Treatment Strategies in the Case of Advanced Attachment Loss
Part 2: Extraction of Critical Teeth and Dental Restorations on Movable Abutments

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In patients with advanced bone loss, it is desirable to use a treatment strategy that conserves critical teeth, to avoid complications during prosthetic restoration. Part 1 discussed treatment options for teeth with horizontal bone loss down to the apical third of the root, vertical bone defects with poor defect morphology, furcations with a large defect height and combined periodontal and endodontic inflammation. If a treatment strategy is followed in which critical teeth are extracted in cases of advanced attachment loss, seating a prosthetic restoration on periodontally compromised abutments cannot be avoided. In addition to periodontal treatment of the remaining dentition, this strategy should focus on periodontal risk assessment and the avoidance of biomechanical and technical complications when seating dental restorations. A case presentation of Generalized Aggressive Periodontitis followed for 11 years demonstrates the implementation of periodontal treatment and prosthetic restoration.

Key words: treatment strategy, periodontitis, bone loss, dental restorations, tooth mobility

RISK ASSESSMENT BEFORE PROSTHETIC RESTORATION

Decisions regarding treatment cannot be taken solely on the basis of evidence-based dentistry, but must also respect the patient’s wishes, and take into account current laws and guidelines, as well as the dental practitioner’s experience. The patient’s financial circumstances and the periodontal and prosthetic risks should also be considered. Part 1 showed that periodontal treatment enables the conservation of critical teeth with advanced attachment loss for many years without progressive bone loss. This procedure is not, however, a “wait and see” strategy of observation after periodontal surgery. It is rather an active maintenance therapy, with the aim of recognizing and treating remaining periodontal pockets or recurring local inflammation at an early stage, as well as of controlling other risks such as endodontic complications and furcation caries. If, in the case of advanced generalized attachment loss, critical teeth cannot be treated but need to be extracted, this is significant for the planning of subsequent prosthetic restoration; it raises the question of the prognosis of the periodontally treated – but possibly already mobile – remaining abutments, and ultimately the question of the life expectancy of the intended dental restoration. According to Lang and Tonetti (1997) six patient related risk factors for periodontal disease were presented in a risk diagramm (Fig. 1):

- inflammatory condition (bleeding on probing)
- frequency of remaining periodontal pockets
- history of tooth loss
- age-related attachment loss
- genetic and/or systemic risk factors
- lifestyle (e.g. smoking).

Fig. 1 shows three different risk levels. The transition from low to intermediate risk occurs at 9% bleeding on probing, with four remaining pockets, four teeth lost, a 0.5% bone loss factor and occasional smoking, whereas the transition to high risk is characterized by 25% bleeding on probing,
In conclusion, decisive prognostic factors for the long-term success of dental restorations on periodontally treated abutments include:

- ensuring absence of inflammation by active maintenance therapy
- taking genetic, systemic or personal risk factors into account
- avoiding biomechanical and technical complications.

It should be noted that, tooth mobility is not a factor in the risk diagram.

TOOTH MOBILITY AND PERIODONTAL TRAUMA ON PROSTHETIC ABUTMENTS

A “loose tooth” is something that causes the patient great uneasiness, and when perceptibly increased mobility persists, despite successful periodontal treatment, the dentist is faced with the question of whether the tooth can be maintained on a long-term basis as a prosthetic abutment.

Lang (1982), and Hartel (2003) have discussed the significance of mobility and the consequences this has for prosthetic restoration on the basis of studies concluded mainly in the 1970s by Ericsson and Lindhe, 1977; Lindhe and Nyman, 1997; Lindhe and Svanberg, 1974; Svanberg, 1974. According to these studies, increased mobility can be seen as a logical consequence of advanced bone loss and the altered lever effect in the crown-root relationship. The extent of mobility is additionally determined by the inflammatory condition of the periodontal tissue, and can be intensified by the effect of an occlusal periodontal trauma.

In untreated periodontitis, attachment loss can be progressively accelerated by periodontal trauma. The primary cause of the observed attachment loss is periodontal inflammation, whereas periodontal trauma can be regarded merely as a co-factor. It is remarkable that, after successful periodontal treatment, periodontal trauma can lead to increased mobility, but does not necessarily result in further attachment loss in the case of inflammation-free periodontal conditions (Ericsson and Lindhe, 1977; Lindhe and Svanberg, 1974; Svanberg, 1974).

