

DENTAL TECHNIQUE

The root submergence technique at single tooth sites to short-span edentulous sites: A step-by-step partial extraction therapy protocol

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Poe et al¹ may have been the first to publish results of submerging vital tooth roots in a cohort of dogs in 1971. Before that time, clinicians were already aware of the restorative problems associated with alveolar ridge resorption.²⁻⁴ In subsequent studies, both vital and endodontically treated roots were submerged beneath the mucosa.^{5,6} When carried out appropriately, the root submergence technique (RST) resulted in ridge preservation.⁷⁻⁹ Early studies investigated RST mainly with removable dentures.^{5,6,10-14} Much later in the 2000s, the RST was reported under fixed partial denture (FPD) pontic sites.^{15,16} The RST differs greatly in fixed versus removable prosthetic treatment, and a tailored approach to each is necessary.

A systematic review of the RST identified several complications,¹⁷ especially exposure of the root perforating the overlying mucosa. This complication was reported to occur in 25.3% of patients¹⁷ but occurred more frequently in earlier studies and was associated with complete removable denture treatment and when incorrect techniques were used.^{10,11,18} Exposures were less frequent when associated with FPD treatment.^{15,16} Nonetheless, when these did occur, incorrect technique was the cause.¹⁹ Drawing on the reported successes and failures and the experience of a partial extraction therapy

ABSTRACT

Submerging roots for ridge preservation was the earliest partial extraction therapy and has been described since the 1970s. Despite the approximately 47 animal and human studies published since, an updated and contemporary step-by-step protocol has not yet been provided. This technique report describes in detail how to manage submerged roots at single tooth sites and at short-span edentulous areas. (J Prosthet Dent 2021;■:■-■)

research group, this technique report provides a step-by-step root submergence technique at single sites and in short-span edentulous areas.

TECHNIQUE

The clinician providing the root submergence requires an intermediate level of surgical knowledge, training or mentoring, and experience. Comprehensive patient assessment prior to the treatment is mandatory. All submerged root sites in the esthetic zone require detailed planning, including the projected prosthetic outcomes initiated by facial and smile analysis and diagnosis.²⁰ The clinician needs to consider all the associated factors with regards to incorporating the pontic site or sites into an ideal smile diagnosis and pink and white esthetics harmonious with the patient's face.²¹ Projected planning transferred to the patient as a trial restoration is strongly advised. Next, decisions regarding the tooth considered for root submergence are made. All alternative treatment options are to be provided to the patient. If considering

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Table 1. Indications, considerations when submerging root(s)

1. Tooth planned for extraction.
2. Tooth without adequate ferrule (d.t. caries, fracture) when all other treatment options have been considered (orthodontic extrusion, crown lengthening).
3. Abutment tooth that compromises ideal pink-white esthetics.
4. Ankylosed tooth.
5. Intending to preserve alveolar ridge tissues.
6. Young patients who have not yet completed growth, who cannot yet receive implant.
7. Medically compromised patients in whom tooth extraction is a risk (antiresorptive drugs, radiation/chemotherapy, elderly or debilitated patients).
8. Maximizing ridge volume and esthetics at pontic sites.
9. Preventing collapse from extraction adjacent to implants.
10. Opting for conservative treatment instead of socket grafting, ridge augmentation.
11. Opting not to use commercially available biomaterials.
12. Tooth roots confirmed free of caries and endodontic disease before submerging.*
13. Both vital and endodontically treated roots may be submerged.
14. Endodontic treatment required if non-vital, necrotic or infected root canal tissue, chronic exposed root canal tissue, previously failed endodontic treatment.*

Coronectomy (decoronation and submergence of mandibular third molars to prevent nerve injury) unrelated topic and not addressed here with ridge preservation. *Submergence of root with pathology absolute contraindication.

RST, compliance with its treatment indications must be considered (Table 1).

The following steps detail the clinical procedures to submerge the root(s) and restore the patient:

1. Thoroughly assess and diagnose the tooth, pulp status, and/or existing endodontic treatment (Table 2). For vital and disease-free roots, proceed to steps 3, 4. If endodontic treatment is required in addition to submerging the root, complete this before decoronation and surgery. Make every attempt to isolate with a dental dam and clamp even if coronal structure is lacking.

