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CLINICAL ARTICLE

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Structurally compromised teeth. Part II: A novel approach to peripheral build up procedures

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Abstract

Objective: To introduce the "Peripheral Build-Up technique – PBUt" as a foundation restoration strategy for structurally compromised teeth (SCT).

Clinical Considerations: Several strategies have been proposed over time (cervical marginal relocation, doughnut, and preformed ring techniques) to enable the management of restorative procedures in challenging situations such as the presence of deep subgingival defects. The PBUt is a versatile, completely additive direct technique that share some strategical concepts with these techniques to approach critical clinical situations while supplying a wider field of application thanks to distinct operative expedients. The clamp insertion modality, the extension of the proximal wall and the matrix customization/stabilization strategies adopted in PBUt endorse the possibility to manage the most apical and peripheral border of the residual tooth structure when located up to >1.5 mm above the bone crest. The periodontal response has to be then monitored over time. Moreover, thanks to the peripheral and apically-extended addictive approach, it allows a massive preservation of residual sound tooth structure and improves the resistance and retentive physical/geometrical features of the abutment tooth. The PBUt operative workflow is herein explained.

Clinical Significance: The Peripheral-Build-Up technique (PBUt) advocates some innovative clinical restorative steps for the management of SCT with coronal and deep subgingival defects.

KEYWORDS
additive technique, build-up, foundation restoration, proximal matrix, residual tooth structure, structurally compromised teeth

1 | INTRODUCTION

Structurally compromised teeth (SCT) have always represented a clinical challenge, causing confusion among dental practitioners on when and how to intervene. Given that the moisture control is possible and rubber dam positioning feasible, resin composites can be located increasingly below the subgingival margin, adjacent or in the context of the supracrestal tissue attachment.[1]

Unlike the traditional belief that violation of the biological width with the restorative margin can cause severe gingival

inflammation,[2,3] recently, it has been observed that subgingival composite resin restorations did not result in periodontal irritation,[4] provided that finishing procedures are correctly performed,[5] and that the patient strictly follows adequate home hygiene procedures, including flossing of interproximal sites, as well as periodic follow-ups.[4]

Several treatment options have been proposed over time to enhance moisture control and restore teeth with massive subgingival defects, possibly allowing to prolong the lifespan of the dental element.[6,7] Originally, surgical crown lengthening, surgical extrusion and orthodontic forced eruption have been considered as the only possible strategies to expose the necessary amount of tooth structure to be isolated; however, due to their major drawbacks related to the potential biological invasiveness[8] as well as the longer treatment time risk of periodontal ligament and pulp damage[9,10] as well as being time-consuming procedures, their use has been advocated to be the last resort in case of inefficiency of previous more conservative approaches.[8,11]

Viable alternative restorative approaches mainly involve deep margin elevation (otherwise known as cervical margin relocation),[12,13] doughnut technique,[14] and pre-formed ring technique (e.g., copper ring).[15] Although each of these techniques have shown important advantages in terms of restorative procedure enhancements of SCT, they cannot be considered as universally feasible in all clinical situations, therefore the selection of one or the other technique have to be made case-by-case.

The decision-making process of the adequate restorative approach should be based on structural assessment and periodontal considerations of the residual tooth structure.[5,16] In particular, the attention should be addressed at the remaining cervical structure, given the biomechanical, biological and operative importance of this area. Previously, the authors of this article have introduced a novel classification proposal of SCT according to the most apical cervical and most coronal location of the residual tooth structure, in relation to the periodontal tissues. In accordance, several clinical scenarios have been drawn considering the apical- and coronal bucco/lingual location of the residual cervical structure with respect to the gingival margin, gingival sulcus, supracrestal tissue attachment and bone crest. This classification has enabled a standardization of the clinical evaluation of SCT as to enlarge the spectrum of possible operative strategies for tooth preservation while offering additional insights for rubber dam positioning procedures.

According to some authors, the physical properties of a core reconstruction become more important as residual intact tooth structure decreases.[17] Consequently, when retentive and resistance features are derived primarily from the core material, the strength of a foundation restoration and the retention of a core can directly influence the survival of the final prosthetic crown.[17] Among the materials nowadays available for build-up procedures, resin composites represent those with greater range of application owing to their good mechanical properties of resistance and, easy management and optimal esthetics.[18]

With the attempt to improve the physical/geometrical characteristics of the SCT and successfully manage the restorative adhesive procedures in deep cervical lesions, this paper aimed to introduce a novel foundation restoration strategy herein referred as "Peripheral Build-Up Technique – PBUt". The PBUt shares some clinical concepts with the cervical margin relocation, doughnut techniques, and customized core-shell technique[19] but, at the same time presents relevant clinical and operative differences that will be discussed step-by-step in the next sections. Moreover, clinical cases of different clinical scenario of SCT are presented, based on the previously introduced classification.

2 | PBUT IN THE DIFFERENT CLINICAL SCENARIOS

According to our previous classification of SCT (Part I), clinicians may face 2 macroscopic clinical conditions where the most apical residual tooth structure, in one portion or along the whole tooth perimeter, is supragingival or subgingival. The supragingival scenarios (W, F, A) are clinically straightforward because dental dam isolation is not operatively-demanding and the peripheral build-up can be performed according to the most peripheral extension of the additive adhesive foundation restoration. In these cases, the peripheral build-up limited to the coronal region, can be performed with the use of matrices or free hand.

FIGURE 1 Clinical case in which, at the removal of the old full-crown prostheses, the tooth abutments presented geometrical defects (excessive taper and minus). In this case, the most apical cervical structure (the visible finishing line) is supragingival with no more than 1.5/2 mm height of residual tissues (absence of ferrule), thus representing a typical scenario A/a (according to the classification presented in the Part I) (A). From an operative point of view, this represents the most manageable scenario not presenting criticalities for rubber dam placement and adhesive restorative procedures. The peripheral coronal build-up can be performed according to the clinician's preferred technique (use of matrices, free-hand, etc.) (B).

