

# Mucogingival conditions in the natural dentition: Narrative review, case definitions, and diagnostic considerations

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## Abstract

**Background:** Mucogingival deformities, and gingival recession in particular, are a group of conditions that affect a large number of patients. Since life expectancy is rising and people are retaining more teeth both gingival recession and the related damages to the root surface are likely to become more frequent. It is therefore important to define anatomic/morphologic characteristics of mucogingival lesions and other predisposing conditions or treatments that are likely to be associated with occurrence of gingival recession.

**Objectives:** Mucogingival defects including gingival recession occur frequently in adults, have a tendency to increase with age, and occur in populations with both high and low standards of oral hygiene. The root surface exposure is frequently associated with impaired esthetics, dentinal hypersensitivity and carious and non-carious cervical lesions. The objectives of this review are as follows (1) to propose a clinically oriented classification of the main mucogingival conditions, recession in particular; (2) to define the impact of these conditions in the areas of esthetics, dentin hypersensitivity and root surface alterations at the cervical area; and (3) to discuss the impact of the clinical signs and symptoms associated with the development of gingival recessions on future periodontal health status.

**Results:** An extensive literature search revealed the following findings: 1) periodontal health can be maintained in most patients with optimal home care; 2) thin periodontal biotypes are at greater risk for developing gingival recession; 3) inadequate oral hygiene, orthodontic treatment, and cervical restorations might increase the risk for the development of gingival recession; 4) in the absence of pathosis, monitoring specific sites seems to be the proper approach; 5) surgical intervention, either to change the biotype and/or to cover roots, might be indicated when the risk for the development or progression of pathosis and associated root damages is increased and to satisfy the esthetic requirements of the patients.

**Conclusions:** The clinical impact and the prevalence of conditions like root surface lesions, hypersensitivity, and patient esthetic concern associated with gingival recessions indicate the need to modify the 1999 classification. The new classification includes additional information, such as recession severity, dimension of the gingiva (gingival biotype), presence/absence of caries and non-carious cervical lesions, esthetic concern of the patient, and presence/absence of dentin hypersensitivity.

## KEYWORDS

attachment loss, classification, diagnosis, disease progression, esthetics, gingival recession, periodontal biotype

## INTRODUCTION AND AIMS

Mucogingival deformities are a group of conditions that affect a large number of patients. Classification and definitions are available in a previous review<sup>1</sup> and in the consensus report on mucogingival deformities and conditions around teeth (Table 1).

Among the mucogingival deformities, lack of keratinized tissue and gingival recession are the most common and are the main focus of this review. A recent consensus concluded that a minimum amount of keratinized tissue is not needed to prevent attachment loss when good conditions are present. However, attached gingiva is important to maintain gingival health in patients with suboptimal plaque control.<sup>2</sup> Lack of keratinized tissue is considered a predisposing factor for the development of gingival recessions and inflammation.<sup>2</sup> Gingival recession occurs frequently in adults, has a tendency to increase with age,<sup>3</sup> and occurs in populations with both high and low standards of oral hygiene.<sup>4-6</sup> Recent surveys revealed that 88% of people aged  $\geq 65$  years and 50% of people aged 18 to 64 years have  $\geq 1$  site with gingival recession.<sup>3</sup> Several aspects of gingival recession make it clinically significant.<sup>3,7,8</sup> The presence of recession is esthetically unacceptable for many patients; dentin hypersensitivity may occur; the denuded root surfaces are exposed to the oral environment and may be associated with carious and non-carious cervical lesions (NCCL), such as abrasions or erosions. Prevalence and severity of NCCL appear to increase with age.<sup>9</sup> Because life expectancy is rising and people are retaining more teeth, both gingival recession and the related damages to the root surface are likely to become more frequent.

The focus of this review is to propose a clinically oriented classification of the mucogingival conditions, especially gingival recession; and to define the patient and site impact of these conditions regarding esthetics, dentinal hypersensitivity and root surface alterations at the cervical area. Therefore, definition of the "normal" mucogingival

condition is the baseline to describe "abnormalities". The definition of anatomic and morphologic characteristics of different periodontal biotypes and other predisposing conditions and treatments will be presented. The third focus of this review is to discuss the impact of the clinical signs and symptoms associated with the development of gingival recessions on future periodontal health status.