Do not plan to provide endodontic treatment during surgery. A dental dam cannot be adequately adapted after raising the flap and decoronation to or below bone crest. Moreover, bleeding at a raised mucosal flap compromises moisture control, and the surgical site cannot be adequately protected from the endodontic irrigant.

2. Decoronate the tooth after endodontic treatment and obturation is complete (Fig. 1). Make an exception for a diagnosis of non-vital endodontic tissue after decoronation, which is discussed in step 13. This may require compromised endodontic treatment during the surgical treatment.
3. Proceed to subsequent steps if the tooth crown is absent or mostly absent because of extensive caries, fracture, or wear.
4. If the tooth crown is in position, decoronate by cutting the crown approximately 2 mm above the gingival level (Fig. 1B). Take special care not to fracture the root during crown removal if an

Table 2. Checklist before providing root submergence technique

1. Patient thoroughly examined, including medical history.
2. Indications for RST and alternative treatment considered.
3. Comprehensive examination, including facial and smile diagnosis, trial restoration transfer, pink-white esthetics evaluation, and patient input.
4. Root(s) planned for submergence diagnosed and treated (especially endodontic status).
4.1 Intraoperative endodontic treatment prepared in event of need.
5. Clinician providing RST confirmed competent, at least intermediate level of surgical knowledge, training/mentoring, and experience.
6. Patient informed consent obtained.
7. All instrumentation and materials prepared: root resection rotary instruments, surgical motor, sterile saline, microsurgical instrumentation necessary to harvest soft-tissue graft, bioactive endodontic cement, materials to protect palatal harvest site, interim prosthesis, and so on.

RST, root submergence technique.

endodontically treated tooth has a post and core and crown.

5. To decoronate the tooth, use a high-speed dental handpiece with a water-cooled rotary instrument, either tungsten carbide or diamond, with a narrow, tapered end (Diamond Bur #850-016; Komet Dental) (Fig. 2). Section the crown from the root, cutting horizontally and mesiodistally. Do this first to a supragingival level both to avoid damaging the soft tissue and to preserve coronal structure in the event of endodontic treatment. Also take care not to damage the adjacent teeth.
6. Start by cutting from the interproximal area if space is sufficient (and papilla absent) (Fig. 3A). Cut the crown in a horizontal sawing motion toward the opposite interproximal space. Do not move only in a lateral motion. Cut horizontally while also moving the rotary instrument in a faciolingual motion. Constant movement prevents the rotary instrument becoming lodged in the tooth. Ensure copious irrigation of the cut tooth.
7. If there is no interproximal space to fit the rotary instrument, cut first vertically from the mid-incisal or occlusal point (Fig. 3B), creating a slot through the crown. Then cut the crown in a lateral motion as described in step 5 (Fig. 3C-F). Always take care not to damage adjacent tissues. Visualize the rotary instrument cutting supragingival on both the facial and lingual aspects. Follow the scallop of the gingiva. Use high-volume suction on the lingual and a suction tip with a large orifice to collect the sectioned crown when dislodged, ensuring the patient does not aspirate fragments. Provide additional protection against aspiration by draping gauze over the back of the mouth.
8. If the tooth has a sound bonded post, the endodontic treatment and the health of the root is also adequate, decoronate the tooth together with the post as described in steps 5 to 7. Figure 4 shows an example from a different patient. Assess the

