Gingival Recession: Clinical Examination and Diagnostics

4

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Abstract

This chapter offers a practical approach to the diagnostic process in everyday dental practice. Gingival recessions are highly prevalent, and presence and extent increase with age.

When regression of the gingival margin is noticed, a structured diagnostic process of information gathering should be initiated. As gingival recessions might have several aetiologies, it is of utmost importance for the practitioner to be able to compile anamnestic, clinical, and radiologic signs and symptoms, as well as laboratory information. This process allows for differential diagnoses of possible underlying reasons and the decision-making in respect to future treatment options or necessities. The assessment of tissue dimensions is necessary to qualify, quantify, and monitor changes during periodontal, restorative, prosthetic, orthodontic, or implant therapy or lifelong maintenance. The practitioner shall be enabled to recognize underlying predisposing and precipitating causes for gingival recessions, evaluate possible risk factors, assess potential for progression, and build a solid base for further decision-making.

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For definitions refer to Chap. 1.

4.1 Chief Complaint, Specific Reason for the Visit or Referral

Get to know your patient: Make sure you understand the patient's demands, expectations, and fears. Miscommunication in the very beginning of a therapeutic relationship may cause future troubles and even elicit legal consequences.

- What is the patient's chief complaint?
  Note: Many patients complaining of receding gums do in fact fear future tooth loss.
- Is the patient in pain, and is tooth/root sensitivity reported?
- How relevant or important are any aesthetic problems subjectively? Is there complaint of "a toothy smile"/tooth discoloration/black triangles?
  Note: For evaluation of subjective items, use of a visual analogue scale (VAS) may be useful [1].
- Was the problem noticed by the patient himself, or was he made aware of it?
- Is the onset of recession acute, or is the history of complaint longstanding? Is there (documented) progression? What is the time frame of progression? *Note: Patients who were made aware of a problem sometimes report it as if it had happened "overnight".*

4.1.1 Medical History

Background: Several systemic diseases and conditions are associated with oral signs and symptoms [2], and many drugs are known to modify gingivitis/periodontitis [3]. Diabetes mellitus is an important risk factor for periodontal inflammation if poorly controlled. Last but not least, age, hormonal changes (e.g. puberty, pregnancy, menopause), and stress (at work, financial, domestic, etc.) influence oral tissues. Make sure that reported diseases and medications do correspond. Regular alcohol use may have a negative impact on either periodontal tissues and/or adherence to treatment. Of particular importance for the evaluation of gingival recessions are the following:

- Tobacco use (duration, daily consumption): Very important for the diagnostic process (less overt bleeding), risk for recession, and healing response [4].
- Dietary habits: Increased risk for caries on denuded root surfaces? Erosive potential of diet (hypersensitivity, abrasion) [5]?
- Recreational drugs (cocaine, meth, smokeless tobacco, bethel nut, etc.) either have direct local influence on oral tissues, are a risk factor for caries (by diminishing saliva flow), or induce negligent behaviour [6].

4.1.2 Dental History

Comprehensive exploration is desirable as past (dental) treatment may be the reason of today's problems. Old radiographs and/or photographs and/or casts are useful for judging progression.

- Orthodontic treatment in the past may be the reason for present recessions.
- Oral appliances (removable partial dentures/denture clasps, occlusal splints, removable orthodontics, anti-snoring mouthpieces, etc.) may impinge on periodontal tissues.
- A history of periodontitis, or necrotizing ulcerative gingivitis/periodontitis (NUG/NUP), or (mechanical/chemical) trauma may explain loss of soft and/or hard tissue attachment, especially interdentally [7].
- Periodontal treatment or surgical procedures may have caused soft tissue recessions.
- Aesthetic dentistry/splinting/filling on anterior teeth may have been used to mask tooth drifting/pathological migration/recessions.
- Oral (hygiene) habits
  - Oral hygiene aids, toothpastes and mouth rinses, frequency/duration of use
  - Nail biting /pen chewing/factitious lesions [8]

4.2 Clinical Examination

Unfortunately, in times of advanced imaging methods, this procedure is sometimes insufficiently utilized. However, to rule out other pathology, it should be performed thoroughly. Make use of adequate illumination, dry areas of interest with suction/compressed air, and inspect and palpate the tissues. Especially in cases of progressive recessions and reported pain, any inflammatory process must be excluded. Systemic diseases may manifest in the oral cavity. Acute painless lesions are always suspicious for malignancy. Soft tissues of the muscles, cheeks, tongue, salivary glands, floor of the mouth, back of the throat, and tonsils should therefore be included in a systematic examination. All patients should be screened for periodontal disease [9].

Assess factors and their relevance for present soft tissue and/or bone loss, and identify predisposing and precipitating conditions (those easily modifiable are marked with an asterisk*) that need to be addressed during future patient management (Table 4.1). Determination of the periodontal biotype, defined by parameters such as gingival thickness (GT), tooth dimension (TD), amount of keratinized tissue (KT), and bone morphology, is of importance for tissue and patient management [14].

Table 4.1 Predisposing and precipitating factors for recessions, adapted from [10–13]

Predisposing factors	Precipitating factors
Tooth (mal)position/tipping	*Plaque, plaque-induced inflammation: Gingivitis, periodontitis
Gingival biotype Thin tissue Functionally inadequate quantity/quality of keratinized/attached gingiva	*Calculus
Frenum pull/muscle attachment/muscular dysbalance/shallow vestibulum	*Trauma: mechanical, chemical, thermal Smoking Overzealous toothbrushing/flossing Piercings Habits Deep bite
Bone dehiscence	Iatrogenic: Orthodontic tooth movement Subgingival restoration margins Oral surgery Ill-fitting restorations/prostheses

4.2.1 Aesthetic Assessment

Caveat: Objective and subjective findings do not necessarily have to correspond, as a significant correlation between neuroticism and general satisfaction with face and body appearance has been found [15]. Still, basic assessment of harmony and symmetry should be undertaken and documented. Facial symmetry, angle class relation, occlusion, dysgnathia, and lip framework at rest, in function, and during smile are important parameters of red/white aesthetics to be taken into account. Although the extent of soft tissue display during a smile is not the most important aesthetic issue, the way the soft tissues are arranged relative to the teeth and lips is of concern in respect to facial aesthetics: A high lip line draws more attention to an uneven gingival contour [16].