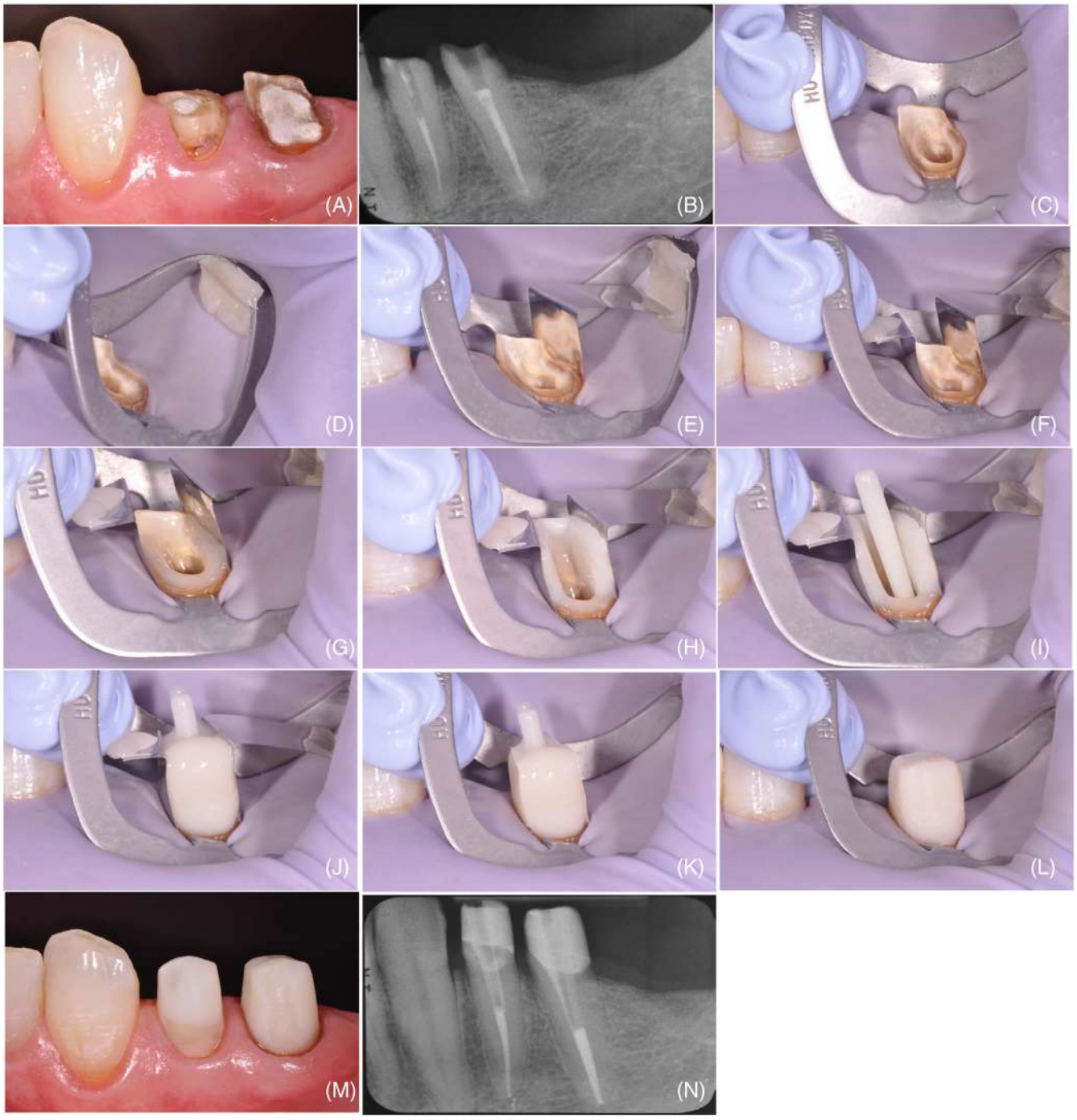

FIGURE 2 The lower left second premolar has the cervical structure, in one limited portion, apical to the gingival margin and to the tip of the proximal papilla, but coronal to the periodontal attachment (that is, the cervical structure is in the gingival sulcus). The most coronal location of the residual buccal/lingual structure was supragingival with no more than 1.5/2 mm height of residual tissues (absence of ferrule) (A, B). In this case, the tooth abutment was classified as B/a. Rubber dam was placed with the help of the assistant, and the clamp 212 was used. In order to stabilize and avoid undesirable rotational movements of the clamp and to provide retention to the subsequent matrix application in case of absence of adjacent teeth, this technique proposes the use of a silicone lump (Skybyte, Sweden & Martina, Due Carrare, PD, Italy), in this case mesially placed between the clamp's bow and the first available proximal tooth (C). As the target tooth is the more distal element, the matrix stabilization was achieved by bonding flow resin composite on the distal clamp's bow (D, E). The proximal matrices were engaged with a periodontal microsurgery needle holder beyond the cervical sound structure (F). Resin composite (A1 shade) was used to reconstruct the 1-mm peripheral collar of the tooth (G). The proximal walls were directly restored (H). After having performed the lingual wall and checking the fit of the fiber post, it was cemented (I) and then the restoration of the buccal wall was performed (J). After light-curing, the matrices were removed (K) and the tooth abutment was finished (L). Once the rubber dam was removed (M) a radiographic check was done (N).

The subgingival scenarios can be furtherly divided according to the possibility of rubber dam placement in relation to the distance of the most apical location of the residual tooth structure from the bone crest. With the distance >1.5 mm we have the subgingival scenarios B and C; differently, from the suprangingival clinical scenarios, B and C require particular precautions for rubber dam placement and the use of proximal matrices for peripheral build-up procedures. Instead, when the distance is <1.5 mm we have the subgingival scenarios D and R, also defined as pericrestal; in these cases, dental dam isolation is prevented by the close relationship between the most apical location of the residual tooth structure with the bone crest, therefore requiring for surgical crown lengthening and orthodontic extrusion.

The clinical management of additive adhesive restorations in scenarios A, B, and C are presented in Figures 1–5.

3 | CLINICAL WORKFLOW OF THE PBUT

3.1 | Evaluation of the residual tooth structure

Before treatment planning, the residual dental structure has to be evaluated from biomechanical and biological perspectives to understand whether the tooth can be isolated. In order to facilitate these analyses, the authors of this article have introduced a novel classification proposal (presented in the Part I of this issue). Once the clinician has localized the most apical position of the residual cervical structure (supra- or subgingival) and the amount of coronal bucco/lingual structure through careful clinical and radiographic evaluations, it is possible to proceed with the PBU operative steps (Figure 6).