On the basis of their results (Nyman and Ericsson, 1982; Nyman and Lindhe, 1979) fixed restorations were seated in periodontally treated patients...
Fig. 2  Teeth with advanced bone resorption and increased mobility can be retained over many years provided that inflammation can be prevented by periodontal treatment. (a) At teeth 12, 11 and 21, bone resorption down to apical third had occurred. (b) The cause of the grade III mobility can be seen not only in the height loss of the supporting bone, but also in periodontal trauma resulting from premature contacts on the existing bridge restoration in the mandible. Radiologically no further clinically relevant bone resorption could be observed 13 years later (c).

without resulting in progressive bone loss, despite the fact that the conditions postulated by Ante were not fulfilled [Ante, 1926]. In a histological case report it was demonstrated that the clamp anchoring of a prosthesis to a mobile abutment with advanced bone loss but inflammation free tissues led to periodontal trauma and an increase in mobility, but that histologically detectable remodeling procedures had occurred in the ligament area without further loss of attachment (Rühling and Piagmann, 2003). In this instance, increased mobility coupled with lack of inflammation in the
periodontal tissue can also be interpreted as physiological adaptation under high functional loading.
A study by König et al. (2002) demonstrated that it is possible to retain 90% of teeth with third degree mobility over 8 years in function. This is illustrated in a patient in which bone loss had occurred at teeth down to the apical third (Fig. 2a). Treatment consisted of preventing inflammation, eliminating premature contacts and splinting with a retainer wire. Despite the degree III mobility no further clinically relevant bone loss was detected after 13 years (Fig. 2c).
In conclusion, the role of periodontal trauma and increased mobility should not be overestimated with regard to its prognostic value. In the case of prosthetic abutments with increased mobility, periodontal trauma should be treated and/or avoided as far as is possible. The main issue, however, is the prevention of inflammation. Attention should be focused on the increased mobility, as this can lead to technical and biomechanical complications after the seating of prosthetic restorations.

BIOMECHANICAL AND TECHNICAL COMPLICATIONS IN PROSTHETIC RESTORATION

Regarding the manufacture and seating of dental restorations on mobile abutments, certain factors should be taken into account by the dentist and dental technician, to avoid biomechanical and technical problems.

Retention Loss and Root Fracture

The aim of abutment preparation is to create a secure form of retention with small preparation angles, to prevent the loss of retention of cemented abutment crowns (Hämerle, 1994). Good conditions can exist in cases of advanced bone loss when the prepared abutments are very long. Supragingival positioning of the crown margins is helpful, as this avoids placing overcontoured margins of the restoration close to marginal gingiva and facilitates impression-taking. Owing to the length of the abutments, however, a proper shoulder preparation is often not possible without endangering their vitality. The same applies when, for aesthetic reasons, the preparation margins must be positioned subgingivally. A further complication is that, in advanced periodontitis, tooth migration may have occurred, which makes the preparation of a common path of insertion impossible.

The root fracture is a complication that can lead to the loss of dental restorations (Hämerle, 1994; Hämerle et al., 2000) (Figs 3a and b). According to results obtained by Nyman and Lindhe (1979), 2.4% of the abutment teeth fractured, and in the case of Landolt and Lang (1988), 3% of the vital and 35% of the endodontically treated abutments were affected by fractures. This is confirmed by further research results, according to which endodontically treated teeth fractured more frequently, particularly in the case of cantilever abutments (Randow and Glantz, 1986). In the case of a exaggerate teeth-cleaning technique and regular professional root planing, supragingival preparation can result in tooth substance loss at the exposed cervical area, which may in turn lead to an abutment fracture (Figs 3c and 3d).

Endodontically treated abutments are usually reinforced with posts or post core constructions. To avoid root fractures, the focus should be not only on the selection of a suitable post system, but also on the conservation of natural tooth substance. The preparation width of the root canal and the dimension of the root canal post must be selected in such a way that the structural strength of the tooth is not unnecessarily weakened. When preparing the root stump for a definitive crown, a ferrule preparation by 2 to 3 mm should be applied, so that the risk of fracture is reduced considerably (Glantz and Nyman, 1982; Mezzomo et al, 2003; Zhi-Yue and XuXing, 2003).