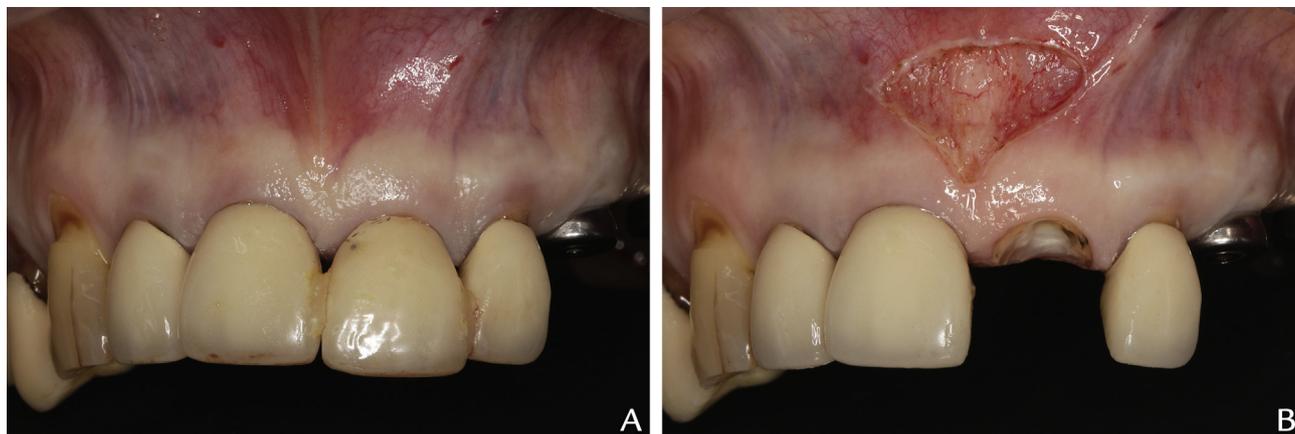


Figure 1. A, Preoperative view. Maxillary left central incisor with cervical fracture. Patient mid-treatment for complete mouth rehabilitation. All crowns planned for revision. Fixed partial denture with pontic tooth at left central incisor site planned. B, Tooth decoronated initially with 2 mm coronal structure before endodontic treatment if needed.

remaining post within the sectioned root. Remove the post if it is mobile. If secure and no further endodontic treatment is needed, leave the remaining post in the root.

9. Make a circumferential intrasulcular incision at the coronal root with a size 15c blade or similar (Fig. 5A). Cut and sever the mid-papillae. Raise a conservative flap of both the facial and lingual gingiva (Fig. 5B, 5C). A split flap is preferable to prevent unnecessary trauma to the periodontal tissues and to provide maximal blood supply to the soft-tissue graft. A microblade (Viper SB004; MJK Instruments) is helpful. Use microsurgical instruments to handle the soft tissue.
10. Use a gingival protector (K0297 PET Partial Extraction Therapy System; Brasseler) or similar elevator to reflect the flap and visualize the coronal root and bone crest (Fig. 5D-F). If planning to submerge beneath a FPD, reduce the root to 1 mm above the bone crest with a high-speed 1:1 surgical handpiece and rotary instrument with cool, sterile irrigation. Several rotary instruments may be suitable. Preferably use a large round coarse-grit diamond rotary instrument (Partial Extraction Therapy [PET] Kit; MegaGen) (Fig. 2B).
11. Option a): If submerging the root/roots beneath a removable prosthesis, reduce the coronal root circumferentially to bone crest. Reduce the root further with the large round coarse-grit diamond rotary instrument (Partial Extraction Therapy [PET] Kit; MegaGen), creating a concave shape to complement the future pontic. Confirm the reduction clinically and radiographically (Fig. 5G, 5H).
12. Option b): Also, if submerging beneath a removable prosthesis, reduce the coronal root circumferentially to at least 2 to 3 mm below the

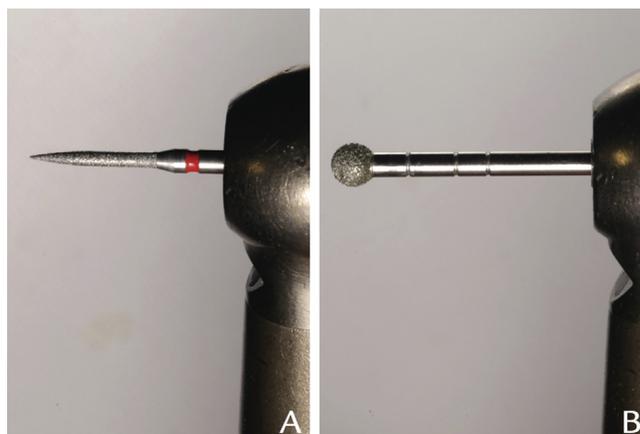


Figure 2. Rotary instruments. A, Narrow-tapered diamond to decoronate tooth. B, Large, round, coarse diamond to reduce apically, create concave coronal surface of root.

crest to allow for coronal bridging and prevent exposure. Use an end-cutting rotary instrument to cut the periphery of the root while not cutting any crestal bone. Also reduce the center of the root to create a concave shape to complement the future pontic.