3.2 | Selection of teeth to be isolated

It is recommended, whenever the clinical condition allows, to perform a multiple teeth isolation. In this case, two clamps will be used: one on the target tooth ("master clamp") and the second ("accessory clamp") placed on the distal tooth. The latter will bear the largest amount of the displacing force exerted by the dental dam. The stress-realizing function will enable the master clamp to be inserted on the more apical position. In addition, the proximal teeth will be also taken as spatial reference during the foundation restoration procedures, as well as stabilizer of the proximal matrices. In case the distal tooth is not present and/or the target tooth is the most distal element in the dental arch, a rigid silicone lump anchored to the bow of the clamp can be employed for the stabilization of the proximal matrix used for the reconstruction of the proximal walls (Figure 2C,I).

3.3 | Anesthesia

Anesthesia is mandatory before proceeding with the rubber dam insertion, also in presence of endodontically-treated teeth. A buccal and lingual/palatal local anesthesia with adrenaline at the distal and mesial regions in apical location (respectively in the alveolar mucosal fold, lingual and palatal mucosa) is suggested. In this way, the apical anesthesia ensures a deeper and longer hemostasis with less papilla distress when compared to the papilla anesthesia.[20,21]

3.4 | Clamps' selection

As previously reported, it is recommended, according to the clinical situation, to position two clamps. Regarding the master clamp, several geometries can be considered for incisors, canines and bicuspids. To our aim, based on 20 years of clinical experience and after having tested different options, the 212 SA is recommended as the first choice for all the 1- to 2-rooted teeth; in less demanding clinical situations dental clamp B4 and W100 can be also used. The clamping strength and apical clamping properties of 212 SA are highly superior but the presence of 2 bows instead of 1 reduces the freedom of clinical access in presence of malpositioned teeth. It is also worth mentioning the possibility to be sectioned in case of clinical necessity. On molars, due to the high variability of the cervical tooth anatomy, clamps 1 or 27 N could be instead suggested. In this case, dental clamp 1 is the first choice thanks to its clamping characteristics due to the geometrical design, with deep festooned beaks, and its superior

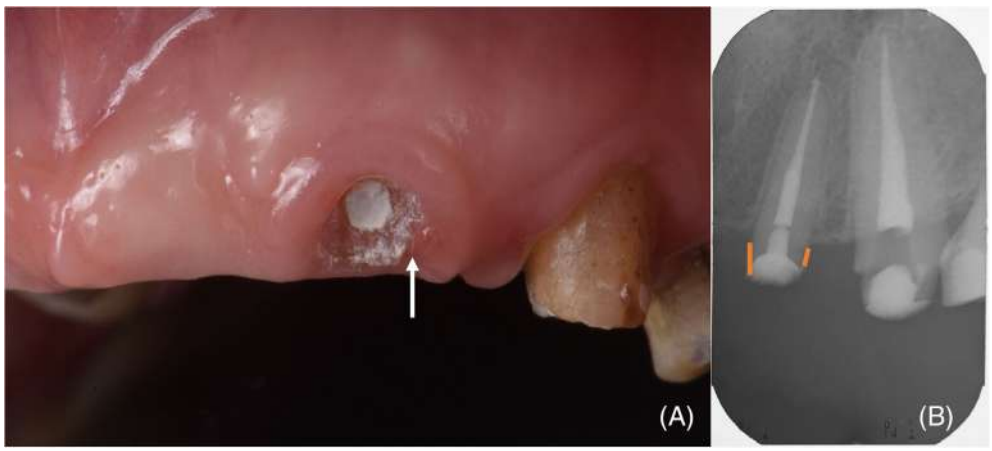

FIGURE 3 The structurally compromised tooth presented the most apical cervical structure and the most coronal location of the residual buccal/lingual structure to be restored subgingival, adjacent or in the coronal portion of the supracrestal tissue attachment, therefore classified as C/c. The evaluation of the residual tooth structure has to be performed both clinically (A) and radiographically (B).

