

# Rethinking the decision-making process to treat gingival recession associated with non-carious cervical lesions

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**Abstract:** The presence of a tooth-surface defect, such as a non-carious cervical lesion (NCCL), associated with sites of gingival recession (GR) defects creates a combined soft tissue/tooth defect (CD) that requires a different treatment plan. This study aimed to critically review the literature regarding the available treatment protocols for CDs and suggest a new decision-making process. NCCLs were classified as Class A-: the cemento-enamel junction (CEJ) was visible and the root surface discrepancy was < 0.5 mm (no step); Class A+: CEJ was visible and the root surface discrepancy was > 0.5 mm (with a step); Class B-: unidentifiable CEJ without a step; Class B+: unidentifiable CEJ with a step. NCCLs affecting both root and crown surfaces (Class B) lead to CEJ destruction and consequently eliminate an important landmark used before and after root coverage procedures. The depth of the root surface discrepancy is vital owing to its possible impact on soft tissue adaptation after healing, which, in turn, may influence the treatment options, namely the use of graft and/or composites to compensate for the discrepancy. Clinically, a step with horizontal depth greater than 0.5 mm should be recognized as the minimum threshold value to define this condition. Extremely deep defects tend to assume a V-shaped topography. Therefore, extremely deep V-shaped defects were classified into subclasses A+V, a V-shaped defect, and B+V, a V-shaped defect with loss of CEJ, for management considerations. The treatment options, supported by the literature, and a decision-making process to deal with each condition are presented.

**Keywords:** Gingival Recession; Tooth Abrasion; Tooth Cervix; Tooth Root; Dentin Sensitivity; Clinical Decision-Making.

## Introduction

Gingival recession (GR) defects are highly prevalent among different populations and can affect up to 100% of individuals, regardless of oral hygiene conditions.<sup>1</sup> Esthetic complaints and dentin hypersensitivity (DH) are common problems related to GR that motivate patients to seek treatment. Consequently, in the past two decades, a considerable number of studies have been published to evaluate the best treatment modalities to treat GR defects. Randomized clinical trials and systematic reviews have shown that the combination of coronally advanced flaps (CAFs) and connective tissue graft (CTG) is considered the gold-standard procedure, with the highest

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chance to achieve complete root coverage and good long-term success rates.<sup>2,3</sup>

However, tooth surfaces associated with GR are frequently damaged, with the presence of a non-carious cervical lesion (NCCL). It has been shown that approximately 50% of GR defects are associated with an NCCL,<sup>4,5</sup> resulting in a combined defect (CD) that reduces the probability of achieving complete root coverage through treatment.<sup>6,7</sup> In addition, it was observed that GRs treated by CTG-based procedures were more likely to result in an apical shift of the gingival margin after 20 years of follow-up when NCCLs are also present.<sup>2</sup> Finally, in cases of CD, where the NCCL involves the cemento-enamel junction (CEJ) and the cervical area of the anatomic crown, root coverage procedures may not be able to cover the entire length of the CD.<sup>8</sup> Therefore, CDs warrant different treatment plan strategies depending on how the NCCL affects the tooth surface.

The first published studies on the treatment of CDs appeared in the literature in 1999 (an abstract publication),<sup>9</sup> with the initial trials published in 2007.<sup>8,10</sup> Since then, some studies have been conducted to establish the best clinical protocol to deal with CDs. This study aimed to critically review the literature regarding the treatment of CDs and recommends a new decision-making process, with algorithms to guide researchers and clinicians in the treatment of CDs.

## Overview on the treatment of gingival recession associated with non-carious cervical lesions

As previously mentioned, surgical root coverage procedures are less likely to achieve complete coverage<sup>6,7</sup> and may even have a higher chance of gingival recession recurrence<sup>2</sup> when performed at sites with NCCL associated with GR. In order to establish a better treatment protocol for CDs, some studies have combined the surgical procedure to treat the gingival recession defects with restorative fillings to reconstruct the damaged tooth surface. In a report of three cases, Santamaria et al.<sup>8</sup> used a resin-modified glass ionomer to restore the tooth surface defect and performed either a CAF or CAF+CTG to treat CDs. After up to 9 months of follow-up, the percentage of CD coverage was 63.8%,

which means that more than half the length of the restoration was located subgingivally. Despite this, all sites presented were reported as clinically healthy with no bleeding on probing. In addition, the patients were satisfied with the final esthetic outcome. Subsequently, a randomized clinical trial was conducted to compare the outcome of treatment of CDs by a combination of resin-modified glass ionomer restoration and CAF (CAF+R – Test Group) and CAF alone (CAF – Control Group). After six months, both groups presented a similar percentage of CD coverage ( $56.1 \pm 11.7\%$  vs.  $59.7 \pm 11.1\%$ , respectively;  $p > 0.05$ ), showing that the presence of the restoration did not interfere with the coverage achieved by CAF. In all CDs allocated to the CAF+R group, the apical margin of the restoration was located subgingivally after treatment. However, all sites were reported as clinically healthy with no bleeding on probing at the end of the study. Interestingly, no sites in either group presented complete CD coverage, suggesting that the NCCLs affected both the root and anatomic crown surfaces. Therefore, CAF failed to cover the entire length of the CD. This result directly influenced the assessment of DH, which showed significant improvement in the CAF+R group, but not in the CAF group. Due to partial coverage of the CD in the CAF group, part of the dentin remained exposed, which could be related to the persistence of DH. Conversely, the NCCLs in the CAF+R group were restored and sealed the exposed dentinal tubules, thereby reducing the chances of this symptom. This study concluded that the presence of resin-modified glass ionomers restoring the tooth surface of CDs does not negatively influence the coverage achieved by CAF. In addition, DH was better resolved when this multidisciplinary approach was followed (*i.e.*, CAF plus restoration), while CAF failed to achieve complete coverage of the CDs.<sup>11</sup> These results were stable after two years of follow-up.<sup>12</sup> Another clinical trial was carried out to evaluate the use of CTG along with CAF, with or without a resin-modified glass ionomer restoration (R) for treating CDs. Forty CDs were randomized to receive either CAF+CTG (Control Group) or CAF+CTG+R (Test Group). After six months, the percentages of CD coverage were  $74.88 \pm 8.66\%$  and  $70.76 \pm 9.81\%$ , respectively, without significant differences between the groups ( $p > 0.05$ ). Although the extent of the CD

coverage was superior with the addition of CTG, no site in either group showed complete CD coverage. Consequently, the results regarding DH were similar to those of the previous study, in which the group that received restorations showed better resolution of DH. This study concluded that the two procedures, that is, CAF+CTG and CAF+CTG+R, provided comparable CD coverage, and the presence of a glass ionomer restoration may not prevent the root coverage achieved by CTG.<sup>6,13</sup> These results were also stable after two years of follow-up.<sup>14</sup>