13. If submerging a vital root, assess the endodontic tissues after the coronal reduction is complete. Use subjective endodontic diagnostic skills. The absence of bleeding or the presence of necrotic tissue or hyperemic bleeding indicates that endodontic treatment is required. This is the exception mentioned in step 2. The use of a dental dam and a coronal clamp should be possible. Take special care with the endodontic irrigant at the surgically exposed tissues. Use liquid dam sealer (Opaldam; Ultradent Products, Inc) and suction judiciously. Seal the root canal and make the necessary



Figure 3. Cadaver model. A, Narrow-tapered, coarse-grit rotary instrument positioned at interproximal area. B, To avoid damaging papillae, first cut from mid-incisal toward apex. C, Cut horizontally from space created after first cut. D, Hemicrown sectioned free without damaging adjacent tooth crown or papilla. Take care to section crown supragingival. E, Cut horizontally to section remaining hemicrown. F, Decoronated tooth. Adequate tooth structure remains for isolation with dental dam if endodontic treatment needed.

radiographs to confirm treatment is successfully completed.

14. The second exception is a non-bleeding root canal with calcification. Use clinical judgment. Although calcified canals may not require treatment, the authors recommend endodontic treatment in such situations if at all possible.
15. Use clinical discretion as to whether to seal the coronal canal of the endodontic-treated root. The authors' preferred protocol recommends a coronal seal as essential. If choosing to seal, bioactive endodontic cement (Biodentine; Septodont) is the first choice (Fig. 5F). Remove 2 mm of coronal canal sealant, and place cement in this coronal



Figure 4. Patient showing maxillary incisors after decoronation. All had endodontic fiber posts previously bonded in canals. Note supragingival coronal structure for dental dam clamps at central incisors. Note intracanal depth cut in left central incisor. No soft tissue damage.

space; the cement hardens within 10 to 12 minutes. Mineral trioxide aggregate (ProRoot MTA; Dentsply Sirona) is not recommended, as it takes 3 hours to harden. Glass ionomer is also not recommended. Note that vital roots do not require a coronal seal.

16. Submerge the fully prepared root under a soft-tissue graft. Use either a connective tissue graft (CTG) or a partially de-epithelialized free gingival graft (FGG). Select any harvest technique from the palatal mucosa. If harvesting a FGG, remove the epithelium from the periphery of the graft (Fig. 5G). Submerge the root beneath the graft such that connective tissue is positioned beneath the flaps and an epithelium covered mucosa faces the oral cavity and pontic tooth.
17. Secure the graft in position beneath the flaps with a suture tied at each corner of the graft (Fig. 5H). Use a thin suture, preferably 6/0 or 7/0 in diameter, with a small suture needle, preferably 11 mm. Enter the surface of the mucosa with the suture needle, and exit via the raised flap. Pass the needle through the graft corner, return under the flap, and exit 2 mm from the first entry point. Gently tie off the suture, taking care not to strangle the mucosa. Repeat these suture steps, and stretch the graft over the root. Add vertical mattress sutures (Fig. 5I) to evert the papillae. Resorbable monofilament suture thread material is recommended in these cases.
18. If submerging 2 or more adjacent roots beneath a short-span prosthesis, repeat steps 1 through 9 for the additional submerged root sites. Use a soft-tissue graft of sufficient size to ensure all roots are adequately submerged.
19. Restore the missing tooth site with a pontic with its ovate surface applying moderate pressure to

the soft-tissue graft to support the interproximal papilla. Ensure adequate space between the graft and the root beneath. Use clinical discretion to shape the pontic's ovate fitting surface and interproximal spaces to develop the soft tissues. Start developing the soft-tissue contours of the site in this manner immediately. Use an interim restoration such as a resin-bonded FPD, a tooth or implant-supported FPD, Essix retainer with a pontic, or even a suitable removable partial denture. Make a baseline radiograph of the submerged root(s) (Fig. 6).