## METHODS

This article is based mainly on the contribution of the most recent systematic reviews and meta-analyses. In addition, case report, case series, and randomized clinical trials published more recently are included. The authors critically evaluated the literature associated with mucogingival deformities in general and gingival recession in particular to answer the following most common and clinically relevant questions: 1) Is thin gingival biotype a condition associated with gingival recession? 2) Is it still valid that a certain amount of attached gingiva is necessary to maintain gingival health and prevent gingival recession? 3) Is the thickness of the gingiva and underlying alveolar bone critical in preventing gingival recession? 4) Does daily toothbrushing cause gingival recession? 5) What is the impact of intrasulcular restorative margin placement on the development of gingival recession? 6) What is the impact of orthodontic treatment on the development of gingival recession? 7) Is progressive gingival recession predictable? If so, could it be prevented by surgical treatment? 8) What is the impact of the exposure to the oral environment on the root surface in the cervical area?

## Information Sources

An extensive literature search was performed using the following databases (searched from March to June 2016): 1) PubMed; 2) the Cochrane Oral Health Group Specialized Trials Registry (the Cochrane Library); and 3) hand searching of the *Journal of Periodontology*, *International Journal of Periodontics and Restorative Dentistry*, *Journal of Clinical Periodontology*, and *Journal of Periodontal Research*.

## Search

The following search terms were used to identify relevant literature: 1) attached gingiva; 2) gingival augmentation; 3) periodontal/gingival biotype; 4) gingival recession; 5) keratinized tissue; 6) dentin hypersensitivity 7) mucogingival therapy; 8) orthodontic treatment; 9) patient reported outcome; 10) non-carious cervical lesions; 11) cervical caries; and 12) restorative margin.

**TABLE 1** Mucogingival deformities and conditions around teeth<sup>a</sup>

1. gingival/soft tissue recession
  - a. facial or lingual surfaces
  - b. interproximal (papillary)
2. lack of keratinized gingiva
3. decreased vestibular depth
4. aberrant frenum/muscle position
5. gingival excess
  - a. pseudo-pocket
  - b. inconsistent gingival margin
  - c. excessive gingival display
  - d. gingival enlargement
6. abnormal color

<sup>a</sup>(AAP 1999, Consensus Report)

**TABLE 2** Classification system of four different classes of root surface concavities

CEJ	Step	Descriptors
Class A	-	CEJ detectable without step
Class A	+	CEJ detectable with step
Class B	-	CEJ undetectable without step
Class B	+	CEJ undetectable with step

## NORMAL MUCOGINGIVAL CONDITION

### Definition

Within the individual variability of anatomy and morphology “normal mucogingival condition” can be defined as the “absence of pathosis (i.e. gingival recession, gingivitis, periodontitis)”. There will be extreme conditions without obvious pathosis in which the deviation from what is considered “normal” in the oral cavity lies outside of the range of individual variability. Accepting this definition, some of the “mucogingival conditions and deformities” listed previously (Table 1) such as lack of keratinized tissues, decreased vestibular depth, aberrant frenum/muscle position, are discussed since these are conditions not necessarily associated with the development of pathosis. Conversely, in individual cases they can be associated with periodontal health. In fact, it is well-documented and a common clinical observation that periodontal health can be maintained despite the lack of keratinized tissue, as well as in the presence of frena and shallow vestibule when the patient applies appropriate oral hygiene measures and professional maintenance in the absence of other factors associated with increased risk of development of gingival recession, gingivitis, and periodontitis.<sup>2,10</sup> Thereby, what could make the difference, for the need of professional intervention, is patient behavior in terms of oral care and the need for orthodontic, implant, and restorative treatments.