Resin-modified glass ionomer was the first restorative material used because of its biocompatible properties. Dragoo<sup>15,16</sup> has shown that hopeless teeth, such as teeth with large root caries or cracks, were restored using resin-modified glass ionomer and could then be maintained. Although the restorations were located subgingivally, a shallow probing depth without bleeding on probing was observed. Moreover, histological analysis has shown that healthy connective tissue and epithelium adapted over the restorative material.<sup>15,16,17</sup> Additionally, a study presenting immunological and microbiological evaluations has shown no significant changes in the levels of several cytokines in the gingival crevicular fluid and the presence of five bacteria (*Porphyromonas gingivalis*, *Tannerella forsythia*, *Prevotella intermedia*, *Fusobacterium nucleatum*, and *Streptococcus sanguinis*) when CDs were treated with resin-modified glass ionomer restorations along with CTG.<sup>18</sup> Other studies have shown that resin-modified glass ionomers could be used subgingivally.<sup>19,20</sup> Although this biocompatible restorative material is suitable for use close to or in the subgingival area, it can discolor over time, which may compromise the outcomes in patients with high esthetic demands. In a retrospective analysis, Santamaria et al.<sup>21</sup> evaluated the esthetic results of four different approaches for treating CDs: CAF, CAF+R, CAF+CTG, CAF+CTG+R,<sup>12,14</sup> after two years of follow-up. It was observed that the two groups that received the restorative material presented the worst esthetic results because approximately 50% of the resin-modified restoration had a color that did not match the tooth's color. The literature shows that resin-modified glass ionomers can discolor over time.<sup>22</sup> Even though correction of this esthetic failure

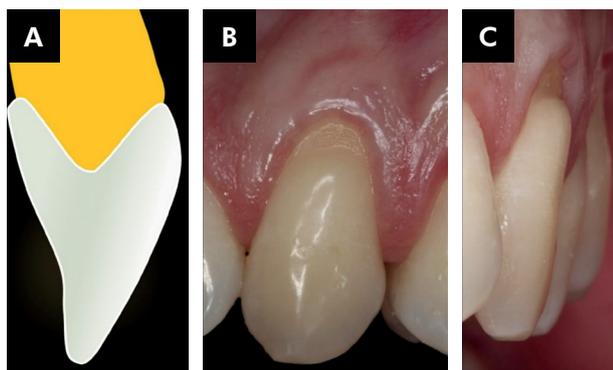
was proposed,<sup>23</sup> it seems that resin-modified glass ionomers may not be the best option for the treatment of CDs, especially in areas of esthetic concerns.

To overcome this limitation of resin-modified glass ionomers, resin composites were evaluated. Lucchesi et al.<sup>10</sup> compared two different surgical-restorative approaches to treat CDs. CAF was associated with either resin composite (microfilled) or resin-modified glass ionomer, both restoring the entire length of the NCCL. These treatments were compared with CAF applied on an intact tooth surface, which is GR not associated with NCCL. The two groups that received restorations achieved similar extents of CD coverage,  $74.18 \pm 15.0\%$  for the resin composite group and  $71.99 \pm 18.7\%$  for the resin-modified glass ionomer group, without significant differences. In addition, the two materials did not present any significant difference in terms of tissue inflammation, with both showing only a few cases with bleeding on probing after six months (1 and 2 out of 20 in each group). This study has shown that similar extents of CD coverage could be achieved regardless of the material used (either resin composite or resin-modified glass ionomer) and that the resin composite is also suitable for subgingival use. An additional analysis of this study was performed, in which the subgingival biofilm of the restored and unrestored sites was compared using the checkerboard DNA-DNA hybridization technique. The results have shown only minor changes in the proportions of *F. nucleatum* that were increased in the resin composite group. The authors concluded that well-finished resin composite or resin-modified glass ionomer restorations did not negatively affect periodontal health.<sup>24</sup> A subsequent randomized clinical trial evaluated the treatment of CDs using CAF+CTG alone (Control group) or CAF+CTG plus restoration of the entire length of the NCCL with resin composite (CAF+CTG+RC - Test Group). No significant differences were observed in terms of CD coverage ( $82.16 \pm 16.1\%$  and  $73.84 \pm 19.2\%$ , respectively), showing that the resin composite did not interfere with the extent of coverage achieved by CAF+CTG. Similar to the results of the previous trial<sup>6</sup> that used a resin-modified glass ionomer, the group that received a restoration presented a better resolution of DH.<sup>25</sup>

It could be observed that regardless of the material used, within the observational period of these clinical trials, the restoration of the entire length of NCCLs prior to the root coverage procedures did not seem to negatively interfere with the extent of soft tissue coverage achieved by different surgical techniques or tissue health (no bleeding on probing). These results were confirmed by other studies.<sup>26,27</sup>

## Classification of tooth surface defects in the presence of recession-type defects

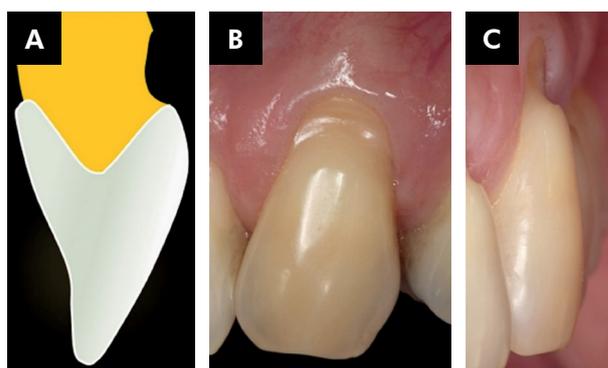
In 2010, Pini-Prato et al.<sup>5</sup> developed a tooth surface defect classification in areas of GR to facilitate the diagnosis and enable the formulation of an appropriate treatment plan for CDs. This classification was based on the presence or absence of a visible CEJ (Classes A and B, respectively) and the presence or absence of surface discrepancy, *i.e.*, presence of a step (Subclasses + and -, respectively). Pini-Prato's classification has four categories: Class A- presents a visible CEJ and no step (the root surface presents a shallow defect < 0.5 mm); Class A+ presents an NCCL (step > 0.5 mm) and a visible CEJ, which means that only the root surface was affected by the NCCL and the enamel was intact; Class B-, unidentifiable CEJ without a step (shallow NCCL affecting the root and crown surface); Class B+, unidentifiable CEJ with a step or deeper NCCL affecting root and crown surfaces (Figures 1-4).