20. Proceed to the definitive restoration after sufficient healing and maturation of the soft tissue (minimum 2 to 3 months) (Fig. 7).

DISCUSSION

Despite being reported in 47 studies in humans and animals between 1971 and 2015,¹⁷ the authors are unaware of a detailed step-by-step description of RST. Provided here is the partial extraction therapy (PET) protocol for submerging roots at single and short-span edentulous sites. The literature reports that complications occur, specifically exposure of the roots,¹⁷ but these were clearly associated with poor technique. The roots must be adequately reduced by 1 of 3 strategies (Fig. 8). For FPDs where the restoration has no movement and no variable pressure on the mucosa over the submerged root, the root may be reduced to 1 mm above bone crest. For removable prostheses, reduction to bone crest and even below bone crest is essential. Histological reports have confirmed that hard tissue (whether bone or cementum) may grow onto or over the cut root surface.^{18,22-24} This is referred to as coronal bridging and would contribute to separating the submerged root from the oral cavity, ensuring mucosal integrity and long-term disease-free sites. When the roots are further reduced to 2 to 3 mm below the bony crest, histological and radiographic data have confirmed complete coronal bridging by bone.^{23,25,26}

After raising a full-thickness mucoperiosteal flap, crestal bone may be lost, and roots initially reduced to bone crest may, after healing, be positioned above the crest, leading to possible exposure.¹¹ Also, submerged roots in completely edentulous jaws and long-span edentulous sites restored with complete removable dentures respond differently from the single to short-span edentulous sites described in this technique report. Larger flaps with vertical and periosteal release incisions may allow for passive flap advancement but result in a loss of vestibular depth.²⁷ This is a particular problem with complete removable dentures but are less of a concern with FPDs because support and retention is not influenced by the ridge and vestibule. Instead, in