## CASE DEFINITIONS

### Periodontal biotype

One way to describe individual differences as they relate to the focus of this review is the “periodontal biotype”. The “biotype” has been labeled by different authors as “gingival” or “periodontal” “biotype”, “morphotype” or “phenotype”. In this review, it will be referred to as *periodontal biotype*. The assessment of periodontal biotype is considered relevant for outcome assessment of therapy in several dental disciplines, including periodontal and implant therapy, prosthodontics, and orthodontics. Overall, the distinction among different biotypes is based upon anatomic characteristics of components of the masticatory complex, including 1) gingival biotype, which includes in its definition gingival thickness (GT) and

keratinized tissue width (KTW); 2) bone morphotype (BM); and 3) tooth dimension.

A recent systematic review using the parameters reported previously, classified the “biotypes” in three categories:<sup>11</sup>

- *Thin scalloped* biotype in which there is a greater association with slender triangular crown, subtle cervical convexity, interproximal contacts close to the incisal edge and a narrow zone of KT, clear thin delicate gingiva, and a relatively thin alveolar bone.
- *Thick flat* biotype showing more square-shaped tooth crowns, pronounced cervical convexity, large interproximal contact located more apically, a broad zone of KT, thick, fibrotic gingiva, and a comparatively thick alveolar bone.
- *Thick scalloped biotype* showing a thick fibrotic gingiva, slender teeth, narrow zone of KT, and a pronounced gingival scalloping.

The strongest association within the different parameters used to identify the different biotypes is found among GT, KTW, and BM. These parameters have been reported to be frequently associated with the development or progression of mucogingival defects, recession in particular.

*Keratinized tissue width* ranges in a thin biotype from 2.75 (0.48) mm to 5.44 (0.88) mm and in a thick biotype from 5.09 (1.00) mm to 6.65 (1.00) mm. The calculated weighted mean for the thick biotype was 5.72 (0.95) mm (95% CI 5.20; 6.24) and 4.15 (0.74) mm (95% CI 3.75; 4.55) for the thin biotype.

*Gingival thickness* ranges from 0.63 (0.11) mm to 1.79 (0.31) mm. An overall thinner GT was assessed around the cuspid and ranged from 0.63 (0.11) mm to 1.24 (0.35) mm, with a weighted mean (thin) of 0.80 mm (0.19). When discriminating between either thin or thick periodontal biotype in general, a thinner GT can be found in a thin biotype population regardless of the selected study.

*Bone morphotype* resulted in a mean buccal bone thickness of 0.343 (0.135) mm for thin biotype and 0.754 (0.128) mm for thick/average biotype. *Bone morphotypes* have been radiographically measured with cone-beam computed tomography (CBCT).<sup>12,13</sup>

### Tooth position

The influence of tooth position in the alveolar process is important. The bucco-lingual position of teeth shows increased variability in GT, i.e., buccal position of teeth is frequently associated with thin gingiva<sup>14</sup> and thin labial bone plate.<sup>13</sup>

*Prevalence* of different biotypes varies in studies that consider different parameters in this classification. In general, a thick biotype (51.9%) is more frequently observed than a thin biotype (42.3%) when assessed on the basis of gingival thickness, and distributed more equally when assessed on the basis of gingival *morphotype* (thick 38.4%, thin 30.3%, normal 45.7%).

It is generally stated that thin biotypes have a tendency to develop more gingival recessions than do thick ones.<sup>2,10</sup> This might influence the integrity of the periodontium through the patient's life and constitute a risk when applying orthodontic,<sup>15</sup> implant,<sup>16</sup> and restorative treatments.<sup>17</sup>

Gingival thickness, is assessed by:

- Transgingival probing (accuracy to the nearest 0.5 mm). This technique must be performed under local anesthesia, which could induce a local volume increase and possible patient discomfort.<sup>18</sup>
- Ultrasonic measurement.<sup>19</sup> This shows a high reproducibility (within 0.5 to 0.6 mm range) but a mean intra-individual measurement error is revealed in second and third molar areas. A repeatability coefficient of 1.20 mm was calculated.<sup>20</sup>
- Probe visibility<sup>21</sup> after its placement in the facial sulcus. Gingiva was defined as thin ( $\leq 1.0$  mm) or thick ( $>1$  mm) upon the observation of the periodontal probe visible through the gingiva. This method was found to have a high reproducibility by De Rouck et al,<sup>22</sup> showing 85% inter-examiner repeatability ( $k$  value = 0.7,  $P$ -value = 0.002). The authors scored GT as thin, medium, or thick. Recently, a color-coded probe was proposed to identify four gingival biotypes (thin, medium, thick and very thick).<sup>23</sup>

*Keratinized tissue* width is easily measured with a periodontal probe positioned between the gingival margin and the mucogingival junction.