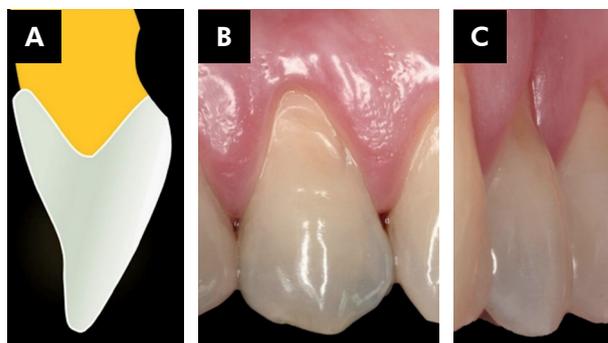
**Figure 1.** Schematic view of the A- tooth surface (a). The gingival recession presents with a visible cementoenamel junction and no step (the root surface presents with a shallow defect < 0.5 mm) (b and c).

## Methods to estimate the levels of lost cementoenamel junction and/or maximum root coverage (MRC)

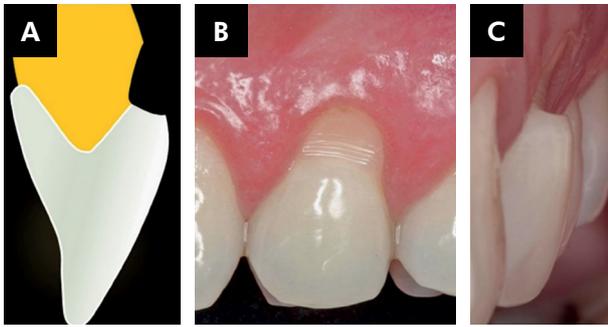
Two studies<sup>28,29</sup> developed methods to estimate the previous location of the CEJ lost due to the progression of the NCCL. Zucchelli et al.<sup>28</sup> proposed a method in which the ideal height of the papilla adjacent to the GR was calculated. The ideal vertical dimension of papillae adjacent to the recession defects was assessed as the distance between the point at which the CEJ crossed the mesiofacial or distofacial line angle of the



**Figure 2.** Schematic view of the A+ tooth surface. A non-carious cervical lesion (NCCL) is associated with gingival recession (GR) affecting only the root surface. The cementoenamel junction (CEJ) and the crown were not involved (a). Facial view of a combined defect (CD) with recession type 1 GR and A+ NCCL. Note the CEJ is still present (b). Lateral view of the same CD. Note the presence of the CEJ (c).



**Figure 3.** Schematic view of the B- tooth surface. A shallow non-carious cervical lesion (NCCL) is associated with gingival recession (GR) affecting both crown and root surfaces; there is no step (a). Facial view of a combined defect (CD) with recession type 1 GR and B- NCCL (b). Lateral view of the same CD. Note that the cementoenamel junction was lost, without the presence of a step (c).



**Figure 4.** Schematic view of the B+ tooth surface. A deep non-carious cervical lesion (NCCL) is associated with gingival recession (GR) affecting both crown and root surfaces; there is a step at the level of the coronal border of the NCCL (a). Facial view of a combined defect (CD) with recession type 1 GR and B+ NCCL (b). Lateral view of the same CD. Note that the cemento-enamel junction was lost, with the presence of a step (c).

tooth and the contact point. At this level, a scalloped line was drawn following the patient phenotype, and this line represented the level of the lost CEJ and line of maximum root coverage (MRC), that is, the level at which the gingival margin is placed in case of complete root coverage for recession type 1 (RT1) GRs.<sup>28</sup> Cairo and Pini-Prato<sup>29</sup> described another method to locate the level of the lost CEJ using either a homologous or contralateral tooth as a reference. For this measurement, two probes were used, one positioned horizontally over the CEJ of the homologous/contralateral tooth, at the base of the adjacent papilla, and the second probe was positioned parallel to the tooth axis at the mid-buccal aspect and crossing the first probe. The mesiodistal width of the crown measured by the first probe at the level of the CEJ and the length of the anatomic crown measured by the second probe were transferred to the tooth presenting with the CD. Then, a scalloped line was drawn connecting the mesiodistal dimension of the crown to the most apical point of the anatomic crown. This scalloped line represented the estimated level of the CEJ.<sup>29</sup> These two methods for determining the location of the lost CEJ in CDs allowed clinicians to anticipate where the gingival margin would be placed if 100% of root coverage was achieved after the surgical procedure (in RT1 cases). Together, these three studies, that is, the classification of the tooth surface<sup>5</sup> and the methods to determine the level of the lost

CEJ,<sup>28,29</sup> were essential to establish specific treatments and new protocols for each clinical situation of CDs.

As reported in the above section, previous studies treated CDs by restoring the entire length of the NCCL (full-length NCCL restoration) using mainly a resin-modified glass ionomer or resin composite combined with CAF or CAF+CTG. It was proposed that only the enamel destroyed by the NCCL be restored using resin composite, considering the evolution of concepts. Hence, the CEJ would be reconstructed by the restorative material, and the root zone of the CD would be left unrestored to be covered later by the gingival tissues. In a case series, 25 CDs were treated with partial restoration of the NCCL reconstructing the CEJ, that is, the apical margins of the restorations were placed at the same level as that of the estimated CEJ level. In addition, CAF or CAF+CTG was performed to cover the apical zone of the CDs. The results after two years showed that 80% of the CDs achieved complete root coverage.<sup>29</sup> Similar results were observed in another case series.<sup>30</sup> The partial restoration of the NCCL as part of the treatment for CD represented an evolution because the gingival tissue covered only a minor portion of its apical part after the surgical procedures and, when needed, the replacement of the restoration would be easier compared to the full-length restoration used previously.

However, the methods to determine the level of the lost CEJ are relatively subjective and, therefore, the final result may be compromised in cases where the estimated CEJ is placed more coronally than the previously destroyed CEJ. In addition, the literature points out that complete root coverage does not occur in all cases. The percentage of complete root coverage ranges from 18.2% to 87%.<sup>31</sup> Therefore, when treating CDs, if the apical margin of the restoration is placed at the same level as that of the estimated CEJ level, then eventually part of the root dentin would be exposed in cases of incomplete root coverage. This situation could be interpreted as a failure. In addition, this failure can increase the risks of persistent DH. Another restorative protocol was proposed to overcome this limitation. In this new approach, the apical margin of the restoration was placed 0.5–1 mm beyond the CEJ (CEJ+1 mm). Therefore, after estimating the location of the CEJ, the restorative procedure reconstructed

the enamel and part of the root surface lost due to the progression of the NCCL<sup>32,33</sup> (Figure 5). This restorative option increased the chances of the apical margin of the restoration being fully covered by the gingival margin, even if complete root coverage was not achieved, avoiding a gap between the apical margin of the restoration and the gingival margin. In the first randomized clinical trial that evaluated this treatment protocol, Santamaria et al.<sup>33</sup> compared the treatment of 40 CDs randomly allocated to receive CAF+CTG and partial restoration (PR) of the NCCL performed with resin composite in which the apical margins were placed 1 mm beyond the CEJ level (CAF+CTG+PR – Test Group). The control group received only CAF+CTG. The results showed similar CD coverage in both groups, without significant differences ( $75.3 \pm 22.7\%$  and  $74.6 \pm 31.5\%$ , respectively;  $p = 0.6$ ), and in the CAF+CTG+PR group, only one case showed a gingival margin not covering the apical border of the restoration. Concordantly with previous studies, the restored group achieved a better resolution of DH. In addition, the CAF+CTG+PR presented a better gingival margin contour, which enhanced the esthetic outcomes. This trial concluded that CAF+CTG+PR, that is, the apical margin of the restoration 1 mm beyond the estimated CEJ level (CEJ+1 mm), is suitable for the treatment of CDs.

