Partial Extraction Therapy (Part 2): Complication Management in Full-Arch Dental Implant Therapy

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Partial extraction therapy (PET) is a group of surgical techniques that preserve the periodontium and peri-implant tissues during restorative and implant therapy by conserving a portion of the patient's own root structure to maintain the blood supply, derived from the periodontal ligament complex. PET includes the socket shield technique (SST), proximal shield technique (PrST), pontic shield technique (PtST), and root submergence technique (RST). Although their clinical success and benefits have been demonstrated, several studies report possible complications. The focus of this article is to highlight management strategies for the most common complications associated with PET, including internal root fragment exposure, external root fragment exposure, and root fragment mobility.
Int J Periodontics Restorative Dent 2023;43:571–577. doi: 10.11607/prd.6127

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Submitted December 6, 2021; accepted February 16, 2022.

Following tooth loss or dental extraction, alveolar ridge resorption and tissue dimensional changes represent significant challenges for the restorative and implant rehabilitation of edentulous areas.[1–3] Historically, clinicians have attempted to preserve the alveolar ridge and limit bone loss by intentionally submerging root remnants. Utilizing submerged roots to maintain the periodontal ligament (PDL) complex and stabilize the alveolar ridge associated with pontic regions of fixed dental prostheses and complete dentures has been repeatedly described since the 1970s.[4]

In the past decade, partial extraction therapy (PET) techniques have emerged as alternative treatment modalities to preserve the alveolar ridge architecture.[5,6] PET is a group of surgical techniques that includes the socket shield technique (SST), root membrane technique (RMT), proximal shield technique (PrST), pontic shield technique (PtST), and root submergence technique (RST). These techniques utilize the patient's root structure to maintain blood supply, derived from the PDL complex, in order to preserve the periodontium and peri-implant tissues during restorative and implant therapy.[5,7–12]

Total extraction and full-arch implant therapy often require a significant amount of bone reduction and palatolingual implant placement.[13,14] A previous case report[15] by the