Although *bone thickness* assessment through CBCT has high diagnostic accuracy<sup>12,13,24</sup> the exposure to radiation is a potentially harmful factor.

## Gingival recession

*Gingival recession* is defined as the apical shift of the gingival margin with respect to the cemento-enamel junction (CEJ);<sup>1</sup> it is associated with attachment loss and with exposure of the root surface to the oral environment. Although the etiology of gingival recessions remains unclear, several predisposing factors have been suggested.

### Periodontal biotype and attached gingiva

A thin periodontal biotype, absence of attached gingiva, and reduced thickness of the alveolar bone due to abnormal tooth position in the arch are considered risk factors for the development of gingival recession.<sup>2,3,11</sup> The presence of attached gingival tissue is considered important for maintenance of gingival health. The current consensus, based on case series and case reports (low level of evidence), is that about 2 mm of KT and about 1 mm of attached gingiva are desirable around teeth to maintain periodontal health, even though a minimum amount of keratinized tissue is not needed to prevent attachment loss when optimal plaque control is present.<sup>2</sup>

### The impact of toothbrushing

"Improper" toothbrushing method has been proposed as the most important mechanical factor contributing to the development of gingival recessions.<sup>3,25-28</sup> A recent systematic review however, concluded that the "data to support or refute the association between toothbrushing and gingival recession are inconclusive".<sup>28,29</sup> Among the 18 examined studies, one concluded that the toothbrushes significantly reduced recessions on facial tooth surfaces over 18 months, two concluded that there appeared to be no relationship

between toothbrushing frequency and gingival recession, while eight studies reported a positive association between toothbrushing frequency and recession. Several studies reported potential risk factors like duration of toothbrushing, brushing force, frequency of changing the toothbrush, brush (bristle) hardness and tooth-brushing technique.

### The impact of cervical restorative margins

A recent systematic review<sup>2</sup> reported clinical observations suggesting that sites with minimal or no gingiva associated with intra-sulcular restorative margins are more prone to gingival recession and inflammation. The authors concluded that gingival augmentation is indicated for sites with minimal or no gingiva that are receiving intra-crevicular restorative margins. However, these conclusions are based mainly on clinical observations (low level of evidence).

### The impact of orthodontics

There is a possibility of gingival recession initiation or progression of recession during or after orthodontic treatment depending on the direction of the orthodontic movement.<sup>30,31</sup> Several authors have demonstrated that gingival recession may develop during or after orthodontic therapy.<sup>32-36</sup> The reported prevalence is spanning 5% to 12% at the end of treatment. Authors report an increase of the prevalence up to 47% in the long-term observation (5 years). However, it has been demonstrated that, when a facially positioned tooth is moved in a lingual direction within the alveolar process, the apico-coronal tissue dimension on its facial aspect will increase in width.<sup>37,38</sup> A recent systematic review<sup>2</sup> concluded that the direction of the tooth movement and the bucco-lingual thickness of the gingiva may play important roles in soft tissue alteration during orthodontic treatment. There is a higher probability of recession during tooth movement in areas with  $<2$  mm of gingiva. Gingival augmentation can be indicated before the initiation of orthodontic treatment in areas with  $<2$  mm. These conclusions are mainly based on historic clinical observations and recommendations (low level of evidence).

### Other conditions

There is a group of conditions, frequently reported by clinicians that could contribute to the development of gingival recessions (low level of evidence).<sup>39</sup> These include persistent gingival inflammation (e.g. bleeding on probing, swelling, edema, redness and/or tenderness) despite appropriate therapeutic interventions and association of the inflammation with shallow vestibular depth that restricts access for effective oral hygiene, frenum position that compromises effective oral hygiene and/or tissue deformities (e.g. clefts or fissures). Future studies and documentation focusing on these conditions should be done.