Despite no trial having head-to-head compared the different restorative protocols, that is, full-length NCCL restoration,<sup>8,25</sup> partial restoration at the CEJ level,<sup>29,30</sup> partial restoration at the CEJ+1 mm level,<sup>32,33</sup> a recent systematic review has shown no significant difference between various restorative protocols.<sup>27</sup> In addition, recent clinical trials have adopted the last protocol. de Sanctis et al.<sup>34</sup> evaluated the use of CAF for multiple recessions (MCAF) with site-specific CTG application to treat CDs and GR. The CDs were restored using a resin composite at the CEJ+1 mm level. The authors observed that this protocol prior to MCAF or MCAF+CTG did not influence the extent of coverage and the periodontal conditions, and a satisfactory esthetic outcome was achieved. Cairo et al.<sup>35</sup> compared the treatment of CDs partially restored with resin composite at the CEJ+1 mm level with either CAF alone or CAF+CTG. The authors concluded that, after one year of follow-up, the two

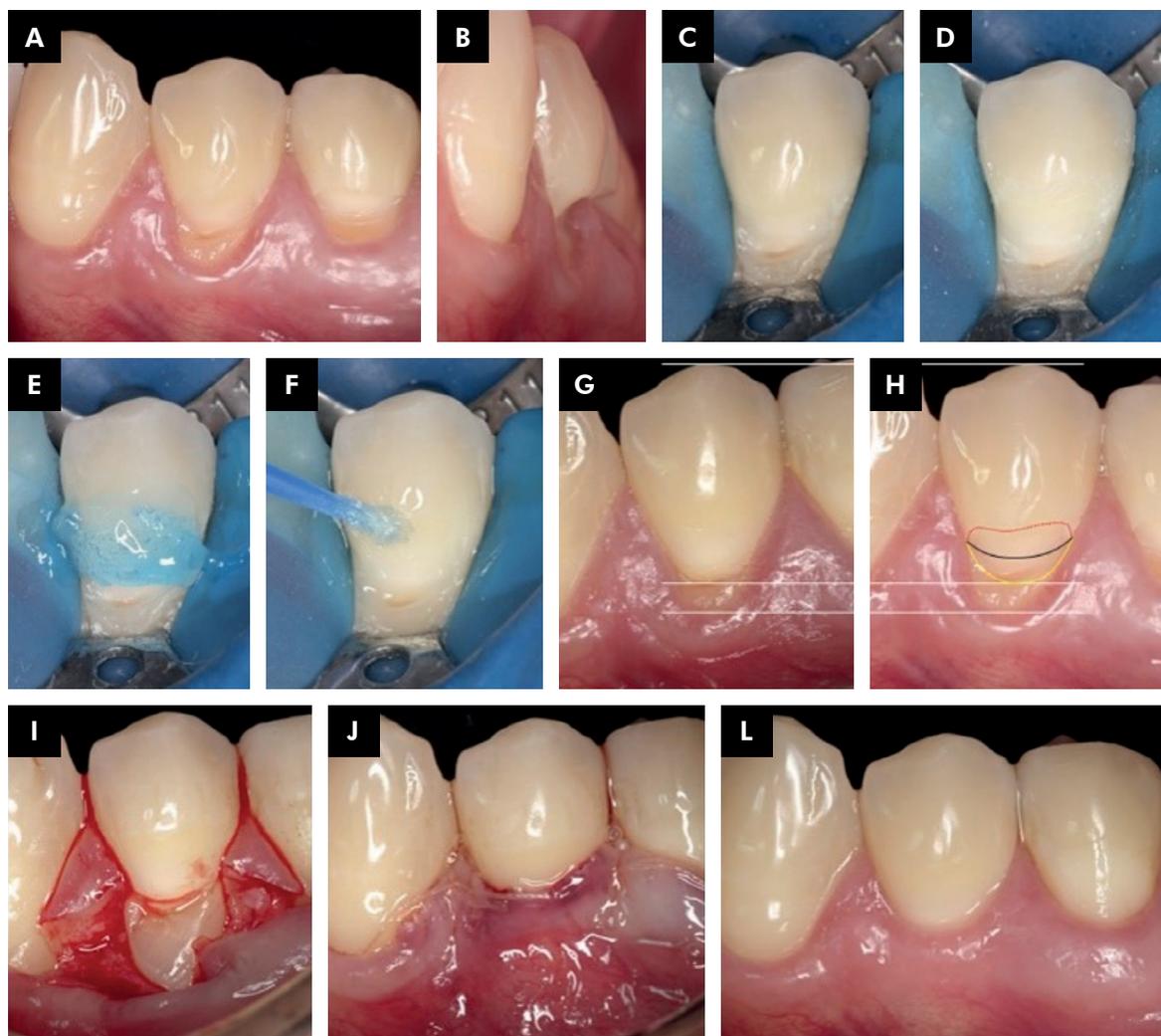
procedures were effective in treating CDs, and adding a CTG under CAF should be considered for sites with a thin gingival phenotype.

## Decision-making process and presentation of an evidence-based algorithm

Previously, a decision-making process to facilitate the treatment of GR associated with NCCLs was proposed based on the topography of the NCCL and its relationship with the extent of MRC achievable by mucogingival procedures.<sup>30</sup> It includes five classes and incorporates an important aspect into the decision-making process: the predetermination of whether the NCCL is totally coverable, partially coverable, or non-coverable by soft tissues after treatment. In addition, it expresses a special concern about the possibility of soft tissue collapse into the NCCL (type 2) and suggests the use of a CTG to fill the space of the radicular defect and help support the flap. Therefore, it is necessary to consider the depth of the NCCL in the process because it may play an essential role in how the lesion can be restored (if required). With this in mind and considering more recently published studies,<sup>32,33,34,35,36</sup> we would like to suggest a new decision-making process based on the classification of the tooth surface defect by Pini-Prato et al.<sup>5</sup> and incorporating considerations on how to deal with extremely deep V-shaped defects.