4.2.2 Mucosa

Inspect for adequate lubrification, pigmentation, any lesions, or growths. Aphthous lesions are often seen secondary to medication (e.g. non-steroidal anti-inflammatory drugs), stress, or Behçet syndrome. Colour changes [17]: pallor can be present with anaemia, while pigmentation can be associated with ethnicity, tobacco, dietary intake, medications, diseases, or syndromes. Haematomas, varices, and petechiae appear to be pigmented. Diffuse swelling and cobblestone mucosa may be seen even before intestinal symptoms in Crohn's disease patients.

Special attention should be given to:

- Depth of vestibulum: adequate space for oral hygiene procedures.
- Frenula: possible frenum pull at place of insertion.

- Scar tissue might exert tension.
- Piercings: position of the intraoral disc in relation to the gingiva [18].

4.2.3 Gingiva

Check for gingivitis and periodontitis; assess colour, contour, texture, and swellings. Is the colour consistent with the patient's intraoral pigmentation and skin complexion (mucogingival disorders, amalgam tattoos, malignoma)? Gingival enlargement/overgrowth may be drug-associated; desquamative gingivitis is often seen with lichen planus, systemic lupus erythematosus, pemphigus, pemphigoid, and lichenoid reactions [19].

Assess the periodontal biotype [20]: As visual inspection alone is not reliable enough to judge gingival thickness [21], the gingiva should be described based on the observation of the periodontal probe shining through [22]. Note that the biotype may differ between the lower and upper jaw within the same patient [23].

- Gingival biotype (Fig. 4.1a–d) [24, 25]: Categorize according to visibility of periodontal probe after insertion into the facial sulcus.
  - Thin scalloped: association with triangular-shaped crown, subtle cervical convexity, interproximal contacts close to incisal edge, narrow zone of KT, thin delicate gingiva, and relatively thin alveolar bone (Fig. 4.1a)
  - Thick scalloped: associated with slender teeth, thick fibrotic gingiva, narrow zone of KT, and a high gingival scallop (Fig. 4.1b)
  - Thick flat: associated with more square-shaped tooth crowns, pronounced cervical convexity, large interproximal contact located more apically, broad zone of KT, thick, fibrotic gingiva, and thick alveolar bone (Fig. 4.1c)
- Width of keratinized (attached and free) tissue/gingiva (in case of implants, i.e. *mucosa*) (KT)
  - Rolling test: see Fig. 4.2a.
  - Staining test: with Lugol's iodine solution [26]; check medical history for allergy/thyroid issues; see Fig. 4.2b.
- Width of attached tissue: subtract PPD from width of KT (= KT−PPD)
- Width of KT tissue at neighbouring teeth
- Soft tissue margin level: alterations in gingival morphology, irregularities?
  - Draw a line connecting the most apical points of the facial aspect at the midfacial level of the soft tissue margins at adjacent teeth.
  - Inconsistent heights of gingival margins in comparison with neighbouring teeth (Fig. 4.3a); incomplete or delayed/altered passive eruption (Fig. 4.3b).
- Interdental papilla
  - Presence or absence: loss due to periodontal disease, missing contact point (Figs. 4.3a and 4.4a), or tooth position next to edentulous area
  - Classification of papilla height (distance between the tip of the papilla to a line connecting the midfacial level of the soft tissue margin of two adjacent teeth [27]) after identifying anatomical landmarks: interdental contact point (iCP), facial apical/buccal extent of the cemento-enamel junction (fCEJ), and interproximal/coronal extent of the CEJ (iCEJ)

Nordland and Tarnow [28]: normal papilla (fills embrasure space to the apical extent of the iCEJ); class I (tip of papilla between iCP and most coronal extent of iCEJ); class II (tip of papilla at or apical to iCEJ but coronal to the apical extent of fCEJ) (Fig. 4.3a); class III (tip of papilla level with or apical to fCEJ) (Fig. 4.6a)

- Cardaropoli et al. [29]: Papilla Presence Index (PPI) 1–4 (Figs. 4.3a and 4.4a)