### Diagnostic considerations

Proposed clinical elements for a treatment-oriented recession classification are as follows.

**Recession depth** A recent meta-analysis concludes that the deeper the recession, the lower the possibility for complete root coverage.<sup>40</sup> Since recession depth is measured with a periodontal probe positioned between the CEJ and the gingival margin, it is clear that the detection of the CEJ is key for this measurement. In addition, the CEJ is the landmark for root coverage. In many instances, however, CEJ is not detectable because of root caries and / or non-carious cervical lesions (NCCL), or is obscured by a cervical restoration. Modern dentistry should consider the need for anatomical CEJ reconstruction before root coverage surgery to re-establish the proper landmark.<sup>41,42</sup>

**Gingival thickness** GT <1 mm is associated with reduced probability for complete root coverage when applying advanced flaps.<sup>43,44</sup> GT can be measured with different approaches, as reported previously. To date, a reproducible, and easy approach is observing a periodontal probe detectable through the soft tissues after being inserted into the sulcus.<sup>21-23</sup>

**Interdental clinical attachment level (CAL)** It is widely reported that recessions associated with integrity of the interdental attachment have the potential for complete root coverage, while loss of interdental attachment reduces the potential for complete root coverage and very severe interdental CAL loss impairs that possibility; some studies, however, report full root coverage in sites with limited interdental attachment loss.<sup>45,46</sup>

A modern recession classification based on the interdental CAL measurement has been proposed by Cairo et al.<sup>47</sup>

- **Recession Type 1 (RT1):** Gingival recession with no loss of interproximal attachment. Interproximal CEJ is clinically not detectable at both mesial and distal aspects of the tooth.
- **Recession Type 2 (RT2):** Gingival recession associated with loss of interproximal attachment. The amount of interproximal attachment loss (measured from the interproximal CEJ to the depth of the interproximal sulcus/pocket) is less than or equal to the buccal attachment loss (measured from the buccal CEJ to the apical end of the buccal sulcus/pocket).
- **Recession Type 3 (RT3):** Gingival recession associated with loss of interproximal attachment. The amount of interproximal attachment loss (measured from the interproximal CEJ to the apical end of the sulcus/pocket) is greater than the buccal attachment loss (measured from the buccal CEJ to the apical end of the buccal sulcus/pocket).

This classification overcomes some limitations of the widely used Miller classification<sup>48</sup> such as the difficult identification between Class I and II, and the use of “bone or soft tissue loss” as interdental reference to diagnose a periodontal destruction in the interdental area.<sup>49</sup> In addition, Miller classification was proposed when root coverage techniques were at their dawn and the forecast of potential root coverage in the four Miller classes is no longer matching the treatment outcomes of the most advanced surgical techniques.<sup>49</sup>

The Cairo classification is a treatment-oriented classification to forecast the potential for root coverage through the assessment of interdental CAL. In the Cairo RT1 (Miller Class I and II) 100% root coverage can be predicted; in the Cairo RT2 (overlapping the Miller class III) some randomized clinical trials indicate the limit of interdental CAL loss within which 100% root coverage is predictable applying different root coverage procedures; in the Cairo RT3 (overlapping the Miller class IV) full root coverage is not achievable.<sup>46,47</sup>

#### Clinical conditions associated with gingival recessions

The occurrence of gingival recession is associated with several clinical problems that introduce a challenge as to whether or not to choose surgical intervention. A basic question to be answered is: *what occurs if an existing gingival recession is left untreated?* A recent meta-analysis assessed the long-term outcomes of untreated facial gingival recession defects.<sup>50</sup> The authors concluded that untreated facial gingival recession in subjects with good oral hygiene is highly likely to result in an increase in the recession depth during long-term follow-up. Limited evidence, however, suggests that the presence of KT and/or greater gingival thickness decrease the likelihood of a recession depth increase or of development of new gingival recession.