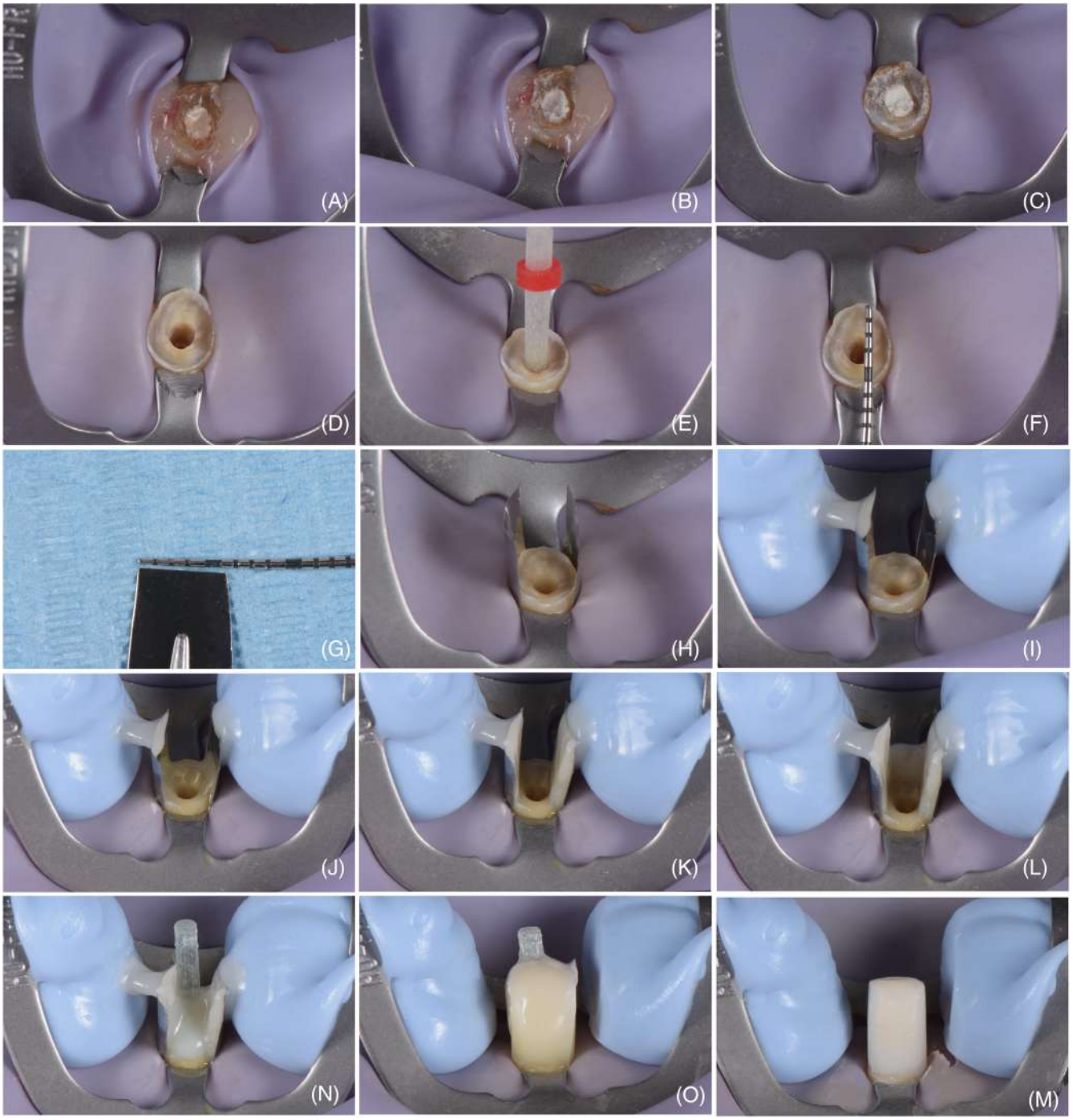

FIGURE 4 Detailed representation of the isolation and restorative procedures performed according to the PBUt in clinical scenario C. With the help of the assistant who has to enlarge the hole of the rubber dam, the dentist inserts the clamp (212) on the target tooth (A). The clamp's insertion is performed in one or multiple consecutive steps, while slowly sliding the clamp beak along the to the root surface in a corono/apical direction (B). This would allow a detachment of the periodontal attachment (reminiscent of the periotome action in tooth extraction). The clamp force and the elasticity of the rubber dam allow to expose the sufficient tooth structure for an effective isolation (C). After rubber dam placement, the tooth preparation was finished (D) and the selected fiber post was checked (E). A periodontal probe was used to measure the bucco/lingual distance of the tooth (F). This measure was reported to the matrix adding approximately 0.5 mm (to compensate for the degree of cervical curvature of the dental elements and ensure the most intimate adaptation possible to the tooth cervical structure) (G). The customized proximal matrices were placed by means of periodontal microsurgical needle holder and engaged beyond the cervical sound structure (H). Once decided the inclination of the matrix, it is then stabilized with resin composite adequately bonded on the mesial and distal silicone stumps appropriately placed on the clamp's bows (I). A first thin layer of resin composite was placed on the proximal walls and light-cured (J). Then, the resin composite is placed up to the selected height of the abutment and light-cured (K). After proximal reconstruction, the palatal wall is performed (L). Fiber post was cemented (M) and the reconstruction completed (N). The restoration after removal of the matrices (O).

FIGURE 5 The foundation restoration immediately after rubber dam removal (A). Clinical situation after 1 week of temporary prosthesis (B) with radiographical aspect (C).

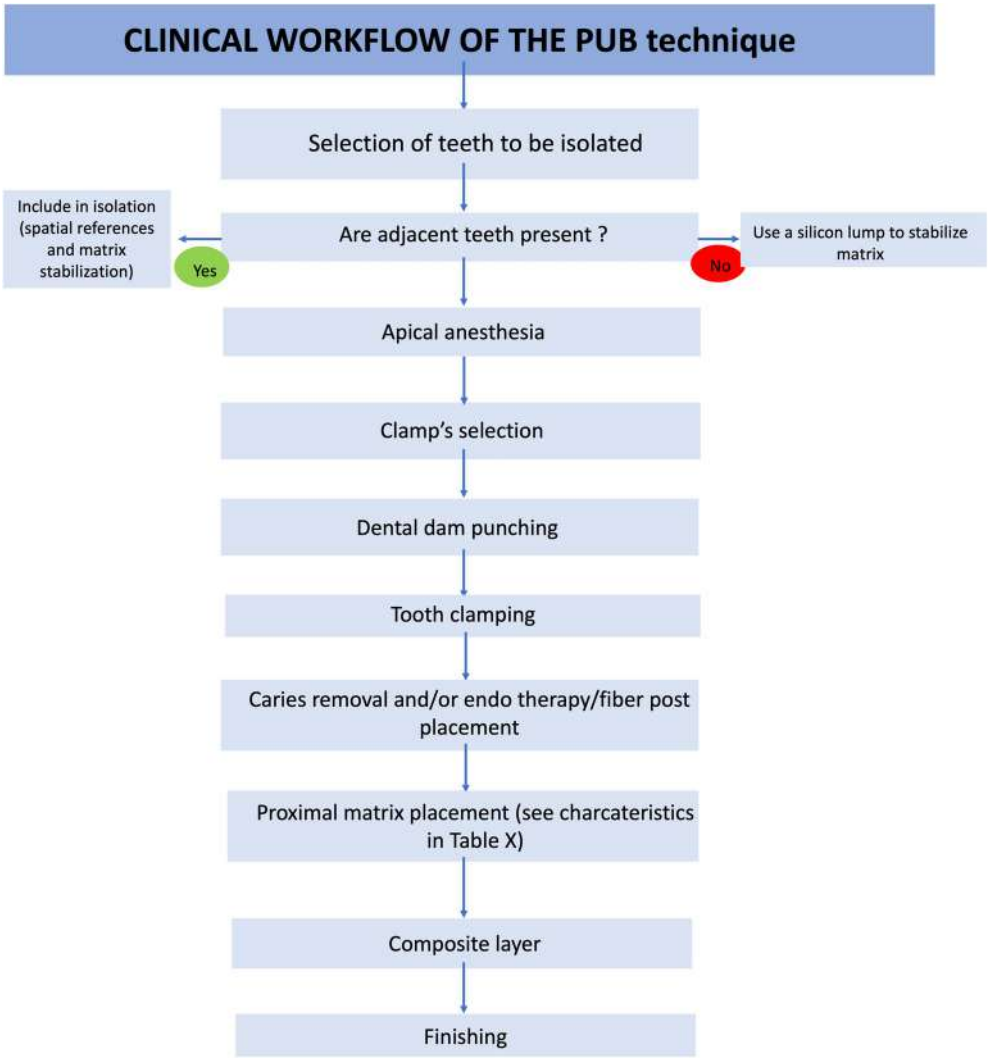

FIGURE 6 Schematic representation of the clinical workflow of the Peripheral Build-Up technique (PBUt).

clamping strength. All these clamps can be activated and/or modified by one or a couple of universal pliers in order to increase the grasp and improve the apical clamping of the target tooth.