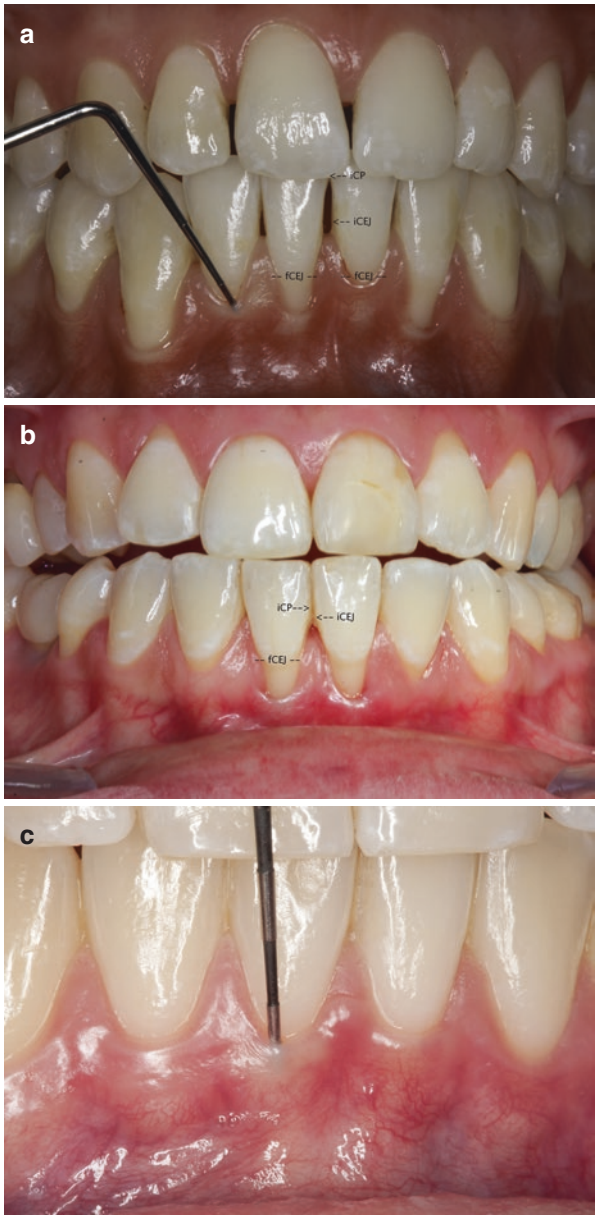

Fig. 4.1 (**a**) Thin-scalloped biotype, periodontal probe shining through delicate free gingiva, PPD 1 mm; note location of papilla tips due to natural diastemas and recessions mostly at teeth with buccal position; (**b**) thick-scalloped biotype; (**c**) thick-flat biotype with broad band of keratinized tissue, thick, fibrotic gingiva

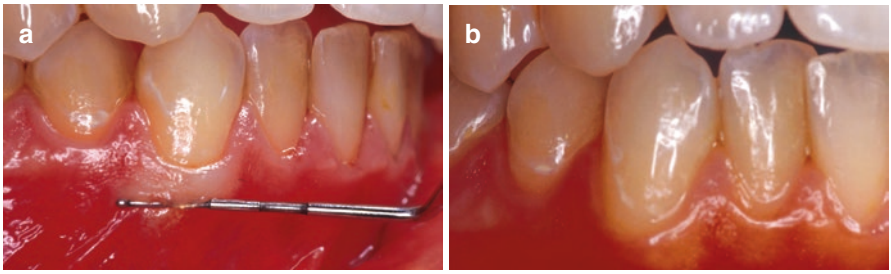

Fig. 4.2 (**a**) Rolling test: softly push the adjacent mucosa coronally with a periodontal probe to identify width of the blanching attached gingiva/tissue. (**b**) Staining test with Lugol's iodine: glycogen containing mucosa stains brownish in contrast to orthokeratinized gingiva

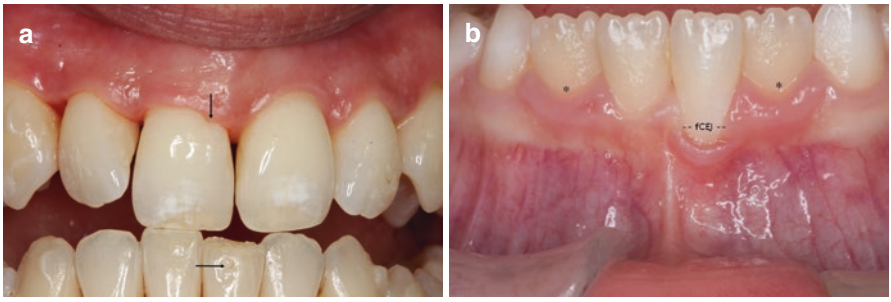

Fig. 4.3 (**a**) Irregular gingival scallop due to developmental enamel indentation #11, loss of central papilla height (class II (Nordland and Tarnow), PPI 3 (Cardaropoli et al.)); (**b**) inconsistent height of gingival margin (incomplete eruption of #32, #42, recession in #31)

- Gingival thickness
  - Transgingival probing: After local anaesthesia a periodontal probe or a needle is pierced vertically to the mucosal surface (optionally a silicone disc can be placed to facilitate reading of the measurement) until resistance of the bone is felt [30].
  - Ultrasonic pulse-echo [31]: SDM® (Krupp Corp., Essen, Germany; manufacturing discontinued)
- Aberrant frenal insertions: Ankyloglossia? Blanching? (Fig. 4.4a–d)
- Oral hygiene-induced or self-induced lesions
  - Stilman's clefts? Incomplete (red) or complete (white) lesions [32], (Fig. 4.5a–c)
  - McCall's festoons
  - Gingival erosions (Fig. 4.5d)

4.2.4 Periodontal Assessment

Make use of a periodontal probe with millimetre markings (e.g. North Carolina, UNC-15, Williams). Assess gingival inflammatory status. Gently run the periodontal probe around the gingival margin area at the dentogingival junction: No bleeding

Fig. 4.4 (**a**) Buccal position of #31 and #41 and gingival recession, very thin zone of KT, frenum pull, blanching, missing contact point, low interdental central papilla (PPI 4 (Cardaropoli et al.); (**b**) irregular frenum, frenum pull at #13 with blanching; (**c**) irregular frenum, lingual position of #41, lingual recessions, persistent lingual frenum; (**d**) irregular frenula, buccal recessions #22–25, cervical abrasions #23, frenum pull and blanching in #23 and #24, possible plaque niche # 24 distal of frenum insertion

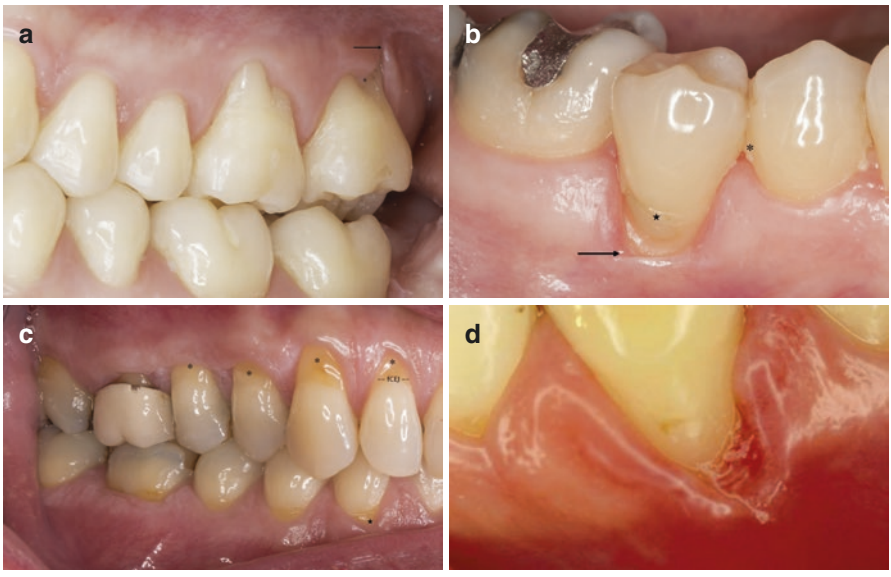

Fig. 4.5 (**a**) Red Stilman's cleft at distobuccal root of #27 (note buccal malposition); (**b**) buccal malposition of #45, loss of buccal soft (red Stilman's cleft) and hard tissue, due to overzealous toothbrushing (however, note insufficient plaque control interdentally); (**c**) generalized buccal recession and abrasions, white Stilman's clefts #12 and #34; (**d**) gingival erosion due to self-inflicted trauma (brushing and flossing) #33, red Stilman's cleft #32