### Gingival recession (RT1)<sup>37</sup> associated with A- tooth surface (RT1A-)

In this clinical situation, the GR presents with a visible CEJ and no step (the root surface presents a shallow defect  $< 0.5$  mm) (Figure 1). Thus, the treatment for this condition is a surgical procedure for root coverage selected according to the periodontal phenotype. The available evidence indicates that CAF+CTG should be recommended for treating recession at sites with a thin phenotype, that is, thin gingival tissue thickness and less than 2 mm width of keratinized tissue. On the other hand, CAF alone can be performed in cases with a thick phenotype.<sup>38</sup> A thin phenotype (thin gingival thickness) can be identified by the transparency of a periodontal



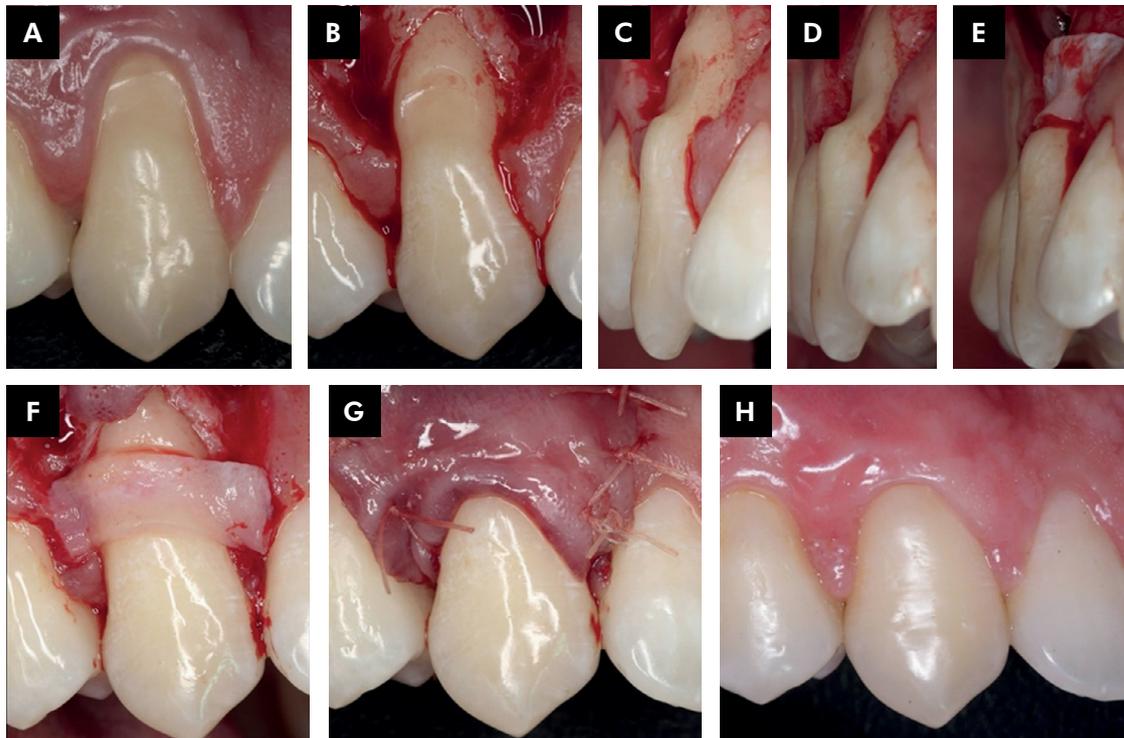
**Figure 5.** Representative case of a combined defect (CD) treated with a partial restoration (CEJ+1 mm) of the non-carious cervical lesion (NCCL) and a coronally advanced flap with connective tissue graft (a-i); Facial (a) and lateral (b) views of the recession type 1 and B+ NCCL. Rubber dam placed (c). Bevel performed to reduce the coronal border of the NCCL and provide a proper and harmonious emergence profile (d). Restorative procedures (e, f). After completion of the restorative procedure. The apical margin of the restoration was placed 1 mm apical to the estimated cemento-enamel junction (CEJ) level (CEJ+1 mm) (g). The red line represents the coronal border of the NCCL, the black scalloped line represents the location of the lost CEJ level, estimated by one of the available methods, and the yellow scalloped line represents the level where the apical margin of the restoration should be (h). After flap preparation, the apical border of the NCCL was planed and the graft was stabilized (i). The flap was coronally sutured (j). One year postoperatively (l).

probe through the gingival margin while probing the sulcus,<sup>39</sup> i.e., if the probe is visible, the gingival tissue can be considered thin. Other existing local anatomical characteristics should also be observed.

### **Gingival recession (RT1)<sup>37</sup> associated with A+ tooth surface (RT1A+)**

In this clinical scenario, the GR is associated with an NCCL that affects only the root surface, and complete

coverage by soft tissues after surgery is likely. Thus, the CEJ and cervical enamel are intact (Figure 2). Usually, when the NCCL is not extremely deep and does not have a V shape, a “biological restoration” is recommended, that is, a CTG is used to fill the remaining gap of the NCCL after root planing associated with CAF<sup>40</sup> (Figure 6). However, when a deep V-shaped lesion is present, the lesion falls into the subclass A+V, and other treatment options are needed.



**Figure 6.** Representative case of A+ combined defect (CD) treated with a coronally advanced flap with connective tissue graft. Buccal view of the CD (a). After flap elevation. Note that the cemento-enamel junction is intact with the presence of a step (b); Lateral view of the root defect (c). After scaling and root planing (d), the graft was placed in position (e, f), coronally advanced flap and sutures (g). Outcome after one year (h).

### Gingival recession (RT1)<sup>37</sup> associated with A+ V-shaped tooth surface (RT1A+V)

This subclass is being proposed because it may require a different treatment approach. Due to its multifactorial etiology, an NCCL can present different geometric forms. They were classified as V-shaped/wedge-shaped, characterized by a sharp internal line angle with a V shape; a saucer-shaped lesion with a rounded internal line angle that is C- or U-shaped; mixed-shaped showing flat gingival and semi-circular occlusal walls with smooth lines and semi-circular in shape.<sup>41</sup> Usually, V-shaped defects are extremely deep (in the buccopulpal direction) but do not extend very high (in the apicocoronal direction), with a depth/height ratio that can be close to 1. Although some studies have addressed the treatment of GRs associated with NCCLs using only flap/graft procedures, there is no evidence showing that a graft procedure would “biologically” seal and fill severely deep ( $\geq 2$  mm of depth) V-shaped cavities.<sup>6,11,25,33,40</sup> In

addition, in some cases of GR recurrence, the gingival margin may “fall” into this cavity. Therefore, a deep V-shaped defect may require restoration, even if only the root surface is affected, owing to its excessive depth. Ideally, the apical margin of the restoration should be kept as far as possible from the apical limit of the NCCL (apical cavosurface angle), allowing a minimum extension of the restorative material to the apical portion of the root surface defect. To do so and to re-establish an adequate emergence profile to receive the graft/flap, bevels at the apical and coronal NCCL angles may be required. However, depending on the extent of the sound structure to be removed and the height of the GR defect, only a conventional NCCL restoration may be performed (no periodontal surgery) if the patient considers the GR to be small with an insignificant discrepancy in relation to the gingival margin of the neighboring teeth. This would avoid a subgingival restoration. However, when a significant GR defect is combined with a deep A+V defect, a full NCCL restoration may be considered

to avoid excessive removal of the tooth structure. In this case, the difficulties related to a possible future need for replacement of the restoration (related to the subgingival location) should be discussed with the patient before a final decision is made (Figure 7).