Agudio et al.<sup>51</sup> (2016) compared the periodontal conditions of gingival augmentation sites versus untreated homologous contralateral sites presenting with thin gingival biotype with or without recessions in a population of highly motivated patients. At the end of the follow-up period (mean of 23.6 ± 3.9 years, range 18 to 35 years), the extent of the recession was reduced in 83% of the 64 treated sites, whereas it was increased in 48% of the 64 untreated sites. However, the amount of recession increase in 20 years was very limited: 1 mm in 24 units, 2 mm in 6 and 3 mm in one. This study showed that thin gingival biotypes augmented by grafting procedures remain more stable over time than do thin gingival biotypes; however, highly motivated patients can prevent the development / progression of gingival recession and inflammation for more than 20 years. Limited evidence also suggests that existing or progressing gingival recession does not lead to tooth loss.<sup>50,51</sup> Even though progression of gingival recession seems not to impair the long-term survival of teeth it may be associated with problems like esthetic impairment, dentin hypersensitivity, and tooth conditions that concern the patient and the clinician.

**Esthetics** Smile esthetics is becoming a dominant concern for patients, in particular when dental treatment is required. However, most of the articles that have been published on this topic did not consider patient-reported outcomes.<sup>2,52</sup> A recent survey of the American Academy of Cosmetic Dentistry (2013) consisting of 659 interviews reported that 89% of the patients decided to start cosmetic dental treatment in order to improve physical attractiveness and self-esteem. Several factors are important in the esthetics of the smile, including the facial midline, the smile line, interdental papillary recession, the size, shape, position, and color of the teeth, the gingival scaffold, and the lip framework.<sup>53-59</sup> All of these factors contribute to the esthetics of a smile. In particular, factors associated with the

**TABLE 3** Classification of gingival biotype and gingival recession

Gingival site				Tooth site	
	REC Depth	GT	KTW	CEJ (A / B)	Step (+/-)
No recession					
RT1					
RT2					
RT3					

RT = recession type, REC Depth = depth of the gingival recession, GT = gingival thickness, KTW = keratinized tissue width, CEJ = cement enamel junction (Class A = detectable CEJ. Class B = undetectable CEJ), Step = root surface concavity (Class + = presence of a cervical step >0.5 mm. Class - = absence of cervical step).

gingival scaffold are the position of the free gingival margins, the color/texture of the gingiva, the presence of scars, and the amount of gingiva displayed by the smile.<sup>53,54,56-58</sup> However, even if all of these factors are identified by the clinicians, little information is available about which variables are better perceived by the patients.<sup>60</sup> It is very clear that esthetic ratings are based on subjective assessment. In a recent study patients' perception of facial recessions and their requests for treatment were evaluated by means of a questionnaire.<sup>61</sup> Of 120 enrolled patients, 96 presented 783 gingival recessions, of which 565 had been unperceived. Of 218 perceived recessions, 160 were asymptomatic, 36 showed dental hypersensitivity, 13 esthetic issues, and nine esthetic + hypersensitivity issues. Only 11 patients requested treatment for their 57 recessions. The authors concluded that perception of gingival recessions and the patients' requests for treatment should be evaluated carefully before proceeding to treatment. Interestingly, a survey among dentists showed that esthetics account for 90.7% of the justification for root coverage procedures.<sup>62</sup> Recently, the Smile Esthetic Index (SEI) has been proposed and validated.<sup>63</sup> Ten variables were chosen as determinants for the esthetics of a smile: smile line and facial midline, tooth alignment, tooth deformity, tooth dyschromia, gingival dyschromia, gingival recession, gingival excess, gingival scars, and diastema/missing papillae. The presence/absence of the aforementioned variables correspond to a number (0 or 1), and the sum of the attributed numbers represent the SEI of that subject (from 0 - very bad, to 10 - very good). The SEI was found to be a reproducible method to assess the esthetic component of the smile, useful for the diagnostic phase and for setting appropriate treatment plans.