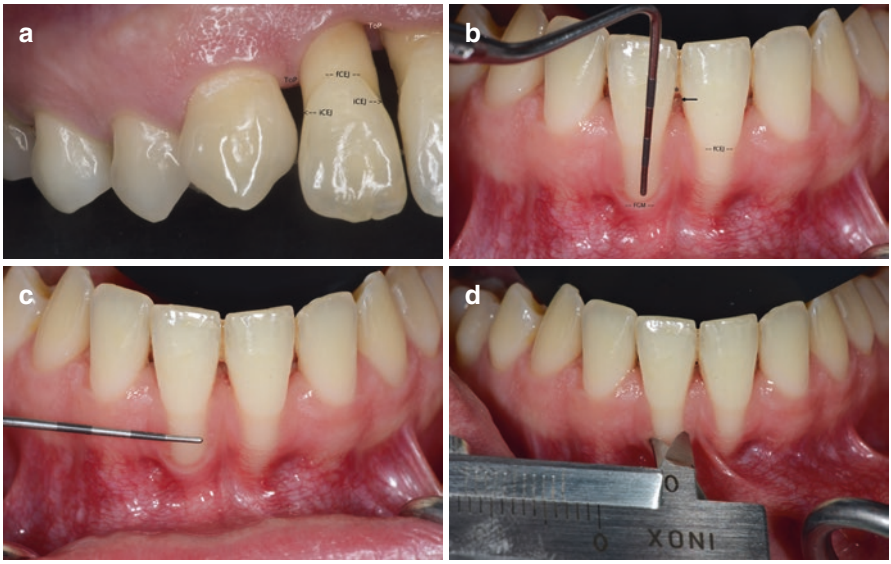

Fig. 4.6 (**a**) Healthy (in #12 and #11 reduced) periodontium (note circumferential recession, loss of interdental papilla due to past periodontal disease/treatment), incomplete eruption of #13, papilla height class III between #12 and #11 (Nordland and Tarnow), (**b**) assessment of width, and (**c**) height of recession making use of a periodontal probe or (**d**) a caliper (note extremely thin blanching buccal tissue in #31)

correlates with healthy conditions. *Note: In heavy smokers there might be diminished bleeding.*

- Exposure of tooth root surface visible: gingival recession (REC) (i.e. "location of the gingival margin apical to the cemento-enamel junction" [33]). This might be a result from apical migration of either uninflamed gingival tissues with normal bone levels or in the case of periodontal bone loss, or as a combination of both.
  - Location: facial/oral or proximal?
  - *Note: If interproximal recessions are visible, circumferential loss of attachment is present* (Fig. 4.6a).
  - Single/multiple?
- Identification of the CEJ: in healthy situations normally not visible, as covered by free marginal gingiva [34] (Chap. 1, Fig. 1.1)
  - Tactile approach with 45° angulated probe: beware of diagnostic pitfalls such as with cervical abrasions, restorations, rotated teeth, and incompletely erupted teeth (delayed and altered passive eruption) [35].
  - Compare with neighbouring teeth (incomplete eruption; Fig. 4.3b) or estimate if CEJ is no longer visible/obliterated (Fig. 4.9a–c).
- Extension of recession (REC)
  - Recession depth: distance free gingival margin (FGM) to CEJ (Chap. 1, Fig. 1.1, Fig. 4.6b)
    Apical border within or beyond the MGJ?

  - Recession width (measured at most coronal part) (Fig. 4.6c, d)
- Probing pocket depth (PPD): distance FGM to bottom of sulcus/pocket; use standardized gentle probing force (0.25 N), probe angulation 0–10°
  - Guide probe along root surface until first resistance of the gingival connective tissues is met, "walk probe" around tooth, measure deepest measurement at 6 sites (3 b, 3 l) to the nearest millimetre. Record measurements as positive numbers if apical of CEJ; when the gingiva is extending above the CEJ, record as negative numbers (Fig. 4.7).
- Clinical attachment level (CAL) = REC + PPD.
- Assess bleeding on probing (BoP) or exudation within 30 seconds after probing as they are signs of inflammation.
- In molars assess presence, location, and extent of furcations [36].

4.2.5 Teeth

Check for patient's oral hygiene (plaque, supra-/subgingival calculus) and anatomical features such as furcations, grooves, enamel projections, concavities (Fig. 4.3a), and resorptions. Determine tooth/root position, CEJ, and tooth form: Tooth form determines the most apical point of the contact area and has been found to correlate with the extent of the keratinized tissue KT, its bucco-lingual gingival thickness (GT), as well as height of the interdental papilla [37]. Furthermore it is a predictor for gingival and buccal alveolar bone thickness [38].