### Gingival recession (RT1)<sup>37</sup> associated with B- tooth surface (RT1B-)

In this clinical situation, the GR is associated with a shallow NCCL affecting both root and crown. Thus, the CEJ is lost, but no step is observed (Figure 3). Usually, a shallow NCCL without a step presents with a rounded coronal border. For RT1B- cases, two treatment options are available. The first is a mucogingival procedure for root coverage only. Because a shallow NCCL does not bring about a significant discrepancy, the tooth surface is already suitable to receive the flap/graft.<sup>42</sup> In addition, studies have shown that after root coverage procedures, the development/progression of NCCLs may be prevented.<sup>12,14,36</sup> The other option is to perform a restorative procedure to reconstruct the destroyed enamel and part of the root (CEJ+1 mm), after which the root coverage procedure is performed. This option may be indicated when the patient presents with severe DH due to the exposure of the coronal dentin, which cannot be covered by mucogingival procedures.

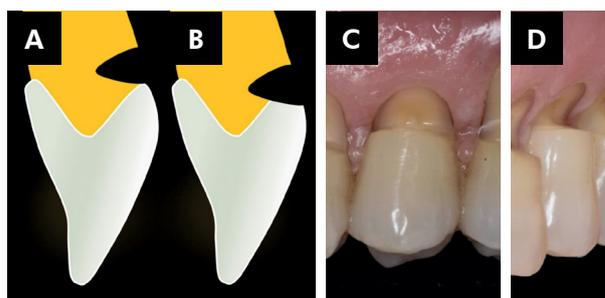
### Gingival recession (RT1)<sup>37</sup> associated with B+ tooth surface (RT1B+)

In this clinical scenario, the GR is associated with a deep NCCL affecting both root and crown. Thus, the CEJ is lost, and steps or significant discrepancies can be observed not only at the coronal border but also at the apical border of CDs (Figure 4). This is the most challenging condition and requires a multidisciplinary treatment plan, involving both restorative and mucogingival procedures. When a non-V-shaped NCCL is present, the most coronal zone may be restored with resin composite before the surgical procedure. It may be recommended that the restoration reconstruct the enamel and up to 1 mm of the root surface (partial restoration with the apical limit at the point estimated 1 mm beyond the CEJ level).<sup>29,33</sup> Then, a procedure for root coverage is performed according to the requirements of the local anatomy. In this scenario, it is essential to perform the

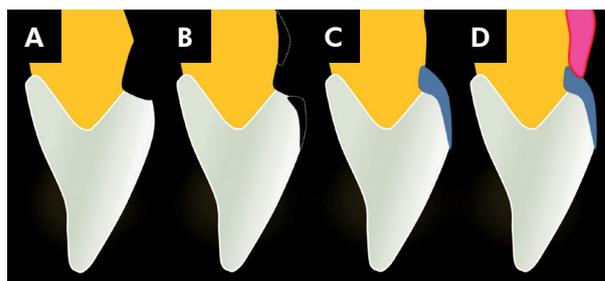
restoration before the surgical procedure because the restoration can modulate the formation of a scalloped gingival margin after the healing period, which can improve the final esthetics<sup>33,43</sup> (Figures 5 and 8).

### Gingival recession (RT1)<sup>37</sup> associated with a B+ V-shaped NCCL (RT1B+V)

This subclass is being proposed because it may require a different treatment plan compared with other B+ surfaces. In contrast to the A+V defect, in which the coronal border of the NCCL is apical to the level of the

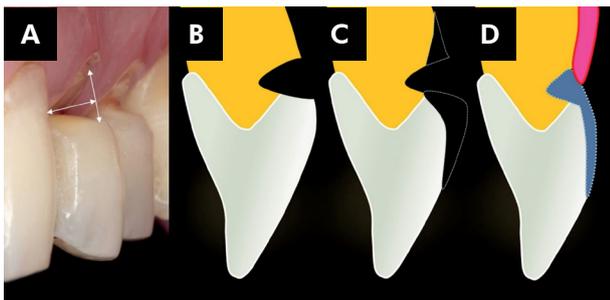


**Figure 7.** Schematic view of the A+V and B+V defects (a, b; respectively). There is a V-shaped non-carious cervical lesion (NCCL) associated with gingival recession affecting either only the root surface (a) or both crown and root surfaces (b). Representative clinical case, facial (c) and lateral (d) views of a combined defect with B+V NCCL.



**Figure 8.** Schematic view of how to manage a B+ tooth surface. Baseline view of the defect (a). The coronal and apical borders of the non-carious cervical lesion (NCCL) should be managed. The two black zones delimited by white dotted lines represent the extent of the structure that should be removed to provide a proper and harmonious emergence profile (coronal zone) and to smooth the root surface to receive the graft/flap (apical zone) (b). After completion of the restorative procedure. The blue area represents the partial NCCL restoration placed apically 1 mm beyond the estimated cemento-enamel junction (CEJ) level (CEJ+1 mm), correcting the emergence profile. Note that the root surface is smooth (c). Final representation after root coverage (d).

MRC and CEJ, in B+V defects, the level of the MRC/CEJ will be somewhere between the apical and coronal borders of the lesion (complete coverage is less likely for this type of lesion). In cases where V-shaped defects are not very high, performing a partial restoration may require a different approach from that used to restore B- and conventional B+ defects (Figure 7). The restorative procedure in B+V situations should also consider keeping the apical margin of the restoration as coronal as possible, allowing a minimum extension of the restorative material to the apical portion of the root surface defect but providing adequate support for soft tissue adaptation (Figure 9). If the GR defect is considered small and insignificant by the patient and the extent of removal of the sound structure necessary to re-establish the emergence profile is excessive, then performing only an NCCL restoration (and not the root coverage surgical procedure) may be an option. In this case, it is possible to avoid placing the restoration subgingivally. When a significant GR defect is combined with a B+V surface defect, a full-length NCCL restoration may be considered (to avoid excessive removal of sound tooth structure). However, the difficulties related to a possible need for future replacement of the restoration should be discussed with the patient before a final decision is made.