**Dentin hypersensitivity** Dentin hypersensitivity (DH) is a common, often transient oral pain condition. The pain, short and sharp, resulting immediately on stimulation of exposed dentin and resolving on stimulus removal, can affect quality of life.<sup>64,65</sup> Of a study population of 3,000 patients, 28% stated that DH affected them importantly or very importantly.<sup>66</sup> Prevalence figures range widely from 15% to 74% depending on how the data were collected. Risk factors include gingival recession. Furthermore, an erosive diet and lifestyle are linked to tooth

wear and dentin hypersensitivity, especially in young adults.<sup>66</sup> Because life expectancy is rising and people are retaining more vital or minimally restored teeth,<sup>67</sup> dentin hypersensitivity occurs more frequently. Treatment modalities include the use of different agents applied to the root surfaces<sup>68</sup> or the application of root coverage procedures.<sup>69</sup> In a recent systematic review,<sup>69</sup> the authors analyzed nine studies on the influence of root coverage procedures on cervical DH. A reduction in Cervical DH was reported in all studies reviewed. The mean percentage of decreased DH was 77.83%. The authors concluded that these results must be viewed with caution because most of the studies had a high risk of bias and cervical DH was assessed as a secondary outcome. There is not enough evidence to conclude that surgical root coverage procedures predictably reduce cervical DH.

**Tooth conditions** Different conditions of the tooth, including root caries<sup>67</sup> and non-carious cervical lesions (NCCL)<sup>70,71</sup> may be associated with a gingival recession. Historically, NCCL have been classified according to their appearance: wedge-shaped, disc-shaped, flattened and irregular areas.<sup>70,71</sup> A link between the morphological characteristics of the lesions and the main etiological factors is suspected. Thus, a U-shaped or disk-shaped broad and shallow lesion, with poorly defined margins and adjacent smooth enamel suggests an extrinsic erosive cause by acidic foods, beverages, and medication. Lesions caused by abrasive forces, such as improper toothbrushing techniques, generally exhibit sharply defined margins and on examination reveal hard surface traces of scratching. There is no scientifically sound evidence that abnormal occlusal loading causes non-carious cervical lesions (abfraction).<sup>9</sup> However, the shape cannot be considered determinative of the etiology. Recent studies found a prevalence of NCCL ranging from 11.4% to 62.2%. A common finding is that prevalence and severity of NCCL appears to increase with age.<sup>70-72</sup>

The presence of these dental lesions causes modifications of the root/tooth surface with a potential disappearance of the original CEJ and/or the formation of concavities (steps) of different depth and extension on the root surface. Pini-Prato et al.<sup>73</sup> (2010) classified the presence/absence of CEJ as Class A (detectable CEJ) or Class B (undetectable CEJ), and the presence/absence of cervical concavities (step) on the root surface as Class + (presence of a cervical step >0.5 mm) or Class - (absence of cervical step). Therefore, a classification includes four different scenarios of tooth-related conditions associated with gingival recessions. (Table 2).

The prevalence of tooth deformities associated with gingival recessions is very high. In the cited study<sup>73</sup> more than half of the 1,010 screened gingival recessions were associated with tooth deformities: 469 showed an identifiable CEJ without a step on the root surface (Class A-, 46%); 144 an identifiable CEJ associated with a step (Class A+, 14%); 244 an unidentifiable CEJ with a step (Class B+, 24%); and 153 an unidentifiable CEJ without any associated step (Class B-, 15%). The presence of NCCL is associated with a reduced probability for complete root coverage.<sup>74,75</sup>

## DIAGNOSTIC AND TREATMENT CONSIDERATIONS BASED ON CLASSIFICATION OF PERIODONTAL BIOTYPES, GINGIVAL RECESSION, AND ROOT SURFACE CONDITIONS

On the basis of the various aspects discussed in the present review a diagnostic approach of the dento-gingival unit is proposed to classify gingival recessions and the associated relevant mucogingival conditions and cervical lesions with a treatment-oriented vision (Table 3). The proposed diagnostic table is based on a 4 × 5 matrix and is explained through the following cases a to d.

### 1. Absence of gingival recessions

The classification is based on the assessment of the gingival biotype, measured through GT and KTW, either in the full oral cavity or in single sites (Table 3).