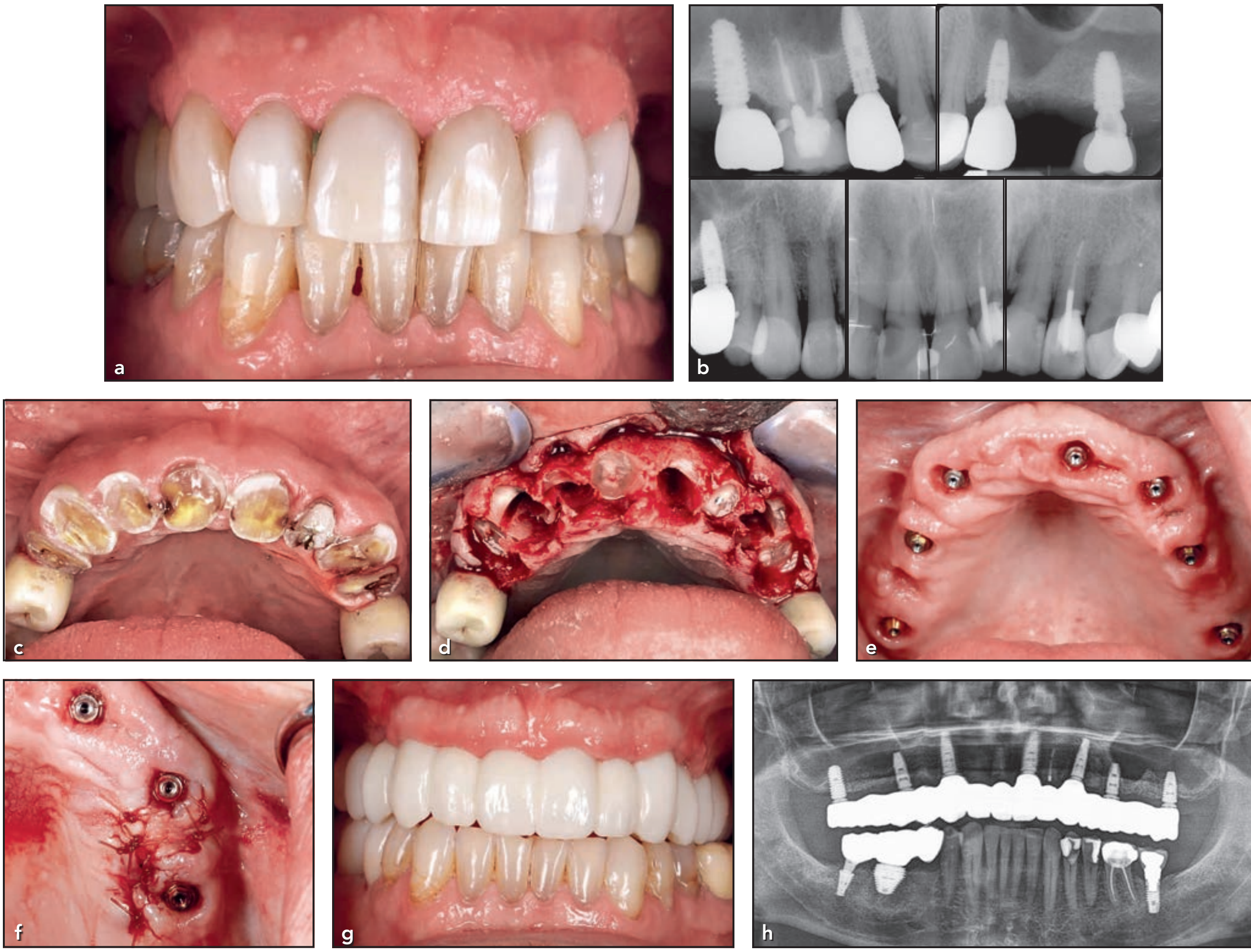

Fig 1 *Case 1: Management of internal shield exposure.* (a) *Initial clinical and* (b) *radiographic presentation.* (c) *The first step in shield preparation involves reducing the crown aspects to the bone level, followed by RST and SST preparation.* (d) *A combination of RST and SST were performed.* (e) *The healed ridge revealed a small internal shield exposure.* (f) *A rotated palatal pedicle graft was used to close the exposure.* (g) *The final prosthesis was inserted.* (h) *Panoramic radiographic view of the final result.*

present authors demonstrated the use of a combination of PET techniques and minimally traumatic extraction to achieve highly esthetic outcomes for full-arch implant therapy.

As PETs gain popularity in the clinical arena, with numerous clinical studies demonstrating their benefits, several clinical studies and case reports have shown that complications may occur.[8,16–19] A majority of these complications are manageable without implant loss. To ensure predictable treatment outcomes and quality patient care, it is paramount for clinicians to understand the prevention and management of complications associated with PET. In this article, methods to manage the most commonly encountered complications are discussed, and cases with various clinical scenarios are presented, including internal root fragment exposure, external root fragment exposure, and root fragment mobility.

Clinical Cases

Case 1: Internal Shield Exposure Management

Case 1 demonstrates internal exposure of a root fragment as part of a maxillary immediately loaded implant-supported fixed partial denture case involving multiple SST treatments. A healthy 59-year-old man presented to the clinic with previous implants in the posterior maxilla (Fig 1a).