Problems Occurring during Impression-taking and Framework Manufacture

Because of increased mobility, undesirable movement of the abutment can happen when using rigid materials during impression-taking. For the same reasons, difficulties can also occur during the removal of the impression, particularly in pronounced undercuts of the tapering of the root below a supragingival preparation limit, as well as not enough blocking out of the wide open interproximal spaces. The accidental extraction of a tooth rarely occurs, as a tooth with healthy remaining ligaments, even with attachment loss of two thirds of the root length,
still possesses sufficient stability despite increased mobility, provided that undercuts are carefully blocked out. For additional safety, an acrylic impression tray, e.g. a stable replica of a prefabricated tray can be used, which can, if necessary, should cut apart. When removing impressions of very long prepared teeth, the dental technician should be informed so that prepared roots do not break off during the making of the plaster model. It is better to cut the individual impression tray apart before removing the impression. If occlusal splints do not fit perfectly when mounting the models in the articulator, it is possible that, not only while making the impression but also during bite registration, deflections – and hence inaccuracies – occur because of increased abutment mobility.

When seating rigid, blocked crowns or bridge substructures on abutments with different degrees of mobility, a high degree of tension can result in the substructures as a result of normal occlusal function, leading to an increased risk of fatigue fracture in the metal substructure. For this reason, stable substructures manufactured with a distortion-resistant alloy and avoiding soldering – particularly furnace soldering – are recommended. Tooth migration means it is not always possible to achieve a common path of insertion (Fig. 4). To an extent, this problem can be compensated because of the mobility of the abutments themselves. Fig 4b shows that only a very brief deflection of the anterior teeth is required to insert the substructure (Fig. 4c). At the moment in which the crown margins

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**Fig. 3** Technical and biomechanical complications threaten the long-term success of treatment. (a) In 1985 the bridge abutment of 17 was root-amputated and a bridge seated; (b) 18 years later no progressive loss of attachment was observed, a longitudinal fracture of the abutment 15 had occurred. In another patient, (c) a removable restoration with supragingival margins was seated in 1985. The telescope radiograph from 2003 shows that after 18 years of active maintenance therapy with a brushing technique and regular scaling, tooth substance loss to the exposed tooth necks had occurred, which had in turn led to the transverse fracture of abutment 45 and the mesial root 46.
reach the preparation limit, the abutments embedded in the alveolar ridge are once again free from tension (Fig. 4d).

During the manufacture of telescopic restorations on mobile abutments, consideration should be given to the adhesive force of conus crowns; if too great, this can lead not only to a periodontal trauma resulting in a further increase in mobility, but also in fracture of the tooth root (Figs 3c and d) if the supraconstruction can only be removed by the patient by applying a large amount of force. Particular care is required to avoid this problem. Whether the outer part of the telescope will become detached from the inner part is not solely dependent on a defined adhesive force, but also on the strength of the abutment itself. For this reason, in the case of abutments with increased mobility, it may be a good alternative solution to aim for fixed restorations with primary splinting of the abutment teeth (Bölle-Müller, 1994; Nyman and Lang, 1994).

Fig. 4 (a) Tooth mobility as a result of advanced periodontitis made it impossible to prepare a common path of insertion. On manufacturing the substructure (b) the nonaxial position of the prepared abutments can be seen. (c) A brief deflection of the anteriors is required to seat the substructure. (d) At the moment in which the crown margins reach the preparation limit, the abutments in the alveolar ridge are once again stress free.
Fig. 5 In the case of a 33-year-old patient with generalized aggressive periodontitis, periodontal treatment with subsequent prosthetic restoration was performed in 1992. (a) The anterior gingiva was more or less unremarkable. (b, c) Posteriorly, severe inflammation with localized exuding pus was observed.

CASE PRESENTATION: PERIODONTAL TREATMENT AND PROSTHETIC RESTORATION IN ADVANCED GENERALIZED AGGRESSIVE PERIODONTITIS

Case History

This 33-year-old woman was referred to us by her dentist in 1992. She has been suffering from recurring pocket abscesses since 1990. She was a non-smoker and had no systemic diseases.

Diagnosis

The patient’s dentition was in good condition in terms of conservative and prosthetic dentistry and testified to good oral hygiene. The anterior gingiva was unremarkable (Fig. 5a), but the molars showed, severe inflammation with localized exudation (Figs. 5b and c) and probing depths of 6 to 12 mm with furcation involvement, detectable by probing.