The rationale behind the clamp's recommendations, relies on the different thicknesses that characterize each clamp beak, that is lower in the central part and tends to increase in the lateral regions (corresponding to the contact point with the tooth structure, therefore representing the higher level of strength provided). The accurate knowledge of the clamp's thickness is necessary, as this geometrical parameter regulates the minimum supracrestal tooth structure that can be displaced during clamp's insertion; in case of 212 SA clamp, the maximum thickness of lateral side of the beaks is 0.75 mm. Considering that the clinician needs some minimum extra space to manage a correct and reliable clamp placement, a 1.5 mm distance from the margin of the bone crest can be considered the minimum extent for an effective clamping and dental dam isolation in 1- to 2-rooted teeth. Instead, the margin to bone crest distance in molars is larger (around 2–2.5 mm) due to the bigger dento-gingival complex, supra crestal tissue dimension, tooth anatomy and posterior position, requiring higher clamp insertion force to displace periodontal tissue with consequent harder operative management.

3.5 | Dental dam punching

In general, an elastic dam sheet should be preferred to ensure adequate retraction effect over the soft tissues.[22] Specifically, two main parameters should be taken into consideration during dental dam punching: the inter-hole distance and the hole size. The holes on the dental dam should be customized case-by-case and, in general, placed at higher distance than those provided in the standardized prefabricated templates supplied by manufacturers. In order to reduce the traction tension of the dam fabric and enhance its appropriate dimension at the most apical tooth/periodontium interface a higher inter-holes distance and bigger size of hole are imperative interface.[23] These recommendations should be followed to avoid stretching and/or tearing of the dam fabric that inevitably would lead to improper marginal isolation.

3.6 | Tooth clamping

A 4 hands procedure should be performed with the assistant in charge to manually enlarge the rubber dam hole related to the target tooth. The rubber dam is stretched over the tooth and the proximal, lingual, and buccal gingiva have to be visible. From the other side, the dentist clamps the target tooth; clamping can be done in one long, continuous step or in multiple steps by slowly sliding the clamp beak along the root surface in a corono/apical direction (Figure 4A–C). In most cases, this would result in a detachment of the periodontal attachment, in a manner reminiscent of a periotome during tooth extraction (REF).[24]

The apical displacement/detachment of periodontal tissues provided by the clamp beaks along with the abundant dam fabric allow the dentist to invaginate the dental dam along the mesial and distal tooth-periodontium interface by means of a thin spatula and gentle air-blow. The absence of tension of the dam sheet around the target tooth represents the unequivocal confirmation of the correctness of the isolation procedure (Figure 4C,D).

3.7 | Caries removal and root canal treatment

The PBUt is an addictive approach, in which the maximum preservation of healthy tissue should be taken in mind in case of caries removal and/or endodontic treatments. Accordingly, caries removal starts from the periphery of the cavity and it is advisable to avoid high-vibrational rotatory instruments with multi-blade burs as these do not allow a controlled removal of the carious lesion and can cause propagation of cracks eventually present.

In case the tooth has to be endodontically-treated, the residual tooth structure should be carefully examined to evaluate if the number, position and thickness of residual walls can guarantee adequate retention and resistance to the composite build-up.[7,16] If the residual tooth structure is evaluated as inadequate, fiber posts can be cemented to increase the biomechanical resistance to tangential forces of the tooth-restoration complex.[25]

3.8 | Proximal matrix placement (distinctive step of PBUt)

In this step, metal matrices are strategically placed to reproduce the mesial and distal walls of the peripheral foundation restoration. The matrices should possess certain characteristics, such as thickness and stiffness, to fulfill specific restorative needs based on biomechanical principles. The authors suggest the use of sectional metal matrices with a thickness of 0.045 mm (i.e., Hawe Steel Matrix band with a width of 7 mm). The choice of the matrix metal thickness is very important because the clinician need a matrix with a poor elastic memory, so that it can be bent for a better adaptation to the cervical contour of the target tooth. Above all, a sufficient stiffness is required to allow apical insertion without distortion into the interface between the cervical tooth structure on one side and the rubber dam and supracrestal tissue on the other side.

The matrix is customized in width and height according to the target tooth anatomy and restorative-prosthetic needs and inserted at the mesial and distal sides. The width adjustment is performed to avoid any interferences between the matrix and the clamp. As to do so, a periodontal probe is used to measure the bucco-lingual tooth dimension that is reported to the matrix, adding approximately 0.5/1 mm (to compensate for the degree of cervical curvature of the dental elements and ensure the most intimate possible adaptation to the tooth cervical structure) (Figure 4F,G).

By definition a proximal matrix must apically overcome the cervical tooth structure in order to work as a stable support for the restorative material. The geometry and apical location of the sound cervical tooth structure of the target tooth influence the procedure for the apical engagement of the sectional matrix, which should be associated with stability and tight intimate contact at the most apical level of the cervical tooth structure. In order to achieve an adequate engagement of the matrix beyond the cervical sound structure, the clinician should keep and feel a continuous contact with the cervical supracrestal tooth structure along its apical progression; if this kind of action is not performed, the sectional matrix cannot be stabilized and it is displaced by the elastic reaction of the dental dam and gingival tissue. It is highly recommended the use of a periodontal microsurgery needle holder as a matrix carrier to handle and place the matrix.

In the clinical scenario A, where the proximal cervical tooth structure to be isolated is peripherally supragingival, the use of a matrix is absolutely facultative; in fact, the superficial and coronal position of the residual cervical tooth structure can be used as a peripheral guide for a free-hand placement of the composite material in order to build-up the proximal and peripheral walls (Figure 1).