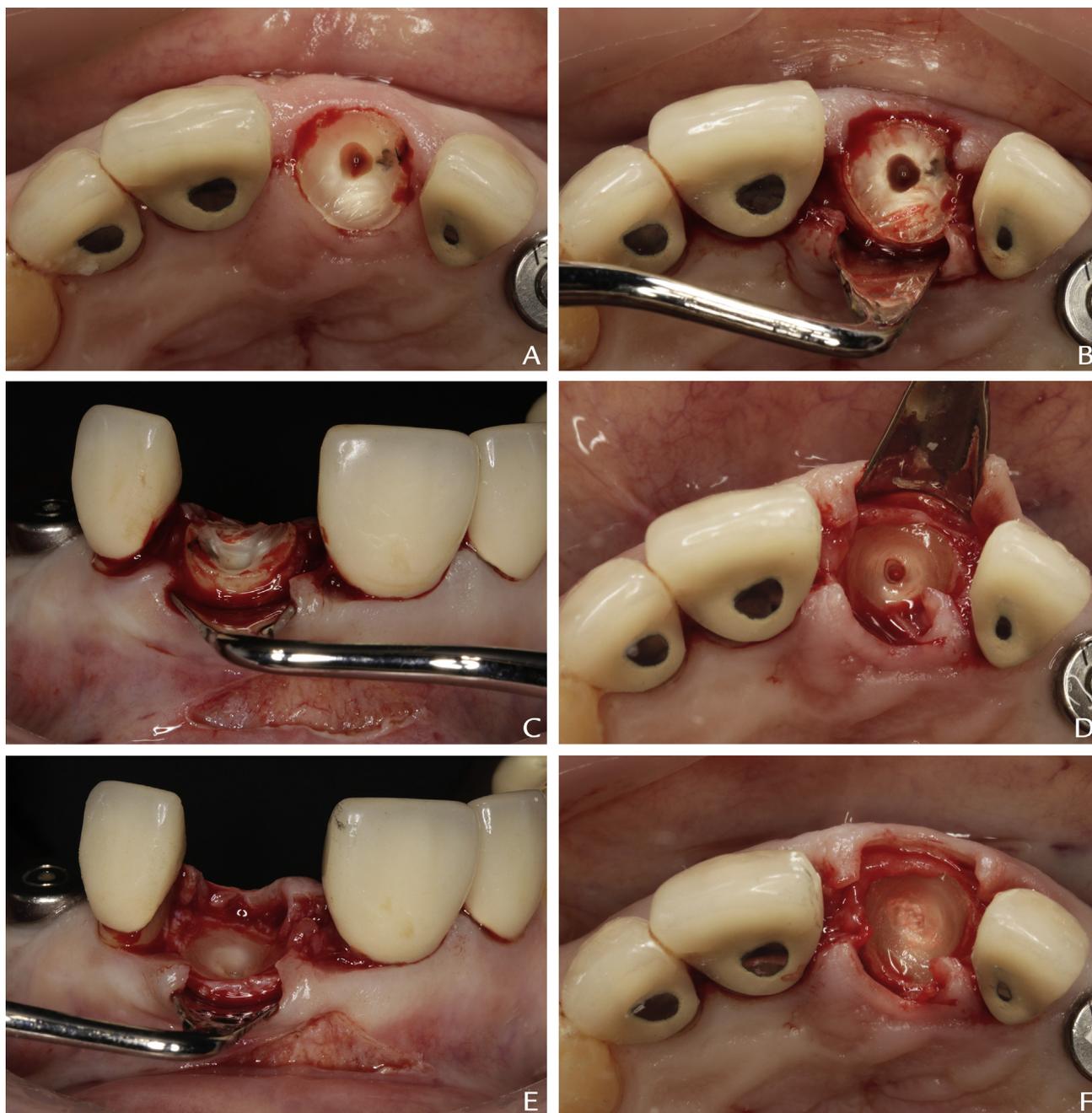


Figure 5. A, Sever gingival attachment circumferential to decoronated tooth and sever papillae. Both incisions made with size 15c blade or smaller. B, C, Gently reflect flap with gingival protector or similar instrument. D, Root periphery reduced to bone level. Center of root further reduced forming concave shape. E, Reduction to bone crest or below, visually confirmed. F, Coronal seal using bioactive endodontic cement.

almost all treatments with RST, a soft-tissue graft is required. Submerged roots beneath FPD have been managed incorrectly in the past, as authors expected the soft tissue to fully granulate over the avascular coronal root.¹⁹ Incomplete healing and exposure of the root to the oral cavity may occur. Moreover, clinically, the mucosa may appear mostly or fully healed, yet histological examination has confirmed fistulae, ingress of bacteria, and inflammation.²⁵

A few scenarios that occur when a soft-tissue graft might be omitted:

1. When the submerged root or roots and ridge are reduced, treatment without a soft-tissue graft may be possible because the flaps are not advanced and the vestibular depth might not be significantly reduced. The reduced ridge height allows for adequate, even excess, attached keratinized gingiva