Radiological Examination

The radiographs of the maxilla and mandible showed no severe bone loss anteriorly. Advanced bone loss with deep, vertical defects and marginal/apical confluent radiolucencies as well as osteolytic granulomas were observed at teeth 25–28, 34 and 44–48. Tooth 13 showed profound caries. Incomplete root-canal fillings were seen in teeth 16, 35 and 44 (Figs. 6, 7a). A vitality check of tooth 34 revealed a weak positive reaction (Fig. 10a).

Diagnosis

Generalized Aggressive Periodontitis, caries on tooth 13 and a suspected endo-perio lesion on tooth 34 were diagnosed.
Treatment Strategy

The treatment goal was to extract hopeless teeth, carry out periodontal treatment with root resections on the furcation involved molars and if possible, seat a fixed temporary prosthetic restoration consisting of metal-reinforced bridges. Because of the remarkably large osteolytic granulomas, a biopsy was performed to rule out Langerhans Cell Histiocytosis.

Therapy

The initial treatment session in 1992 comprised the immediate extraction and/or resection of hopeless teeth or single roots. A sample of granulation tissue was taken at tooth 26 for pathohistological assure the absence of examination to Langerhans Cell Histiocytosis. The result was negative.

In the maxilla, resection of the distobuccal root and revision of the root canal filling of tooth 16, root canal fillings of 13 (Figs. 7a and b), radectomy of the mesiobuccal and distobuccal roots of 26 with a root canal filling in the palatal root (Figs. 8a and b) and extraction of 18, 25, 27 and 28 were performed.

In the mandible, teeth 44, 45 and 48 were extracted, the mesial root of 46 and the distal root of 47 resected and the remaining roots of 46 and 47 treated endodontically (Figs. 9). In the 3rd quadrant a root canal filling was carried out on 35 with closed root debridement (Figs. 10a and b). Subsequently a metal-reinforced, long-term temporary restoration was seated from 24 to 26, with the palatal root of 26 as a bridge abutment, and a bridge from 43 to 46/47 with the distal root of 46 and the mesial root of 47 as bridge abutments.

Prosthetic Restoration

The temporary bridges were replaced with permanent ones two years after the start of treatment by the patient’s regular dentist (Fig. 11). The bridge in the fourth quadrant was connected by an attachment distally of tooth 43.


The patient has been receiving maintenance treatment for 11 years. The average plaque index is 11%; the probing depth is generally 2–3 mm and, at tooth 35, up to 5 mm without bleeding on probing.

The radiograph of the bridge abutment 46/47 showed no further clinically relevant bone loss in 1995, but a good osseous regeneration mesially.
of tooth 46 and distally of tooth 47 (see Fig. 9c). At tooth 34 a connective tissue-like healing, but no progressive bone resorption, was observed in the distal bone defect (Fig. 10). There was no disease progression in the radiographs in 1996, 1999 and 2003 (Fig. 12) compared with 1994 (Fig. 6).


The radiograph image from 2003 (Fig. 12) showed a periapical lesion of endodontic origin on the radectomy abutments 46/47 and a vertical defect distally of tooth 47.

Epicrisis

In 1992 the 33-year-old patient presented for treatment of a generalized aggressive periodontitis. Radiologically, severe advanced bone resorption with remarkably large, marginal/apical confluent osteolytic granulomas was observed. A Langerhans Cell Histiocytosis was diagnostically ruled out. The primary aim of treatment was to arrest the progression of the periodontitis and to treat the patient prosthetically in the interim with metal-reinforced bridges. Owing to the aggressive character of the periodontitis, solely therapeutic considerations with regard to the possibilities of periodontal treat-
ment were made; a speculative discussion regarding the definitive prosthetic restoration – in particular concerning the long-term prognosis of implants – was deliberately avoided.

Teeth that could not be maintained were immediately extracted and strategically important molars radectomied or endodontically treated. Since the initial treatment resulted in complication-free healing, antibiotics were not required. The periodontal treatment was carried out without a regenerative approach as none of the vertical bone craters and furcation involved molars warranted the use of regenerative methods. Furcations on the molars were successfully eliminated by root resections.

Fig. 9  (a) The 1992 radiograph shows deep vertical defects also affecting the apex, particularly mesially of tooth 46 and distally of tooth 47 (see Fig. 6). (b) Teeth 44, 45 and 48 were extracted and the mesial root of 46 and the distal root of 47 amputated. (c) Radiological examination five years later showed no indication of an aggressive progression of the disease, but rather a dense osseous stabilization at 46/47.