- Tooth form [39]
  - Square: associated with thick-flat tissue, large interproximal contact located more apically, a broad zone of KT, thick, fibrotic gingiva, and a comparatively thick alveolar bone

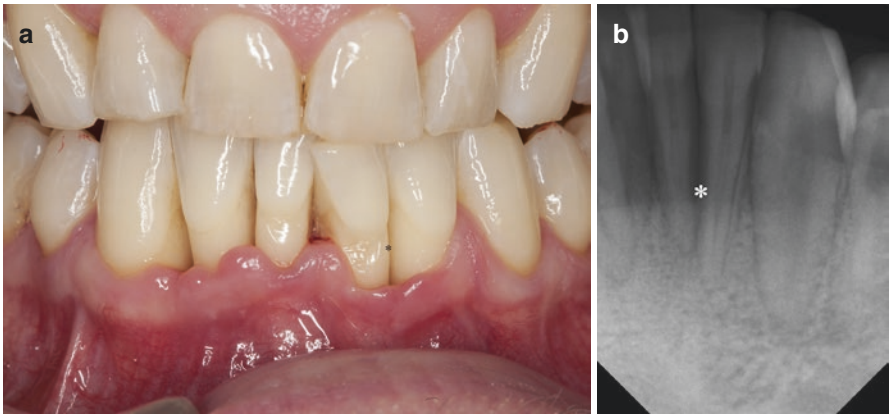

Fig. 4.7 (**a**) Buccal position/rotation of #31, root proximity #31/32, interdental and buccal recessions up to 5 mm in 5th sextant, PPD up to 5 mm, CAL up to 10 mm (#31); (**b**) periapical radiograph of #31/21 with bone loss of more than 2/3 of the root length

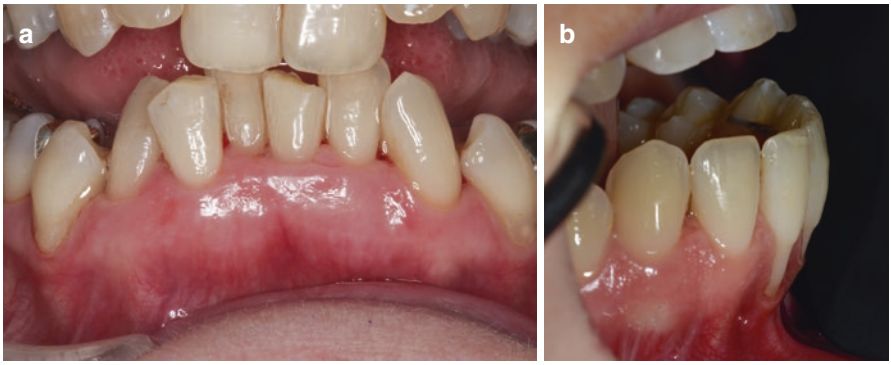

Fig. 4.8 (**a**) Multiple misalignments of front teeth in all three planes; (**b**) same case as 4.6b–d: buccal malposition of #31 (Miller class I recession), #41 (Miller class II recession), minimal zone of keratinized attached gingiva, marginal gingivitis in #41

  - Square-tapered: higher interproximal papilla, less keratinized tissue, and thinner bucco-lingual GT than patients with square teeth
  - Triangular: association with higher interproximal papilla, less keratinized tissue and thinner bucco-lingual GT, and a relatively thin alveolar bone
- Tooth (mal)position in the arch in three planes: rotated, tilted, displaced, and incompletely erupted (Figs. 4.1a, 4.4a, c, 4.5b, 4.7a, and 4.8a, b)
  - Vertical (apical-coronal): cervical portion apical or coronal of the FGM of adjacent teeth (Fig. 4.8a)
  - Sagittal (buccal-lingual): variability of gingival thickness and underlying bone plate (Fig. 4.8b)
  - Horizontal: crowding, rotation (Fig. 4.8a)
- Caries and non-carious tooth substance loss (erosive/abrasive lesions, Fig. 4.9a [40])
  - For identification of the former CEJ, try to compare with adjacent teeth (Figs. 4.5c and 4.9b).
- Hypersensitivity of root surface?
- Sensitivity to thermal testing: pulpal pathology
- Mobility: horizontal and/or vertical (check with handles of two instruments)
  - Signs of occlusal trauma: wear facets, attrition
  - Loss of periodontal support

4.2.6 Restorations/Appliances

Assessment of fixed or removable appliances should reveal any trauma to soft or hard tissues due to impingement, plaque accumulation, or exertion of torque.

- Pre-existing conditions/restorations (class V fillings): Identify former CEJ (Fig. 4.9a–c)
- Overhanging/retentive margins

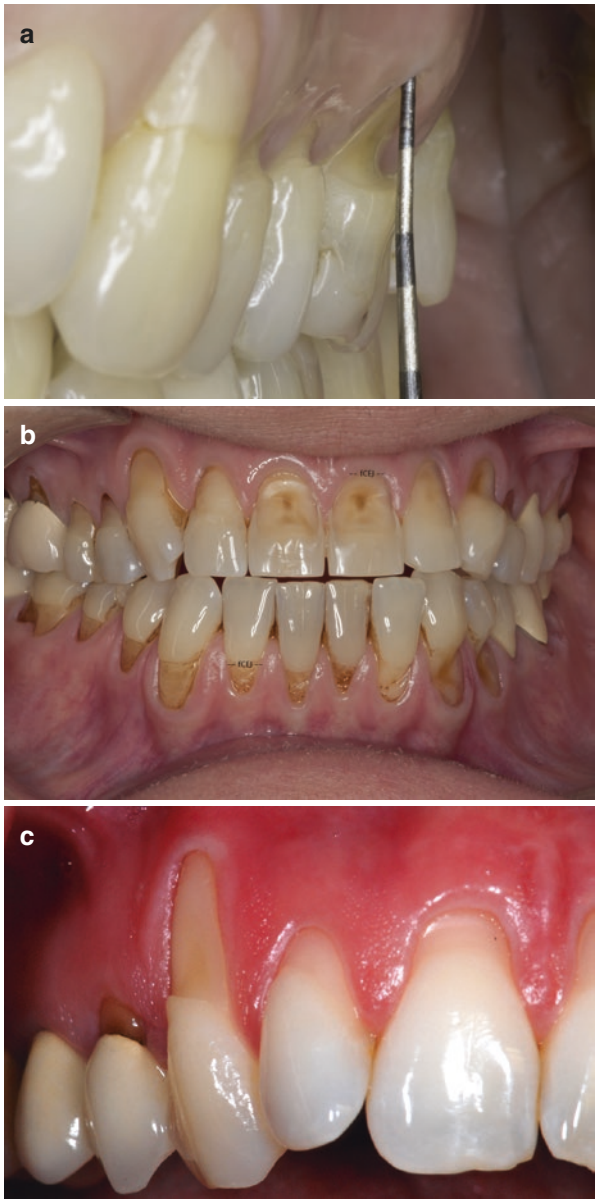

Fig. 4.9 (**a**) Visualization of amount of non-carious buccal tooth substance loss #26, buccal restoration #23 exceeding the CEJ; (**b**) buccal non-carious tooth substance loss, assessment of CEJ in #13, 23, 34, and 33 is only possible in comparison with adjacent tooth/crown margins; (**c**) multiple recessions first quadrant up to 8 mm (#13), buccal dentinal abrasions