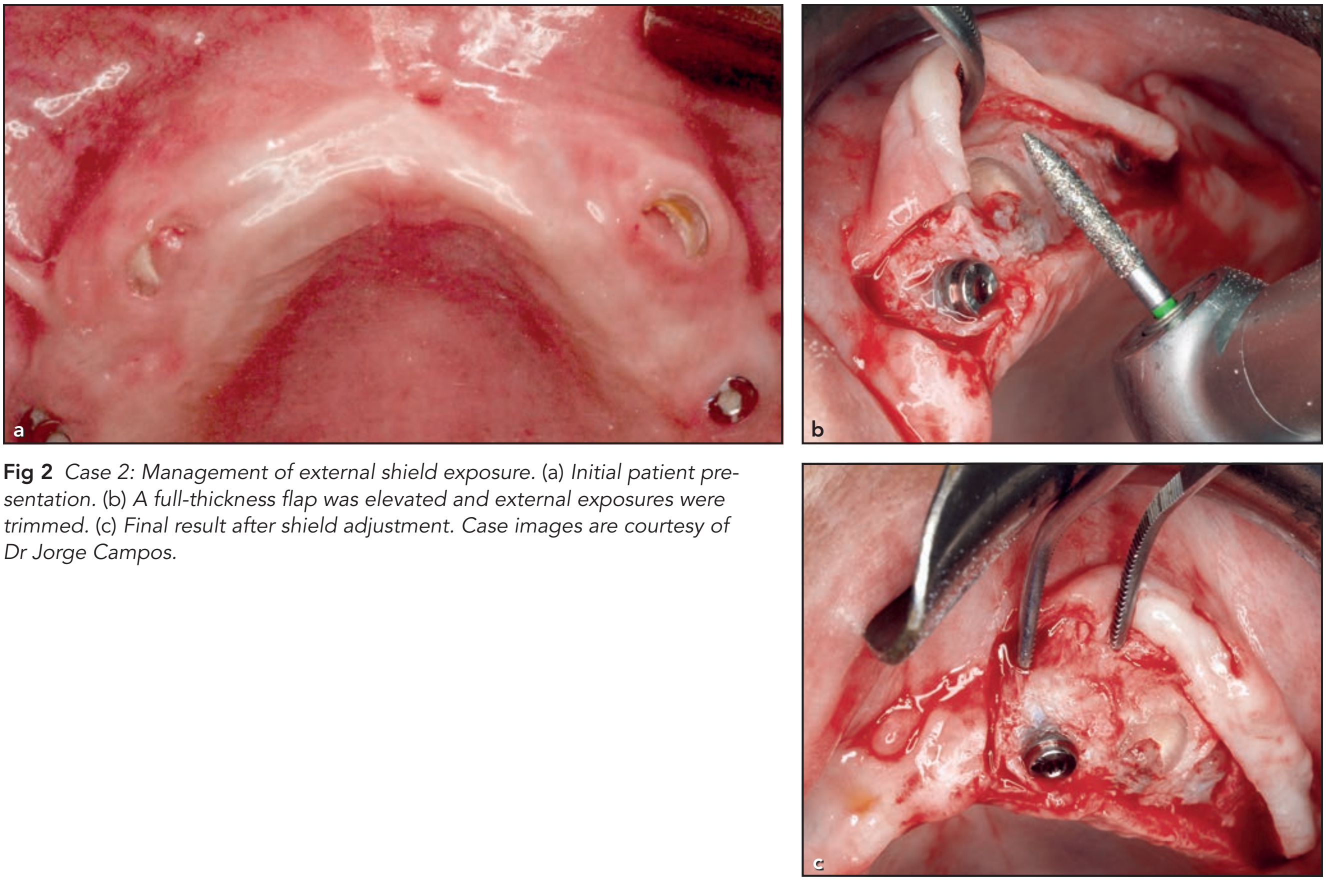

Fig 2 *Case 2: Management of external shield exposure.* (a) *Initial patient presentation.* (b) *A full-thickness flap was elevated and external exposures were trimmed.* (c) *Final result after shield adjustment. Case images are courtesy of Dr Jorge Campos.*

Radiographic examination revealed multiple teeth with a hopeless prognosis due to extensive root caries (Fig 1b). After presentation of treatment options, including a thorough discussion of further crown and bridge options with endodontic treatment, the patient chose to pursue an implant-supported full-arch option for the maxilla. A combination of SST and RST was performed to preserve buccal hard and soft tissues in conjunction with immediate implant placement (Figs 1c and 1d). After a 3-month healing period with an immediately loaded temporary restoration, a small internal shield exposure was observed (Fig 1e). Management of this complication includes adjusting the temporary prosthesis to relieve pressure on the edentulous area and using a rotated palatal subepithelial connective tissue pedicle graft to cover the exposed aspect (Fig 1f). Once tissue maturation was confirmed, fabrication of the definitive monolithic zirconia final prosthesis was completed (Fig 1g). Figure 1h shows the final panoramic radiograph after insertion.