**Figure 9.** Clinical and schematic view of the B+V tooth surface (a, b; respectively). Because V-shaped non-carious cervical lesions (NCCLs) can be extremely deep with a depth/height ratio close to 1 (a), a partial restoration performed to treat this defect may be challenging due to excessive removal of sound structure for re-establishing an adequate emergence profile. The two black zones delimited by white dotted lines represent the extent of the structure that should be removed to provide a proper and harmonious emergence profile (coronal zone) and to smooth the root surface to receive the graft/flap (apical zone) (c). The blue area represents the partial NCCL restoration performed for treating extremely deep V-shaped defects (d).

### In addition to these clinical situations, CDs can have RT2<sup>37</sup> GRs

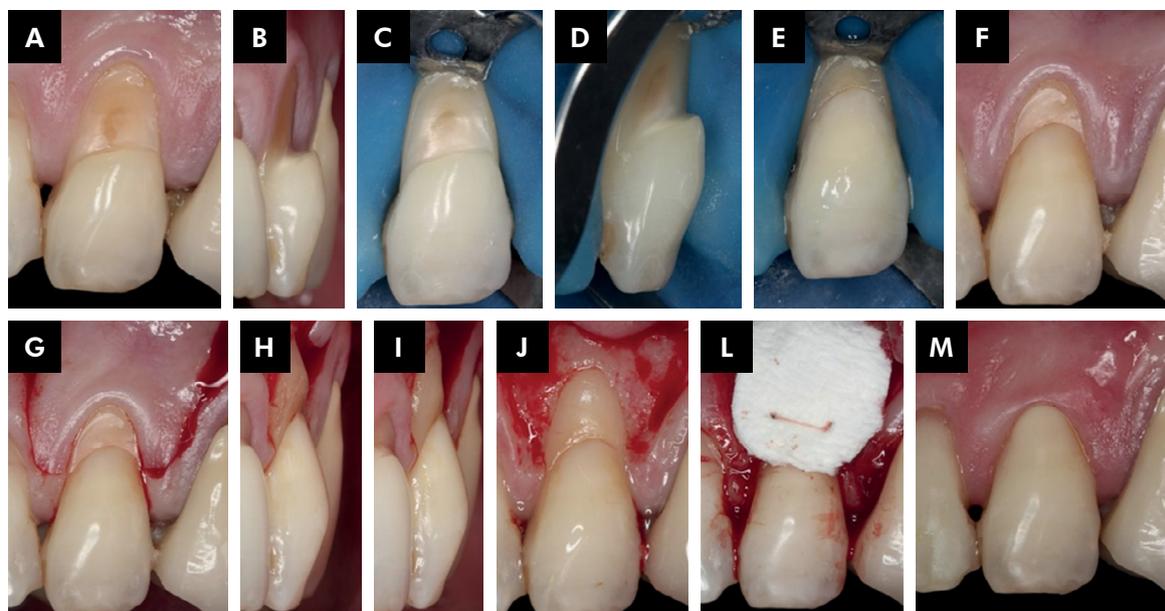
When this is the scenario, due to the unpredictability of the extent of soft tissue coverage that can be achieved and the subjective nature of the estimation methods for the MRC level, it would be advisable to perform the restoration with its apical margin 1 mm beyond this estimated point, which is the MRC level (even Classes A- and A+ may need restoration, especially in cases with severe DH). Similar considerations may apply to V-shaped surface defects combined with RT2 regarding the possible need for a complete NCCL restoration. If the NCCL is completely located in a “non-coverable” zone, only restorative treatment is recommended (Figure 10).

Figure 11 summarizes the possible strategies for the treatment of combined defects based on the condition of the tooth surface.

### Restorative considerations of multidisciplinary approaches

Overall, the two current restorative protocols used for treating CDs are: partial restoration (CEJ reconstruction and CEJ+1 mm restoration) and full-length NCCL restoration. The literature in the field of restorative dentistry provides extensive reports on different adhesives/restorative materials to use for conventional NCCL fillings, namely full-length NCCL restorations. Although resin-modified glass ionomers and glass ionomer-based materials have both presented the lowest annual failure rates,<sup>44</sup> resin composites have been chosen as the first choice due to their esthetic and physical properties.<sup>45</sup> In addition, although there are many types of resin composites available, the literature states that these materials do not influence the retention rates of these restorations. This may be because NCCLs present a small C-factor. This means that the adhesive system plays a major role in the retention of these restorations rather than the type of resin composite.<sup>44</sup> Therefore, understanding the ideal adhesive protocol is of paramount importance.

The literature shows that the best-performing adhesive categories with the lowest annual failure rates are 3-step etch-and-rinse, 2-step self-etch, and



**Figure 10.** Representative case of a combined defect (CD) in which recession type 2 (RT2) gingival recession associated with B+ was treated with partial restoration and periodontal surgery. Buccal and lateral views of the CD (a and b); buccal and lateral views after isolation (c and d). The apical limit of the restoration was placed 1 mm apical to the estimated maximum root coverage level (e and f). Flap design (g) and lateral view of the tooth defect. Note that the apical border of the non-carious cervical lesion (h) was scaled and planed (i and j). View of the collagen matrix graft (l) and final outcome after one year (m).

1-step self-etch (Optibond FL, Kerr; Clearfill SE Bond, Kuraray Noritake; and G-Bond, GC).<sup>46,47</sup> Regardless of the adhesive system chosen, the operator plays a decisive role. It is essential to be aware of the manufacturer's instructions and fully know the step-by-step protocol and apply them correctly.<sup>48</sup> Therefore, it is pointless having the best adhesive system if the procedures were not carried out correctly. Another vital point to achieve optimal bonding is the use of rubber-dam isolation. A systematic review has shown that the type of isolation had a significant influence on the long-term results for the treatment of NCCLs. It was observed that restorations placed under rubber-dam isolation performed significantly better than those placed without it.<sup>49</sup>