- Clasps, bands, etc.
- Non-passive orthodontic retainers
- Piercings (Fig. 4.10)

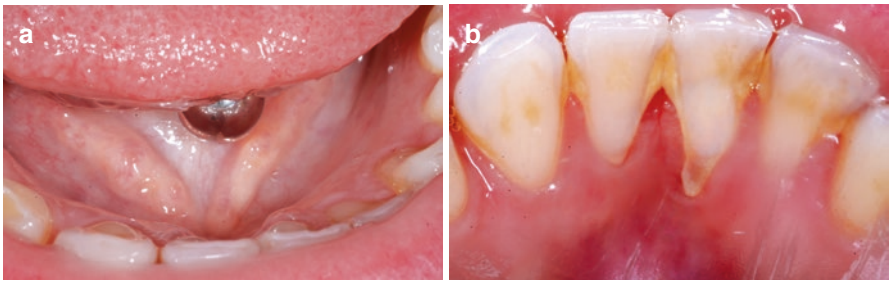

Fig. 4.10 (**a**) Tongue piercing; (**b**) lingual gingival recession at the opposed tooth #41

4.3 Radiographic Assessment

Single facial/oral recessions might not necessarily need radiographic assessment. However, as soon as (surgical) treatment is considered, additional information is warranted. Radiographs for periodontal diagnosis require a longer scale of contrast compared with caries detection, which can be achieved digitally after image acquisition before interpretation [41]. To obtain correct image geometry, a paralleling technique must be used.

4.3.1 Periapical Radiograph

- Root morphology and crown-to-root ratio
- Periodontal ligament (PDL) space:
  - Widening of the PDL: sign of occlusal trauma or periapical pathology
  - Bone hyperdensity of lamina dura: sign of functional adaptation to occlusal forces
  - Loss of PDL: sign of ankylosis
- Root proximity: possible risk factor for periodontal disease (Fig. 4.7b), might have influence on treatment options [42]
- Furcation involvement: separation coefficient, length of root trunk

4.3.2 Bitewing Radiograph

Due to the perpendicular visualization of the teeth, it is ideal for reliable assessment of the alveolar crestal bone [43] and diagnosing caries/restorations.

- Distance of CEJ to interdental bone crest
  - 2 mm: crestal bone loss?
    "Fuzziness" on the mesial/distal aspect of the interdental septa indicating loss of mineral content?

CEJ discrepancies of adjacent teeth: horizontal or vertical type of bone loss? Interradicular radiolucencies might indicate possible furcation involvement.
  - < 2 mm: incomplete eruption?
- Distance of interproximal alveolar crest to contact point: influence on presence (≤5 mm) or absence (>5 mm) of interdental papilla [44]
- Calculus/caries/overhanging or open margins/resorptions?

4.3.3 Panoramic Radiograph

Allows for a general overview of the patient's maxillofacial structures: bone loss pattern (horizontal and/or angular, furcation involvement), impacted teeth, periapical pathologies, etc. Any deviations from normal warrant further intraoral radiographs.

4.3.4 Cone Beam Computed Tomography

Overcoming the limitations of two-dimensional radiographs CBCT is the only method that allows for an analysis of the buccal and lingual/palatal surfaces [45, 46] and an improved visualization of the morphology of a periodontal defect, especially in the evaluation of dehiscencies, fenestrations (Fig. 4.11a, b), interradicular bone (Fig. 4.12), and furcation defects [47]. A novel approach using a lip/tongue retractor allows for visualization and measurement of the periodontal dimensions, gingival thickness, and the dentogingival attachment [48].

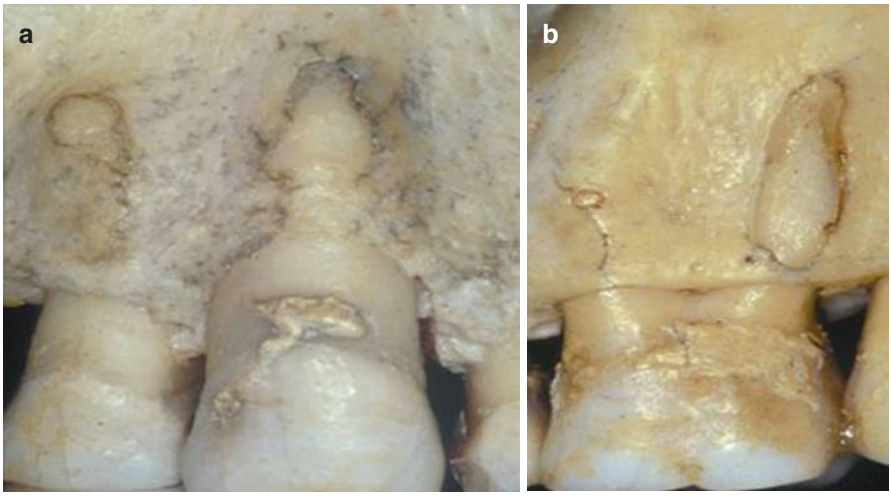

Fig. 4.11 (**a**) Bony dehiscence (right tooth), fenestration (left tooth), and thin buccal plate predispose to gingival regression; (**b**) bony fenestration and protrusive root