Case 2: External Shield Exposure

Case 2 demonstrates a full-arch maxillary reconstruction using a two-stage approach. External root fragment exposures were observed on the canine socket shields, which needed to be reshaped (Fig 2a). A full-thickness flap was raised to allow for adequate visualization. The exposed shield was trimmed down to the level of the surrounding alveolar bone to ensure no sharp ledges were present (Fig 2b) Figure 2c shows the final position of the root fragment in relation to the bone crest. Any high-pressure or friction points from the prosthesis should be relieved and adjusted to avoid additional exposures.

Case 3: Management of Shield Mobility

In some circumstances, the SST or PtST can become mobile during the initial healing stage. This may be due to inadequate length of the prepared

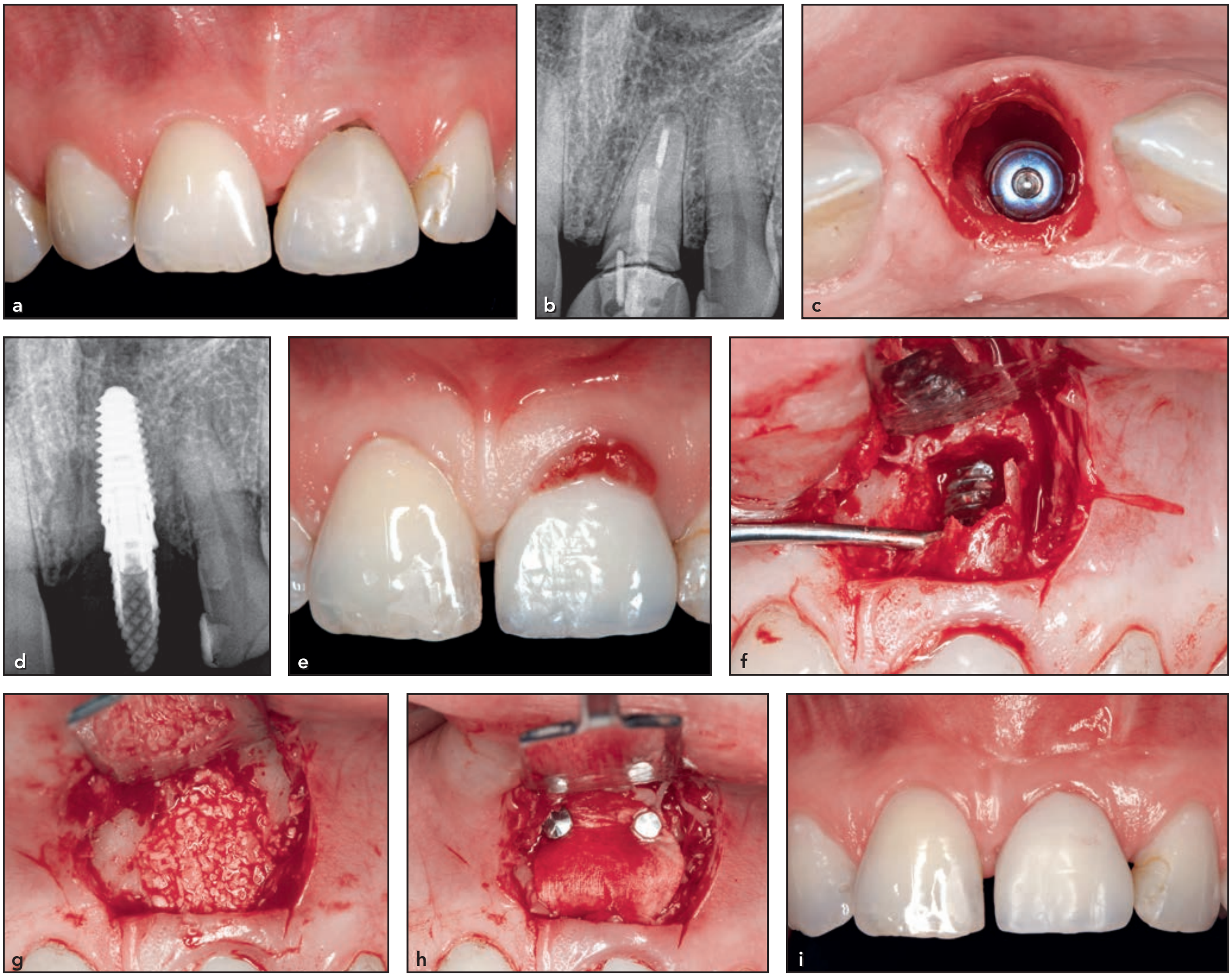

Fig 3 *Case 3: Management of socket shield mobility.* (a and b) *Initial clinical and peri-apical radiographic presentation.* (c and d) *The SST procedure was performed with immediate implant placement.* (e) *At 2 weeks postoperative, soft tissue granulation tissue was noted.* (f) *An esthetic buccal flap was raised to remove the loose shield.* (g) *Grafting of the defect was performed.* (h) *A pericardium membrane was secured using two tacks.* (i) *Clinical view of the final healing and restoration at 3 months postoperative.*

root fragment or due to proximity of the implant abutment to the root fragment. Case 3 demonstrates the management of a mobile shield 2 weeks after immediate provisional restoration.

The patient presented with a post core crown on a maxillary left central incisor that had lost its retention (Fig 3a). There was a complete lack of ferrule, and thus it was decided that the nonrestorable tooth should be removed and replaced with an implant. PET was carried out on the remaining root (Fig 3b). The socket shield was completed after removing the palatal portion of the root and curetting the socket. The shield was thinned to about 1 mm to increase