In the clinical scenario B, where the proximal cervical tooth structure to be isolated is in the gingival sulcus, the apical placement of the matrix goes down to and into the junctional epithelium (Figure 2). In the more demanding clinical situations, like in scenario C, the apical placement of the matrix goes down to and into the connective attachment and, if it is necessary, to the bone crest with engagement into periodontal ligament space, simulating almost the action of a scalpel blade during an intrasulcular incision to the bone crest (Figures 3–5).

As previously introduced in Part I, according to the classification proposal of SCT, 2 different margin geometries can be distinguished: sharp margin and inclined plane. Depending on the geometry of the cervical tooth structure and the inclination of the planned proximal wall, the matrix intimate contact can present a perfect sealing (when in sharp margin) or a gap (when in inclined plan) with the cervical tooth structure. The apical engagement of the sectional matrix is often not sufficient for a reliable stability and apical tight intimate contact. When a sharp margin configuration is present in clinical scenario A and rarely in scenario B, in order to achieve the best matrix contact and adaptation to the cervical structure, a wedge should be used as clinically used during ordinary class II restorations.[26] On the contrary, in most of clinical scenario B and always in scenario C, independently of the geometry, the wedge cannot be used due to the apical anatomical location of the residual cervical structure.

In every case with inclined plane configuration, in most of clinical scenario B and always in scenario C, the apical tight intimate contact and stability of the sectional matrix is achieved by the support of the adjacent mesial and distal teeth. The absence of contiguous dental elements can be compensated by the use of a quick-hardening silicone lump injected and locked at the level of the clamp bows (Figures 2 and 4). Alternatively, a longer proximal matrix can also be used. In this case, after customization in shape and height, the matrix is bent at 90° to reach the closest clamp bow, where it can be then stabilized with flow composites (Figure 2E). In author's experience, this matrix strategy can be operative demanding, and it does not add significant advantages; however, it can be a viable support in those cases where the silicon lump, due to its dimension, hamper the visibility of the operational site.

In order to stabilize the proximal matrix, a thin layer of bonding is first applied over the occlusal surface of the adjacent teeth or, in case of their absence, over the proximal surface of the silicone lump or clamp bow, and then it is cured.

Once the matrix is inserted and engaged, it needs to be locked with a flowable composite (the same used for the first layer of the peripheral composite build-up) positioned like a bridge between the matrix and the proximal-occlusal surface of the adjacent tooth or silicone lump (Figure 4J); the more the flow composite over the matrix coronal edge is extended, the more apical stabilization we obtain.

The mesio-distal inclination of the future proximal wall of the peripheral build-up is performed at this stage. While the clinician keeps the proper tight contact of the matrix to the cervical structure, the assistant can proceed to cure the flowable composite bridge.If the tooth needs to be prepared and restored with a temporary crown in the same clinical session, it is suggested to place the matrix in a straight position, as to save time for the prosthetic preparation. Otherwise, the matrix can be placed with a divergent open angle.

When treating inclined plane configurations or planning a proximal wall with divergent open angle, matrix and cervical structure come to form a space of triangular shape which has to be filled by restorative composite; flowable composite, usually the first layer of composite build-up, is not indicated in these scenarios for the high possibility of bubbles inclusion.

3.9 | Mesial and distal walls reconstruction

After matrix placement, bonding procedures can be performed. The mesial and distal walls should be simultaneously reconstructed in a single composite layer, ensuring a minimum thickness of about 1.0 mm. The presence of the adjacent teeth will guide the height of the walls, and, in their absence, the walls are prosthodontically planned. The authors recommend the use of resin composites with high-value shade (dentine A1 or white body) for different reasons: to visually facilitate the restorative/tooth interface during prosthetic preparation, surgical crown lengthening and orthodontic extrusion, and to improve the optical properties of prosthetic materials.

The restoration of the two walls will guide the freehand reconstruction of the lingual wall. A single layer of resin composite with a thickness of about 1 mm and a height equal to the mesial and distal walls will fill 3/4 of the cavity (Figure 2H). It also generates a perfectly containing volume to support either central core build-up or, when needed, the fiber post cementation (Figure 2I,J). Finally, the reconstruction of the buccal wall completes the restoration of the SCT (Figure 2K,L).

3.10 | Finishing procedures

The achievement of a perfectly smooth, polished restorative surface is necessary as not to irritate the periodontal tissue.[5] In the PBUt, finishing is performed with taper conical burs, medium diamond grit size, reciprocating tips while rubber burs are used for the polishing step. The finishing and polishing procedures are particularly simple, as the morphology and dimensions of the abutment and the precision of the marginal closures as obtained with the presented procedures reduce the roughness of the composite walls. Particularly referred to scenario C, after interproximal matrix removal, it is possible to detach the junctional epithelium and the more coronal portion of the connective attachment by means of a wide thin spatula to further enhance finishing of the restoration.

4 | DISCUSSION

The rationale beyond the PBUt arises from the need to favor restorative procedures of SCT and obtain efficient restorations from a biomechanical and biological point of view. In this context, rubber dam isolation is mandatory to obtain valid and successful adhesive restorations. Failure to comply with the adhesive protocols would result in unpredictable foundation restoration and consequent poor prognosis of the prosthesis.

When dealing with SCT, the target tooth has suffered extensive loss of tooth structure, particularly evident at the cervical level. Overall, dental dam isolation can be very demanding, even for an experienced operator. Following the rationale of the previously proposed classification and in authors' clinical experience based on more than 20 years in this field, dental dam isolation is not related to how much

the cervical margin is subgingival, but more likely on how much the cervical margin is supracrestal, considering 1.5 mm supracrestal tooth structure enough to perform dental dam isolation on every 1–2 rooted dental element. A separate chapter should be dedicated to the molars, since their anatomical conformation, together with their position in the oral cavity, make the operative procedures more demanding and different.

Regarding the approach to the different clinical scenarios, the isolation of a tooth comprises in case A (in which the cervical structure is entirely supragingival) is undoubtedly the simplest one to carry out and does not require particular precautions other than basic manual skills in positioning the clamp and the rubber dam (Figure 1).