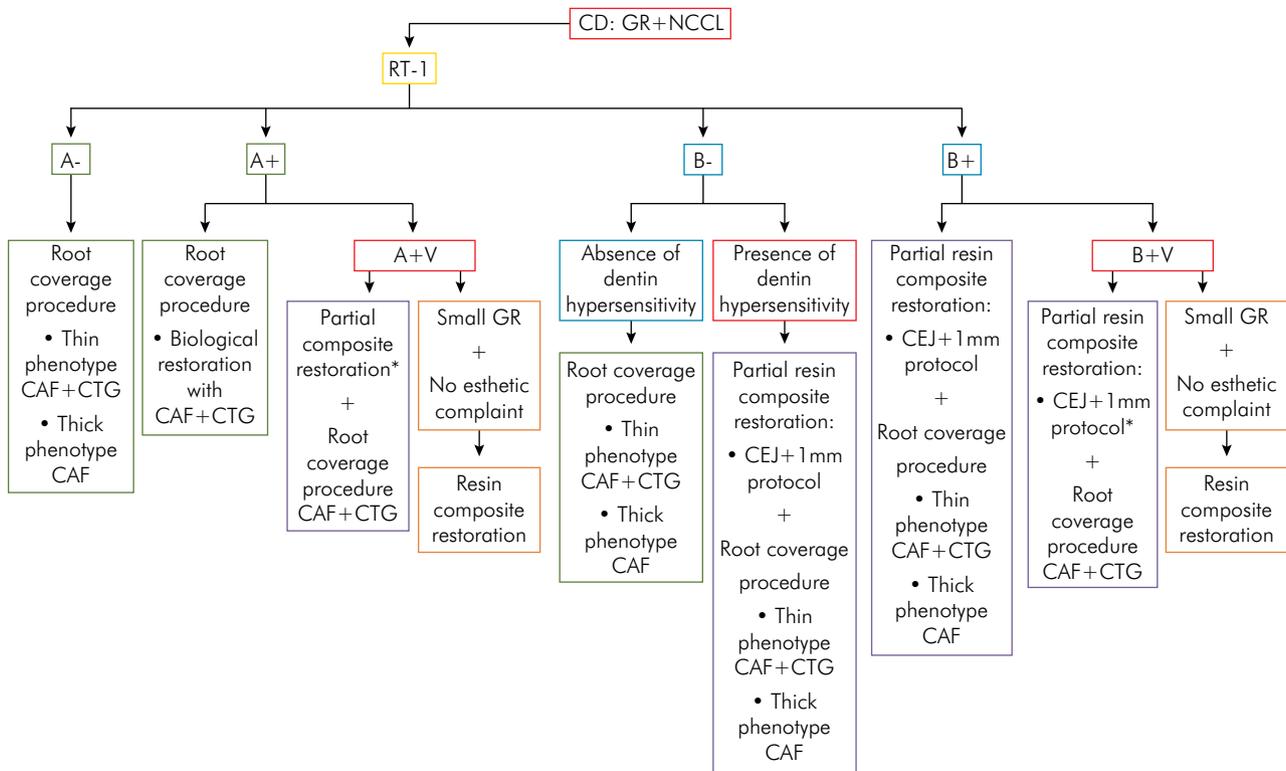
It is important to note that the aforementioned data are from studies that evaluated fully restored NCCLs. Therefore, caution should be taken when this information is applied to the partial restorative protocol suggested for CD treatment. Future studies evaluating the restorative properties of partial restorations must be performed, mainly because of the limited number of randomized clinical trials

on the treatment of GR combined with NCCL using CEJ reconstruction before mucogingival procedures.

## Final considerations

This review aimed to discuss the decision-making process for treating CDs. Two new subclasses were suggested to be added to Pini-Prato's classification of the surface defects in areas of GR, that is, A+V and B+V (V-shaped defects), to facilitate diagnosis and treatment planning. This review does not intend to discuss the options for treating GR alone. CAF+CTG may present a higher percentage of CD coverage. The esthetic evaluation has shown that resin composite is the best material in the long run. However, other clinical trials are needed to evaluate different graft procedures and treatment protocols for multiple CDs. In addition, further studies are necessary to elucidate the best protocol to treat V-shaped defects.

It is clear that before any restorative/surgical procedure, it is necessary to remove or control all the possible etiological factors associated with GR and NCCLs.



\* Full-length NCCL restorations may be considered to avoid excessive removal of the tooth structure. In this case, the challenges related to a possible future need for replacement of the restoration (related to the subgingival location and the need for a second surgical procedure in case of restoration loss) should be discussed with the patient before a final decision is made.

**Figure 11.** Strategies for the treatment of combined defects (CDs) based on the classification of gingival recession and tooth surface condition. An A- tooth surface (visible cementoenamel junction [CEJ]/no step) may be treated by a surgical procedure for root coverage selected according to the periodontal phenotype (a thin phenotype can be identified by the transparency of a periodontal probe through the gingival margin while probing the sulcus, i.e., if the probe is visible, the gingival tissue can be considered thin, and/or absence of at least 2 mm of keratinized tissue). A coronally advanced flap with connective tissue graft (CAF+CTG) should be recommended for treating recession at sites with a thin phenotype, and CAF can be performed in cases with a thick phenotype with at least 2 mm of keratinized tissue. An A+ tooth surface (visible CEJ/with step) may be treated by a surgical procedure for root coverage selected according to the periodontal phenotype. When a deep V shape is present (A+V), two options may be considered: a partial resin composite restoration with a minimum extension of the restorative material to the apical portion of the root surface defect followed by CAF+CTG or, in the case of a small recession, considered insignificant by the patient, only restoration of the non-carious cervical lesion (NCCL) may be performed (no periodontal surgery). A B- tooth surface (no visible CEJ/no step) may be approached by one of these two options: only a root coverage procedure or a combined restorative plus surgical approach. If the patient presents with severe dentin hypersensitivity, it may persist even after the root coverage (the exposed coronal dentin will not be covered by soft tissue). In these cases, a restorative procedure to reconstruct the destroyed enamel and part of the root (CEJ+1 mm protocol, i.e., the apical margin of the restoration placed 1 mm apical to the estimated CEJ level) can be done followed by the root coverage procedure. A B+ tooth surface (no visible CEJ/with step) is characterized by a deep NCCL affecting both root and crown. Thus, the CEJ is lost, and steps or significant discrepancies can be observed not only at the coronal border but also at the apical border of CDs. When a non-V-shaped NCCL is present, its most coronal zone may be restored with resin composite (CEJ+1 mm protocol) before the surgical procedure. A CAF+CTG for a thin phenotype and CAF for a thick phenotype can be performed. When an extremely deep V shape is present (B+V), two options may be considered: a partial resin composite restoration (CEJ+1 mm protocol) followed by CAF+CTG or, in the case of a small recession, considered insignificant by the patients, only restoration of the NCCL may be performed (no periodontal surgery).

Despite the biological properties and good long-term retention of resin-modified glass ionomer materials, resin composites may be recommended

because of their esthetic properties. Future studies are necessary to evaluate the best adhesive protocol for partial restorations.

Finally, future studies should standardize the primary outcome measurements for the treatment of CDs. The available trials evaluated different primary outcomes, such as the percentage of CD coverage, recession reduction (RecRed), and soft tissue coverage measured from the apical border of the restoration. Since the border of the restoration can vary significantly due to the subjective nature of the reference point used, that is, the estimation of the CEJ level, RecRed or the percentage of CD coverage should be used as the primary outcome. In

addition, esthetics (soft tissue/restoration esthetics) and DH should be evaluated by the patient and the professional.

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