the size of the jump gap between the implant and the shield. A 4 × 13–mm implant (AnyRidge, Megagen) was placed in the area with a torque > 50 Ncm. The jump gap was filled with alloplast bone graft particles (Osteon, Genoss). Due to the high initial primary stability, a provisional crown was fabricated using the patient's crown and retrofitted to the implant using flowable composite. The provisional crown was placed on the implant and torqued to 35 Ncm.

At 2 weeks postoperative, the patient presented with a granulomatous soft tissue growth on the buccal aspect of the socket shield (Fig 3c). An esthetic buccal flap was raised to assess the shield (Fig 3d). The buccal bone had resorbed, and the shield was loose. However, the implant still showed excellent stability, and it was decided to keep the implant in place. The exposed implant threads were decontaminated with an Erbium YAG (Er:YAG) laser (Waterlase 2.0, Biolase) as well as sodium bicarbonate spray. The osseous defect was grafted with alloplast particulate bone (Osteon) as well as a pericardium membrane (Jason membrane, Botiss) (Fig 3e). The membrane was secured with two bone tacks and was tucked around the implant neck (Fig 3f). The site was then covered with platelet-rich fibrin (PRF) membranes to enhance soft tissue healing, and the flap was sutured with 6-0 sutures. Implant osseointegration was confirmed via implant stability quotient values at 3 months postoperative (Fig 3g).

Discussion

Although numerous clinical studies have demonstrated the benefits of PET, several groups have demonstrated that complications can occur, though they are typically manageable. Root fragment or submerged root exposure was common to all PET techniques. Most of the complications reported in the literature were successfully managed surgically, and implant osseointegration was maintained. Management ranges from no treatment/observation in shield exposure cases without signs of inflammation, to shield reduction in the case of inflammation, or extraction if the shield is mobile.