Instead, the presented PBU strategy derived from a critical analysis of hundreds of cases suggests operative procedures for the isolation of more demanding clinical cases such B and C (in which the cervical structure is intrasulcular and 1.5 mm above the bone crest, respectively) (Table 1). These suggestions will sustain clinicians to refrain from the use of less predictable and more periodontal tissue injuring retraction strategies such as impregnated cords, teflon tape, copper ring, electrosurgery and, above all, limit the use of resective periodontal surgery. When a dental dam isolation is performed in clinical scenario C, the location of the cervical tooth structure to be restored is unknown, as it can be within the junctional epithelium or in the more coronal portion of the connective attachment. The histological dimension of the supracrestal tissue attachment is different for every patient, tooth and site. In author's opinion, only the subsequent periodontal evaluation, at least 3 months after the "invasive" dental dam isolation (which is able to create a lesion similar to a simple gingivectomy) and repeated at least for 2 times in the next months, can suggest the potential influence of the final tooth-restoration on the periodontal attachment.

During this time the periodontal response to the deep tooth-restoration interface can be pathological or adaptative. In case of a physiological response, as usually happen, it can be safely inferred that a periodontal healing and maturation has occurred with the tooth-restoration interface within the junctional epithelium or in the deepest region of the gingival sulcus. In case of a pathological response, it can be inferred that the tooth-restoration is within the connective attachment or, even if out of it, it presents clinical features non compatible with the periodontal health such as overhangs, gaps, composite or bonding remnants not removed during the finishing phase.

TABLE 1 Recommended clinical techniques to be used during all the steps of the PUBt.

Operative steps	Clinical techniques of PBUt
Selection of teeth	Extend isolation to adiacent teeth or use a silicone lump for matrix stabilization
Clamp's selection	Prefer 212 SA (with 2 bows or separated in a single bow) for 1–2 rooted teeth. In molars, clamp 1 can be suggested.
Dental dam punching	• Hole distance (to intensify the displacement effect over the interdental papilla; • Hole size (facilitate invagination of the rubber dam at the most apical tooth-periodontium interface thanks to the reduction of excessive traction tension).
Tooth clamping	Performed in 4 hands: • The assistant the hole, • The dentist inserts the clamp in two steps, by sliding along the lingual and palatal root surfaces from coronal to far apical as possible to detach part of the periodontal attachment.
Proximal matrix placement	• Customized sectional metal matrices (thickness of 0.045 mm); • Use scissor to shape the matrix; • Feel a continuous contact with the cervical supracrestal tooth structure along its apical progression during matrix engagement beyond the cervical sound structure; • Scenario A: matrix is facultative, possibility to use a wedge; • Scenario B and C: stabilize matrix (through adjacent teeth or silicone lump or customization of the matrix). At this time clinicians decide the degree of mesio-distal inclination of the future proximal wall of the peripheral build-up
Composite layer	• Use high-value shade; • Mesial and distal walls reconstructed in single layer (thickness no less than 1 mm)

4.1 | Simplification of restorative procedures

The sequence of operative steps, as previously presented, determines a valid moisture control by means of dental dam isolation, and simplifies the core build-up restorative approach. Because in the PBUt the peripheral walls are the first reconstructive step, the peripheral adhesive seal is performed immediately at the beginning of the procedure after matrix positioning, without any delay, and it can guarantee the adhesive sealing of all the other centripetal reconstructive steps.

Composite build-up or composite build-up plus prefabricated post restorations for tooth abutment usually are performed adding composite to the residual sound structure (in case of a build-up) or cementing the prefabricated post as the first operative step, followed by centrifugal apposition of composite (in case of a post-core restoration). Instead, although PBUt is a build-up restoration for abutment teeth, it follows the same approach of direct proximal restorations or direct full crown restorations where the proximal walls are built as a first step. With this approach the restoration is simplified because the clinician has peripheral walls that surround the contour of the foundation restoration. Furthermore, the peripheral walls prevent the cement material from an uncontrolled flowing out of the margin and apically along the root.

4.2 | Improved adhesive restorations of deep cervical lesions

Dental dam handling, clamp insertion, and customization/stabilization of the matrix contribute to the realization of a reliable and well-

controlled adhesive protocol. The possibility of obtaining direct visualization of the operative field, allows to adapt the resin composite at the deep cervical level, instead of injecting resin cement that is hard to be controlled enclosing the risk of bubble formation.[27]

The 1.5 mm supracrestal tooth structure is the minimal length of tooth structure that can be grasped by the clamp beaks with a thickness of some tenths of millimeters (0.75 mm). Correct adhesive system application is not related to the location of the cervical structure within the periodontal attachment, but much more to the efficacy of moisture control.

It is noteworthy that a distance <1.5 mm between the most apical location of the residual cervical structure and the bone crest is not restoratively feasible (clinical pericrestal scenarios D and R), as the clamp physically cannot engage the residual supracrestal structure. In this cases, alternative approaches should be performed, such as surgical crown lengthening, orthodontic extrusion or periodontal surgery, according to the clinical situation.

4.3 | Marginal periodontal health

The PBUt allows the maximum control of the finishing procedure of the tooth-restorative interface, fundamental for the marginal periodontal health in case of deep tooth-restorative interface. This is possible because, after foundation restoration is performed, using a wide thin edge spatula, it is possible to detach the junctional epithelium and the more coronal portion of the connective attachment in order to finish the transition between restorative material and root surface. The clamps and the dental dam, used under the suggested recommendations, are used to grind far apically into the gingival sulcus in comparison to gingival cord or spatula retraction. It should be, however, pointed out recalls have to be planned after 3 months to evaluate the periodontal health.

4.4 | Simplification of prosthetic preparation

The maximum volume of the foundation restoration obtained with PBUt allows to simplify prosthetic preparations. It can be considered an ideal prosthodontically driven preparation according to the restorative plan and it is also compatible with every horizontal and vertical preparations. During temporarization of the provisional crown in case of clinical scenarios C and deep scenario B (>1 mm subgingival), the margins have to terminate on the resin composite to favor the healing and maturation of the periodontal tissues after the "trauma" of the clamp insertion (achievement of tissue stability). After tissue's maturation, an analysis should be done whether the composite margins are located proximally, or they also involve the buccal/lingual walls. Previously, the marginal quality of the prosthetic crowns was not influenced by the cervical margin relocation with resin composites.[28] As the PBUt is a margin relocation technique extended at 360°, it can be considered reliable to position the margin on resin composite when these are in the proximal walls. However, when resin composite is also present on the bucco/lingual walls, it is not possible to terminate with the crown, but it should be referred to minimally invasive resective surgery or a minimal orthodontic extrusion.