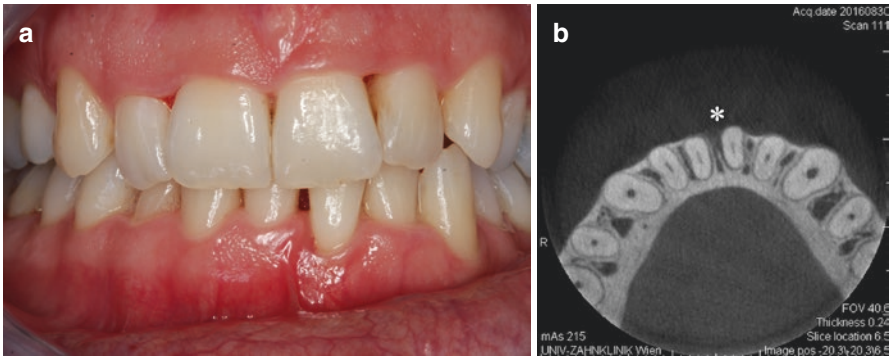

Fig. 4.12 (**a**) Thick periodontal biotype, buccal position of #31, clinical signs of inflamed gingiva, 1.5 mm buccal recession, loss of interdental papilla, PPD 5 mm on mesial aspect, high frenum insertion #41; (**b**) CBCT of area of interest #31: note demineralized interdental bone

4.4 Data Collection and Documentation

Federal medico-dental jurisdiction warrants adequate documentation: All relevant clinical findings are archived in a suitable patient record that allows for establishing a baseline and tracking for any changes during the course of treatment/maintenance. Traditional clinical assessment of obvious dental problems is to be accompanied by general medical and psychosocial information [49]. Standardized photographs and dental casts may serve as longitudinal controls [50, 51]. For written documentation of facial recessions, special charts have been developed [12, 52].

Conclusions

The above-mentioned steps in assessment of patients presenting with gingival recessions offer a very comprehensive approach. If the diagnosis can be made straightforward the application of every mentioned step might not be necessary. However, if doubts about causative factors remain, a structured diagnostic process should be initiated (see Box 4.1).

Box 4.1: Important Steps for Assessment of Gingival Recessions

Visual:

Localized/generalized

Tooth (position in the arch/root torque; hard substance defects, restorations, pulpal status, etc.)

Mucogingival region/vestibulum: frenula, depth, aberrations, etc.

Measurements (with periodontal probe):

Overall periodontal assessment

Determining gingival biotype

Gingival recession (identification or estimation of CEJ)

Width of keratinized gingiva/mucosa (amount of attached gingiva/mucosa; staining with Schiller iodine solution)
Soft tissue margin level (in comparison to the adjacent teeth)
Papilla height
Transgingival probing
Measurements of gingival thickness and contour and bone:
Transgingival probing (ultrasound)
Oral photography
Dental casts
Radiographic bone loss and soft tissue determination (X-ray, ST-CBCT)

References

1. Braun A, Jepsen S, Krause F. Subjective intensity of pain during ultrasonic supragingival calculus removal. J Clin Periodontol. 2007;34(8):668–72.
2. Chi AC, Neville BW, Krayer JW, Gonsalves WC. Oral manifestations of systemic disease. Am Fam Physician. 2010;82(11):1381–8.
3. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol. 1999;4(1):1–6.
4. Kassab MM, Cohen RE. The etiology and prevalence of gingival recession. J Am Dent Assoc. 2003;134(2):220–5.
5. Addy M. Tooth brushing, tooth wear and dentine hypersensitivity-are they associated? Int Dent J. 2005;55(4 Suppl 1):261–7.
6. Saini GK, Gupta ND, Prabhat KC. Drug addiction and periodontal diseases. J Indian Soc Periodontol. 2013;17(5):587–91.
7. Van der Velden U, Abbas F, Armand S, Loos BG, Timmerman MF, Van der Weijden GA, Van Winkelhoff AJ, Winkel EG. Java project on periodontal diseases. The natural development of periodontitis: risk factors, risk predictors and risk determinants. J Clin Periodontol. 2006;33(8):540–8.
8. Rajapakse PS, McCracken GI, Gwynnett E, Steen ND, Guentsch A, Heasman PA. Does tooth brushing influence the development and progression of non-inflammatory gingival recession? A systematic review. J Clin Periodontol. 2007;34(12):1046–61.
9. Palmer RM, Floyd PD. Periodontology: a clinical approach. 1. Periodontal examination and screening. Br Dent J. 1995;178(5):185–9.
10. Chan HL, Chun YH, MacEachern M, Oates TW. Does gingival recession require surgical treatment? Dent Clin N Am. 2015;59(4):981–96.
11. Marini MG, Greghi SL, Passanezi E, Sant'ana AC. Gingival recession: prevalence, extension and severity in adults. J Appl Oral Sci. 2004;12(3):250–5.
12. Merijohn GK. Management and prevention of gingival recession. Periodontol 2000. 2016;71(1):228–42.
13. Tugnait A, Clerehugh V. Gingival recession-its significance and management. J Dent. 2001;29(6):381–94.
14. Zweers J, Thomas RZ, Slot DE, Weisgold AS, Van der Weijden FG. Characteristics of periodontal biotype, its dimensions, associations and prevalence: a systematic review. J Clin Periodontol. 2014;41(10):958–71.
15. Sarin S, Gilbert D, Asimakopoulou K. Why simple aesthetic dental treatment in general practice does not make all patients happy. Br Dent J. 2014;216(12):681–5.
16. Goldstein RE. Esthetics in dentistry, vol. 1. 2nd ed. Hamilton, Ontario: B. C. Decker; 1998.