The most common complication appears to be shield exposures and mobility. Gluckman et al reported root fragment exposure requiring surgical management due to a soft tissue deficiency that requires buccal flap advancement for shield closure and coverage.[8] Bäumer et al reported soft tissue recession around root fragments.[20] A retrospective case series examining 128 sites reported 19.5% combined complication (25/128 sites). Although 5 implants failed to osseointegrate and required removal, the remaining 20 complications were managed with implant survival, including 16 shield exposures, 3 infections, and 1 shield migration.[16] Stuani et al[19] reported periapical radiolucency around an implant, which manifested clinically as a buccal fenestration. The complication was managed surgically with curettage of the lesion and grafting with xenogeneic bone. At the 12-month follow-up, implant osseointegration was maintained and new radiographic bone formation observed.[19] Zuhr et al reported a case of shield mobility after 4 years with deep buccal probing depths. The complication was managed, and the implant survived.[18]

Internal shield exposure is the most common PET complication. This can be due to lack of adequate space between the temporary prosthesis and tissue at the time of initial surgery and/or excessive pressure from the temporary prosthesis. It is important to ensure that the root shield is prepared to the bone crest with an adequate bevel to allow for tissue development around the abutment. In the case of an internal shield exposure, a round diamond bur can be used to trim the exposed root down sufficiently. This allows for clot and epithelium formation to cover the exposed root fragment. Some factors for internal shield exposure are attributed to the overlying connective tissue thickness or to inadequate shield preparation down to the bone crest. In cases where the shield is left supracrestally above the buccal bone crest, it is more likely to become exposed. Thus, shield reduction down to the level of the alveolar bone crest is a key factor in minimizing the chance of internal shield exposure.

In cases where an external exposure occurs, simply trimming the exposed root fragment with a diamond bur will lead to soft tissue scarring. It is more appropriate to elevate a full-thickness flap, with a border separated approximately 3 to 4 mm from the exposed root fragment. Using a diamond bur, trim the root fragment to the level of buccal alveolar bone. At this time, placing a subepithelial connective tissue graft to thicken the soft tissue may be indicated depending on the current keratinized tissue thickness. If the soft tissue is thick (3 to 4 mm), trimming the shield should be sufficient to allow full epithelization over the exposure. However, if the soft tissue is thin, proceeding with soft tissue phenotype modification may beneficial.[21,22]

The most likely reason for early shield mobility presented in Case 3 is excessive thinning of the shield, which may cause flexion. Thus, the buccolingual shield thickness should be about 1.5 to 2 mm, and the corono-apical dimension should be about two-thirds the length of the buccal root. The present case highlights a more profound defect following a complication from PET. In such cases, it is important to understand risk management and be capable of surgically repairing the defect area. When a mobile shield is loose, this often results in total buccal bone loss of the implant as well as a soft tissue defect that both requires immediate resolution. In the present case, adequate implant decontamination was required using an Er:YAG laser in combination with sodium bicarbonate trophy spray. It is worth noting that this area was then grafted with a bone graft to replace the buccal shield loss and was grafted with PRF to improve soft tissue healing.

It has been well documented in the literature that PRF favors soft tissue healing over hard tissues.[23,24] Therefore, when the socket shield is lost along with the buccal plate, the use of PRF (owing to its incorporation of leukocytes) often improves soft tissue healing and reduces the risk of infection during the healing process.[23,24]

Conclusions

The three presented cases demonstrate complication management strategies for the most common PET complications in full-arch implant dentistry and the anterior esthetic zone. Understanding the surgical and restorative considerations are critical in the prevention of complications associated with PET. Ultimately, careful case selection and meticulous treatment execution by experienced clinicians are key to success.

Acknowledgments

The authors declare no conflicts of interest.