**Case a.** Thick gingival biotype without gingival recession: prevention through good oral hygiene instruction and monitoring of the case.

**Case b.** Thin gingival biotype without gingival recession: this entails a greater risk for future development of gingival recessions. Attention of the clinicians to prevention and careful monitoring should be enhanced. With respect to cases with severe thin gingival biotype application of mucogingival surgery in high-risk sites could be considered to prevent future mucogingival damage. This applies especially in cases in which additional treatment like orthodontics, restorative dentistry with intrasulcular margins, and implant therapy are planned.

### 2. Presence of gingival recessions

A treatment-oriented classification could be based on the interdental clinical attachment level (score Cairo RT1-3) and enriched

#### *Mucogingival deformities and conditions around teeth\**

1. Periodontal biotype
  - a. thin scalloped
  - b. thick scalloped
  - c. thick flat
2. gingival/soft tissue recession
  - a. facial or lingual surfaces
  - b. interproximal (papillary)
  - c. severity of recession (Cairo RT1, 2, 3)
  - d. gingival thickness
  - e. gingival width
  - f. presence of NCCL / cervical caries
  - g. patient aesthetic concern (Smile Esthetic Index)
  - h. presence of hypersensitivity
3. lack of keratinized gingiva
4. decreased vestibular depth
5. aberrant frenum/muscle position
6. gingival excess
  - a. pseudo-pocket
  - b. inconsistent gingival margin
  - c. excessive gingival display
  - d. gingival enlargement
7. abnormal color

\***FIGURE 1** Modified from the AAP 1999 Consensus Report, shown in Table 1.

with the qualifiers *recession depth, gingival thickness, keratinized tissue width, and root surface condition*. Other potential contributors are *tooth position, cervical tooth wear and number of adjacent recessions*.

**Case c.** A conservative clinical attitude should employ charting the periodontal and root surface lesions and monitoring them overtime for deterioration. The distance from the CEJ to FGM should be recorded as well as the distance between MGJ and FGM to determine the amount of KT present. Development and increased severity of both periodontal and dental lesions would orient clinicians toward appropriate treatment (see **Case d**).

**Case d.** A treatment-oriented approach, especially in thin biotypes and when justified by patient concern or complaint in terms of esthetics and/or dentin hypersensitivity and by the presence of cervical caries or NCCL, should consider mucogingival surgery for root coverage and CEJ reconstruction when needed. This applies especially to cases in which additional treatment like orthodontics, restorative dentistry with intrasulcular margins, and implant therapy are planned.

Recent information on the best approaches to prevent the occurrence of gingival recessions or to treat single or multiple recessions can be found in reviews and reports from the 2014 European Federation of Periodontology (EFP) and 2015 American Academy of Periodontology (AAP) workshops.<sup>2,8,45,46,76,77</sup>

The clinical impact and the prevalence of the root surface lesion, hypersensitivity and patient aesthetic concern associated to gingival recessions indicates the need to modify the 1999 classification on mucogingival deformities and conditions.

The new classification includes additional information, such as periodontal biotype, recession severity, dimension of the residual gingiva, presence/absence of caries and non-cariou cervical lesions, aesthetic concern of the patient, and presence of dentin hypersensitivity (Figure 1).

## SUMMARY AND CONCLUSIONS

Periodontal health can be maintained in most patients under optimal oral conditions even with minimal amounts of keratinized tissue. However, there is an increased risk of development or progression of gingival recession in cases presenting with thin periodontal biotypes, suboptimal oral hygiene, and requiring restorative/ orthodontic treatment.

- Development and progression of gingival recession is not associated with increased tooth mortality. It is, however, causing esthetic concern in many patients and is frequently associated with the occurrence of dentin hypersensitivity and carious/non-cariou cervical lesions on the exposed root surface.
- Esthetic concern, dentin hypersensitivity, cervical lesions, thin gingival biotypes and mucogingival deformities are best

addressed by mucogingival surgical intervention when deemed necessary.

- A novel treatment-oriented classification based on the assessment of gingival biotype, gingival recession severity and associated cervical lesions is proposed to help the clinical decision process.

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