-membrane technique.[17] This publication came 4 years after the first histologic and clinical data on the socket-shield technique were reported in the literature. However, Siormpas et al were the first to provide significant long-term data on this partial extraction methodology, as well as on a significant number of implant sites and patients (n = 46). Their results showed 100% osseointegration in all cases. Their case series measured crestal bone height, mesial and distal, at the extraction sites, and showed crestal bone loss as little as 0.18 ± 0.09 and 0.21 ± 0.09 mm, respectively. Data to demonstrate a lack of buccopalatal collapse would have been useful.

The difference in methodology is important. Siormpas et al prepared the implant osteotomy site by drilling through the existing and intact tooth root. After preparation of the osteotomy, buccal and lingual root sections were separated. This differs from the original socket-shield methodology, as used in the present case series. Drilling through the tooth root may be detrimental to the implant drills and may damage the attachment of the socket-shield to the buccal BB. Siormpas et al report no complication in this regard.[17] The present authors suggest fully preparing the socket-shield prior to preparation of the pontic site or even implant placement.

Absolute preservation has not been demonstrated with the socket-shield technique. Bäumer et al found a mean loss of 1 mm in a labial direction after the placement of the final restorations.[14] Chen et al in their case report measured 0.72 mm of buccal resorption.[15] The present case series lacked objective methodology to measure any potential loss in ridge width and height following healing of the pontic sites. The results were measured subjectively to ascertain esthetic outcomes in development of the ridge to accommodate a pontic restoration. It is advised that future clinical studies be carried out that include digital ridge scans to compare preservation of the tissues from this technique to a control, possibly established socket/ridge preservation techniques, and sites healing without intervention.

Conclusions

This case series demonstrates the pontic-shield technique as a partial extraction therapy for development of pontic sites. Additional research, documentation, and scientific scrutiny are needed to validate application of the technique in daily clinical practice.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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