References

1. Araújo MG, Lindhe J. Dimensional ridge alterations following tooth extraction. An experimental study in the dog. J Clin Periodontol 2005;32:212–218.
2. Araújo MG, Wennström JL, Lindhe J. Modeling of the buccal and lingual bone walls of fresh extraction sites following implant installation. Clin Oral Implants Res 2006;17:606–614.
3. Avila-Ortiz G, Chambrone L, Vignoletti F. Effect of alveolar ridge preservation interventions following tooth extraction: A systematic review and meta-analysis. J Clin Periodontol 2019;46(suppl 21):195–223.
4. Du Toit J, Salama M, Gluckman H, Nagy K. Root submergence technique as a partial extraction therapy to preserve the alveolar ridge tissues: A systematic review and appraisal of the literature. J Prosthet Dent 2021. Epub ahead of print.
5. Gluckman H, Salama M, Du Toit J. Partial Extraction Therapies (PET) part 1: Maintaining alveolar ridge contour at pontic and immediate implant sites. Int J Periodontics Restorative Dent 2016;36:681–687.
6. Gluckman H, Salama M, Du Toit J. Partial Extraction Therapies (PET) part 2: Procedures and technical aspects. Int J Periodontics Restorative Dent 2017;37:377–385.
7. Siormpas KD, Mitsias ME, Kontsiotou-Siormpa E, Garber D, Kotsakis GA. Immediate implant placement in the esthetic zone utilizing the "root-membrane" technique: Clinical results up to 5 years postloading. Int J Oral Maxillofac Implants 2014;29:1397–1405.
8. Gluckman H, Du Toit J, Salama M. The pontic-shield: Partial extraction therapy for ridge preservation and pontic site development. Int J Periodontics Restorative Dent 2016;36:417–423.
9. Kan JY, Rungcharassaeng K. Proximal socket shield for interimplant papilla preservation in the esthetic zone. Int J Periodontics Restorative Dent 2013;33:e24–e31.
10. Salama M, Ishikawa T, Salama H, Funato A, Garber D. Advantages of the root submergence technique for pontic site development in esthetic implant therapy. Int J Periodontics Restorative Dent 2007;27:521–527.
11. Staehler P, Abraha SM, Bastos J, Zuhr O, Hürzeler M. The socket-shield technique: A step-by-step protocol after 12 years of experience. Int J Esthet Dent 2020;15:288–305.
12. Gluckman H, Du Toit J, Salama M, Nagy K, Dard M. A decade of the socket-shield technique: A step-by-step partial extraction therapy protocol. Int J Esthet Dent 2020;15:212–225.
13. Tinsley D, Watson CJ, Preston AJ. Implant complications and failures: The fixed prosthesis. Dent Update 2002;29:456–460.
14. Gowd MS, Shankar T, Ranjan R, Singh A. Prosthetic consideration in implant-supported prosthesis: A review of literature. J Int Soc Prev Community Dent 2017;7(suppl 1):s1-s7.
15. Bishara M, Sinada N, Wu DT, et al. Partial extraction therapy (part 1): Applications in full-arch dental implant therapy. Int J Periodontics Restorative Dent 2023;43:443–449.
16. Gluckman H, Salama M, Du Toit J. A retrospective evaluation of 128 socket-shield cases in the esthetic zone and posterior sites: Partial extraction therapy with up to 4 years follow-up. Clin Implant Dent Relat Res 2018;20:122–129.
17. Siormpas KD, Mitsias ME, Kotsakis GA, Tawil I, Pikos MA, Mangano FG. The root membrane technique: A retrospective clinical study with up to 10 years of follow-up. Implant Dent 2018;27:564–574.
18. Zuhr O, Staehler P, Huerzeler M. Complication management of a socket shield case after 6 years of function. Int J Periodontics Restorative Dent 2020;40:409–415.
19. Stuani VT, Manfredi GGDP, Sant'Ana ACP, de Rezende MLR. Periapical lesion on an implant after socket shield technique: A case report. J Int Acad Periodontol 2019;21:29–35.

20. Bäumer D, Zuhr O, Rebele S, Hürzeler M. Socket shield technique for immediate implant placement—Clinical, radiographic and volumetric data after 5 years. Clin Oral Implants Res 2017;28:1450–1458.
21. Lin GH, Curtis DA, Kapila Y, et al. The significance of surgically modifying soft tissue phenotype around fixed dental prostheses: An American Academy of Periodontology best evidence review. J Periodontol 2020;91:339–351.
22. 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.
23. Miron RJ, Zucchelli G, Pikos MA, et al. Use of platelet-rich fibrin in regenerative dentistry: A systematic review. Clin Oral Invest 2017;21:1913–1927.
24. Miron RJ, Fujioka-Kobayashi M, Bishara M, Zhang Y, Hernandez M, Choukroun J. Platelet-rich fibrin and soft tissue wound healing: A systematic review. Tissue Eng Part B Rev 2017;23:83–99.