17. Muller S. Melanin-associated pigmented lesions of the oral mucosa: presentation, differential diagnosis, and treatment. Dermatol Ther. 2010;23(3):220–9.
18. Kapferer I, Benesch T, Gregoric N, Ulm C, Hienz SA. Lip piercing: prevalence of associated gingival recession and contributing factors. A cross-sectional study. J Periodontal Res. 2007;42(2):177–83.
19. Lo Russo L, Fedele S, Guiglia R, Ciavarella D, Lo Muzio L, Gallo P, Di Liberto C, Campisi G. Diagnostic pathways and clinical significance of desquamative gingivitis. J Periodontol. 2008;79(1):4–24.
20. Olsson M, Lindhe J. Periodontal characteristics in individuals with varying form of the upper central incisors. J Clin Periodontol. 1991;18(1):78–82.
21. Eghbali A, De Rouck T, De Bruyn H, Cosyn J. The gingival biotype assessed by experienced and inexperienced clinicians. J Clin Periodontol. 2009;36(11):958–63.
22. Kan JY, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. J Periodontol. 2003;74(4):557–62.
23. Cuny-Houchmand M, Renaudin S, Leroul M, Planche L, Guehennec LL, Soueidan A. Gingival biotype assessment: visual inspection relevance and maxillary versus mandibular comparison. Open Dent J. 2013;7:1–6.
24. De Rouck T, Eghbali R, Collys K, De Bruyn H, Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. J Clin Periodontol. 2009;36(5):428–33.
25. Muller HP, Heinecke A, Schaller N, Eger T. Masticatory mucosa in subjects with different periodontal phenotypes. J Clin Periodontol. 2000;27(9):621–6.
26. Nguyen-Hieu T, Ha Thi BD, Do Thu H, Tran Giao H. Gingival recession associated with predisposing factors in young Vietnamese: a pilot study. Oral Health Dent Manag. 2012;11(3):134–44.
27. Olsson M, Lindhe J, Marinello CP. On the relationship between crown form and clinical features of the gingiva in adolescents. J Clin Periodontol. 1993;20(8):570–7.
28. Nordland WP, Tarnow DP. A classification system for loss of papillary height. J Periodontol. 1998;69(10):1124–6.
29. Cardaropoli D, Re S, Corrente G. The papilla presence index (PPI): a new system to assess interproximal papillary levels. Int J Periodontics Restorative Dent. 2004;24(5):488–92.
30. Vandana KL, Savitha B. Thickness of gingiva in association with age, gender and dental arch location. J Clin Periodontol. 2005;32(7):828–30.
31. Eger T, Muller HP, Heinecke A. Ultrasonic determination of gingival thickness. Subject variation and influence of tooth type and clinical features. J Clin Periodontol. 1996;23(9):839–45.
32. Zucchelli G, Mounssif I. Periodontal plastic surgery. Periodontol 2000. 2015;68(1):333–68.
33. AAP. Glossary of periodontal terms. 4th ed. Chicago, Ill: The American Academy of Periodontology; 2001.
34. Evian CI, Cutler SA, Rosenberg ES, Shah RK. Altered passive eruption: the undiagnosed entity. J Am Dent Assoc. 1993;124(10):107–10.
35. Coslet JG, Vanarsdall R, Weisgold A. Diagnosis and classification of delayed passive eruption of the dentogingival junction in the adult. Alpha Omegan. 1977;70(3):24–8.
36. Hamp SE, Nyman S, Lindhe J. Periodontal treatment of multirooted teeth. Results after 5 years. J Clin Periodontol. 1975;2(3):126–35.
37. Stellini E, Comuzzi L, Mazzocco F, Parente N, Gobbato L. Relationships between different tooth shapes and patient's periodontal phenotype. J Periodontal Res. 2013;48(5):657–62.
38. Stein JM, Lintel-Hoping N, Hammacher C, Kasaj A, Tamm M, Hanisch O. The gingival biotype: measurement of soft and hard tissue dimensions—a radiographic morphometric study. J Clin Periodontol. 2013;40(12):1132–9.
39. Gobbato L, Tsukiyama T, Levi PA Jr, Griffin TJ, Weisgold AS. Analysis of the shapes of maxillary central incisors in a Caucasian population. Int J Periodontics Restorative Dent. 2012;32(1):69–78.
40. Pini-Prato G, Franceschi D, Cairo F, Nieri M, Rotundo R. Classification of dental surface defects in areas of gingival recession. J Periodontol. 2010;81(6):885–90.

41. Langland OE, Langlais RP, Preece J. Principles of dental imaging. 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2002.
42. Vermylen K, De Quincey GN, van 't Hof MA, Wolffe GN, Renggli HH. Classification, reproducibility and prevalence of root proximity in periodontal patients. J Clin Periodontol. 2005;32(3):254–9.
43. Merchant AT, Pitiphat W, Parker J, Joshipura K, Kellerman M, Douglass CW. Can nonstandardized bitewing radiographs be used to assess the presence of alveolar bone loss in epidemiologic studies? Community Dent Oral Epidemiol. 2004;32(4):271–6.
44. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. J Periodontol. 1992;63(12):995–6.
45. Fu JH, Yeh CY, Chan HL, Tatarakis N, Leong DJ, Wang HL. Tissue biotype and its relation to the underlying bone morphology. J Periodontol. 2010;81(4):569–74.
46. Kasaj A, Willershausen B. Digital volume tomography for diagnostics in periodontology. Int J Comput Dent. 2007;10(2):155–68.
47. de Faria Vasconcelos K, Evangelista KM, Rodrigues CD, Estrela C, de Sousa TO, Silva MA. Detection of periodontal bone loss using cone beam CT and intraoral radiography. Dentomaxillofac Radiol. 2012;41(1):64–9.
48. Januario AL, Barriviera M, Duarte WR. Soft tissue cone-beam computed tomography: a novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit. J Esthet Restor Dent. 2008;20(6):366–73.
49. AAP. Parameter on comprehensive periodontal examination. J Periodontol. 2000;71(5 Suppl):847–8. https://doi.org/10.1902/jop.2000.71.5-S.847.
50. Ahmad I. Digital dental photography. Part 6: camera settings. Br Dent J. 2009;207(2):63–9.
51. Weinlander M, Lekovic V, Spadijer-Gostovic S, Milicic B, Krennmair G, Plenk H Jr. Gingivomorphometry—esthetic evaluation of the crown-mucogingival complex: a new method for collection and measurement of standardized and reproducible data in oral photography. Clin Oral Implants Res. 2009;20(5):526–30.
52. Ratka-Krüger P, Schacher B, Horodko M, Bürklin T. Plastische Deckung parodontaler Rezessionen. Quintessenz. 2004;5:477–87.