4.5 | Esthetics

Resin composites are used for foundation restoration. As previously stated, the suggested high-value (i.e., A1 shade) has different implications such as the optical features when used under full-ceramic crowns or the facilitation in the individuation of the tooth-restoration interfaces.

4.6 | Versatility

The possibility to adapt the PBUt to different clinical scenarios with a customized, tooth-oriented matrix renders this strategy very versatile. Indeed, the peripheral walls allow for a proper moisture control together with dental dam isolation, immediate cervical dentin sealing, reference for endodontic instruments and space for irrigating solutions. After the endodontic treatment, the composite peripheral walls can be used as a matrix for internal build-up and cementation of prefabricated post.

It can also happen that the clinician cannot perform the definitive prosthetic preparation at the same appointment of foundation restoration and that a temporary crown has to be relined. In this situation, thanks to the maximum volume achieved by the peripheral walls, the PBUt can be considered a direct full-crown composite restoration used as long-term temporary crown, being a benefit for the patient from mechanical and economical aspects. Furthermore, the PBUt, thanks to a different management of the peripheral walls and occlusal surface, can evolve to a direct full crown composite restoration and work like a long-term substitute of a temporary full crown. This kind of restoration can be extremely important and strategic in some specific clinical conditions, like financial constraints, restorative treatment with need of relevant occlusal change and orthodontic treatment (i.e., very useful with clear aligners and attachments that are detrimental to temporary crown retention).

4.7 | Differences between PBUt and cervical margin relocation technique (CMRt)

The CMRt has been developed as a two-step procedure to treat deep subgingival lesions, as a possible alternative to surgical crown lengthening.[12,13] In step one, the subgingival margin is repositioned supragingivally, and in step two, a direct or indirect restoration is placed under improved isolation conditions.[7] In this technique, after improved moisture control and placement of the interproximal matrix, the margin of the cavity is relocated to a supragingival level using a direct composite resin material. Literature has highlighted the necessity for the matrix to be supported by sufficient buccal and lingual walls, to prevent extended elevation in buccal and lingual directions.[12,13] Both PBUt and CMRt are restorative strategies intended to

be adopted for SCT in borderline clinical scenarios when the cervical margin are located in the deep subgingival area and in proximity of the STA. Rubber dam isolation and the use of the matrix is a similar condition in both techniques. The main differences between the two restorative approaches are related to the indications (clinical scenario C can be approached with the PBUt predictably), the extension of the proximal wall and the matrix customization/stabilization strategy.

4.8 | Differences between PBUt and doughnut technique (Dt) or preformed ring technique (Rt)

The Dt is a free-hand flowable composite reconstruction of deep cavity walls, after the insertion into the sulcus of a retraction cord to displace soft tissues.[29] In the Rt, a copper ring is used to pre-shape the core-build up reconstruction.[15] PBUt shares with the Dt and the Rt the concept of a restorative strategy for the clinical scenario where the residual cervical structure is within the more coronal portion of the STA (clinical scenario C). It also shares the indication for severely compromised tooth that have lost all or the majority of the coronal structure, as well as the concept of a whole peripheral build-up. However, differences can be found in the clinical versatility, the dental dam isolation, and use of customized sectional matrices and their stabilization strategy.

4.9 | Differences between PBUt and customized core-shell technique (CCSt)

PBUt shares with customized core-shell technique the concept of a restorative strategy to correct the defects of the residual coronal structure in order to achieve the best volume and geometry of the tooth abutment.[30] However, differences are mainly related to superior management of the cervical tooth structure in the PUBt where the most apical and peripheral border of the residual tooth structure can be isolated and predictably restored. In the CCSt the core shell is filled up by injectable composite and the quality of composite adaptation to residual coronal structure is questionable. This problem can be overcome in the PUBt where a more controlled composite application is achieved. Finally, but important from an economical point of view, the fabrication of the customized core-shell implies higher economical and more time-consuming aspects.

However, in some particular cases, it could be possible to integrate the two techniques to achieve the best cervical build-up management (as in the PBUt) together with the fully customized coronal buildup (as in the CCSt), similarly to what occurs with the index techniques in which a customized occlusal table index is used in combination with the direct reconstruction of the proximal walls.[31]

4.10 | Limitations and disadvantages of PBUt

The limitations of the PBUt are related to the clinician experience with the dental dam use. The learning curve is related to the improvement of the skill to classify the residual tooth structure according to biomechanical and biological requirements, to acquiring experience in the dental dam use (in terms of material selection and clamp insertion in most apical areas) and to familiarizing with matrix customization/stabilization procedures and management in the proximal apical portions. In order to adequately comply with the proposed technique, it is mandatory to use the suggested materials and instruments (i.e., thickness of the matrix, clamp's selection, microsurgical needle plier ecc).

The disadvantages of the PBUt are the same disadvantages of direct post-and-core technique versus indirect post-and-core technique, being more operator-dependent and time-consuming.

5 | CONCLUSIONS

PBUt is a direct additive foundation restoration strategy for SCT. It encloses some of the concepts of CMRt, Dt, and Rt, overcomes their drawbacks, and widens the clinical versatility and the indication range. It represents a viable alternative approach to SCT even in the worse periodontal clinical scenarios such as deep subgingival locations of the residual tooth structure. The rationale of the presented technique relies on biomechanical and biological concepts in order to provide long-lasting adhesive foundation restorations.

AUTHOR CONTRIBUTIONS

Conceptualization: Guido Fichera; Methodology: Guido Fichera, Vincenzo Picciariello, Claudia Mazzitelli; Formal analysis and investigation: Guido Fichera, Vincenzo Picciariello, Claudia Mazzitelli, Tatjana Maravic; Writing – original draft preparation: Guido Fichera, Claudia Mazzitelli, Tatjana Maravic, Uros Josic, Annalisa Mazzoni; Writing – review and editing: Guido Fichera, Uros Josic, Annalisa Mazzoni, Lorenzo Breschi; Supervision: Guido Fichera, Claudia Mazzitelli, Lorenzo Breschi.

CONFLICT OF INTEREST STATEMENT

The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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