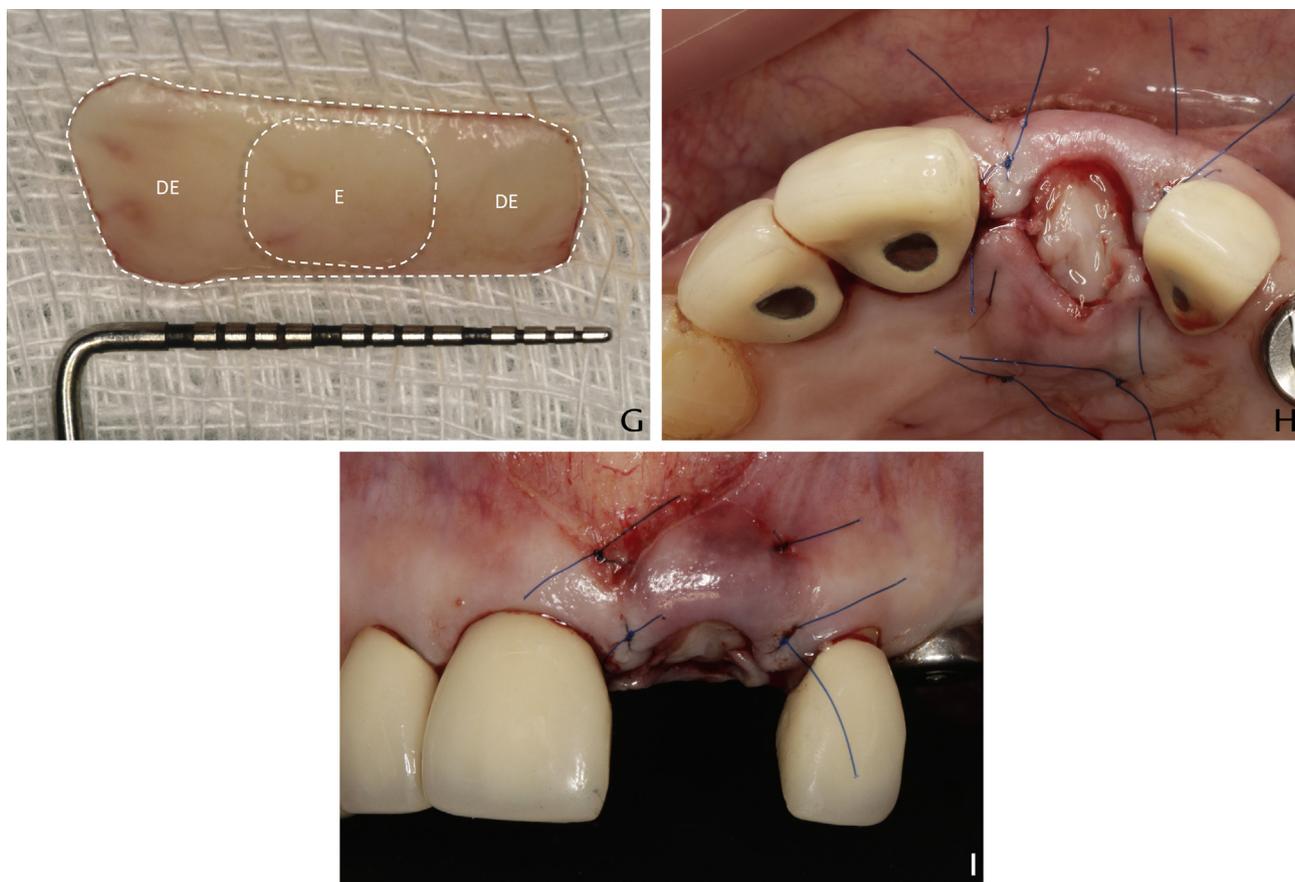


Figure 5. (continued). G, Free mucosal graft from palate. Center portion retains epithelium (e). Remainder of graft de-epithelialized (de) with scalpel blade after harvesting. H, Soft-tissue graft secured in position. I, Facial view immediately postoperative. Soft-tissue graft secured in position. Root submerged.

from both the facial and the lingual aspects to be passively sutured over the root.

2. When a flap is advanced at submerged roots beneath a FPD, healing by primary intention is possible, but the vestibular depth is reduced. At a FPD (unlike the impact on a removable denture flange), this may be acceptable.

To summarize, the current authors recommend correct root and flap management. Seal and cover the submerged roots with a soft-tissue graft as described in this report or with a similar connective tissue graft of sufficient size and technique. Integrity of the overlying mucosa is key to long-term success with all partial extraction therapies. When done correctly, ideal esthetic results and complete mucosal healing can be achieved at RST sites.

CONCLUSIONS

1. The root submergence technique is one of the original partial extraction therapies with a 5-decade history in clinical practice and research.



Figure 6. A, Preoperative periapical radiograph. Site assessed, fracture visualized, previous endodontic treatment adequate, absence of pathology confirmed. B, Immediate postoperative, baseline radiograph.