Fig. 10  (a) In the 3rd quadrant only a strictly localized defect at tooth 34 could be observed. The radiograph shows that mesially of 34 a radiolucent bone wall structure is still present, while distally the attachment loss has reached the apex. A combined periodontal-endodontic lesion was suspected. After endodontic treatment, the apical inflammation was first allowed to heal and the remaining pocket treated with root debridement. (b) A radiological examination 1.2 years later later revealed no signs of osseous regeneration but no progressive bone loss despite of the aggressive type of disease.
Fig. 11 Two years after starting treatment, the metal-reinforced provisional restorations were replaced by permanent bridges. Figs. a and c show the bridge from tooth 24 to the palatal root 26. In the mandible the critical tooth 35 was treated to conserve the bridge from 35 to 37 (a and d). In the upper jaw, the crown of 16 was conserved after radectomy (b and c). In the mandible seating of a bridge of tooth 43 on the distal root of 46 and the mesial root of 47. The bridge was divided by a precision attachment distally of tooth 43 (b and d).

A combined periodontal/endodontic lesion was suspected in the isolated defect distally of tooth 34 although the tooth showed a weakly sensitive reaction. Since the bridge from 35 to 37 was to be conserved, 34 was now of strategic importance. The preoperative probing depth was 12 mm. Endodontic treatment and a root debridement to a depth of only 6 mm to allow healing of the periodontitis apexicalis was performed. The radiograph showed neither bone-dense filling nor any signs of progressive bone resorption 12 years postoperatively, but the tooth was clinically unremarkable and the probing depth was 4–5 mm without bleeding on probing. The patient decided in favor of the replacement of the metal-reinforced temporary bridges by definitive bridges from 24 to 26 and 43 to 46/47, with the option of an implant in the fourth quadrant at a later date. Owing to the increased risk of root fracture, the radectomyed abutments were supported by thin root posts and adhesively supported, and the bridge was divided by a stress braking attachment distally of 43 to counteract possible technical complications. A postoperative radiological examination of abutment 46/47 after 5 years showed no signs of progressive bone resorption, but did show osseous regeneration mesially and distally. Eleven years postoperatively (2003) a complication became evident at 46/47. Radiologically examination revealed periapical lesions and a bone defect distally of root 47. This is suspected to be an endodontic origin or an in-
complete fracture of the roots. A localized probing depth of 7 mm was measured. The primary aim of treatment – namely to arrest the progression of the aggressive periodontitis – was achieved; the loss of the bridge in the fourth quadrant, however, can not be avoided. Should the suspected diagnosis of a root fracture of this bridge abutment be confirmed, this would represent a typical biomechanical complication, as described. After extraction, osseous implants in the regions 44, 45 and 46 are planned as an option with good prognosis. The risk profile of the patient according to Lang and Tonetti (see Fig. 1) shows that at the beginning of maintenance therapy (1992), the proportion of bleeding on probing was only 3%, with three remaining pockets (5 mm) and five missing teeth, but the age-related bone resorption factor was very high (3.0). The patient had reported no systemic diseases and was a non-smoker. This represents an intermediate risk for progressive attachment loss, since three factors are in the low-risk and one factor (bone loss) in the high-risk segment. Because of the aggressive nature of the disease, discussion about implant restoration has been avoided at the outset of treatment. Even if the risk profile has not altered significantly in the course of the subsequent 11 years, prognosis can be described as good on the basis of the overall positive results of the treatment to date, so that there are no contraindications to implant restorations.
CONCLUSIONS

When it is necessary to seat dental restorations of patients with advanced attachment loss, the main focus of treatment – after the periodontal treatment of the prosthetic abutments – is in preventing inflammation by active maintenance therapy and the avoidance of biomechanical and technical complications. An individual risk analysis according to Lang and Tonetti can help in the assessment of the periodontal prognosis. The prognostic value of increased tooth mobility and the role of periodontal trauma should not be overestimated. A periodontal trauma can increase mobility by occlusion or the anchoring of prosthetic restorations, but given inflammation-free periodontal tissues, does not automatically lead to progressive attachment loss. With regard to the manufacture of dental restorations, whether from the point of view of the dentist or dental technician, the nature of the individual situation must be taken into account to avoid typical complications such as root fractures, substructure fractures, fracture of solder areas and retention loss of cemented abutment crowns. In the case of patients with aggressive periodontitis, the success of the periodontal treatment should first be ensured to fulfill the criteria for an implant restoration.

REFERENCES


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