2. Less-invasive treatment declined as the use of commercial biomaterials became widely popular.
3. Preserving the patient's own tissues should always be considered as a treatment option rather than the extract-and-augment mindset.



Figure 7. A, Occlusal view. Note ridge preservation, volume at maxillary left central incisor site. Root fully submerged. B, Facial view of prosthesis. Note ridge preservation, volume of interproximal papillae. C, Oblique view of prosthesis. Note ridge volume at submerged maxillary left central incisor root.

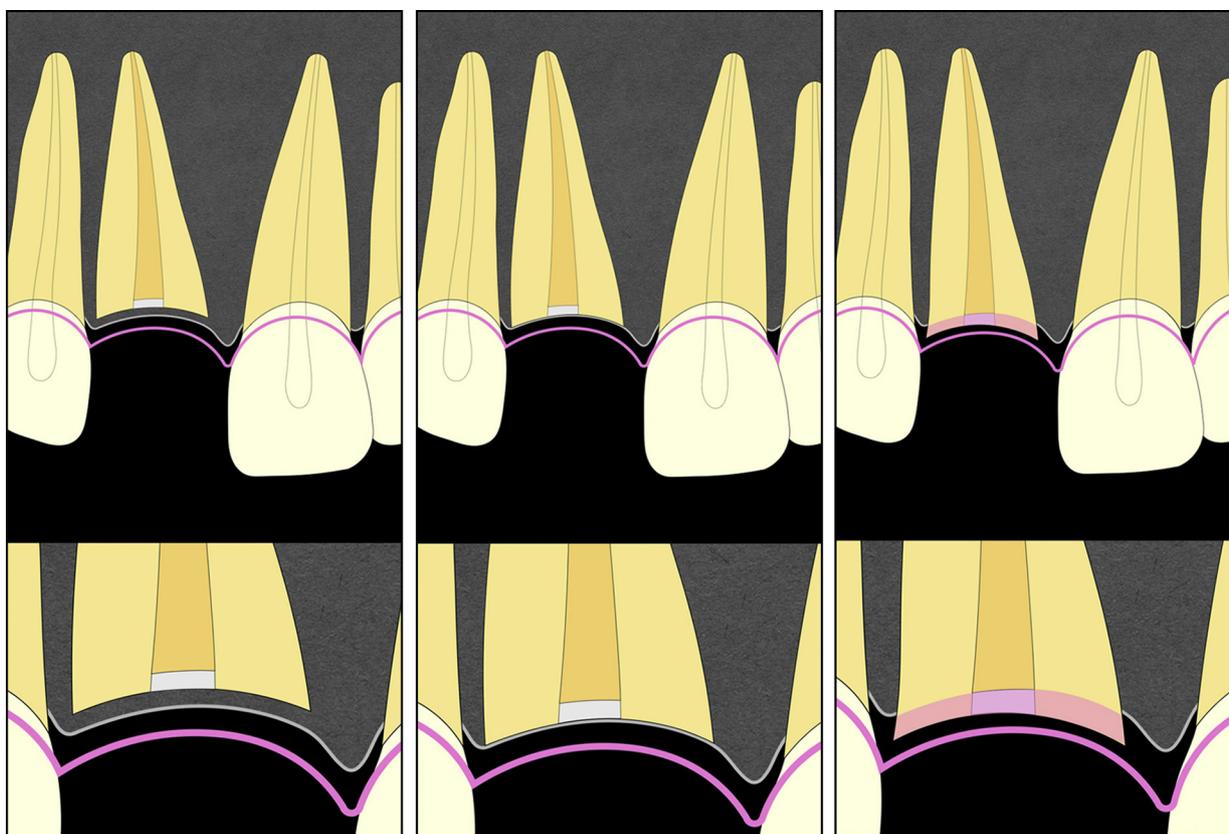


Figure 8. For removable prostheses, root reduction to below bone crest (A) or to bone crest level (B) essential. For fixed partial dentures, 1 mm above bone crest (C) permissible.

4. Provided here is the detailed partial extraction therapy protocol for submerging roots at single and short-span edentulous sites.

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<https://doi.org/10.1016/j.prosdent.2021.10.004>