

Periodontal prosthesis: control of key factors from surgery to teeth preparation and to final cementation

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Introduction

Prosthetic periodontal treatment with a fixed partial prosthesis has been carried out over the last 50 years to treat patients affected by severe periodontitis in order to restore dentition to good health, function, and esthetics. The literature has proven that the biological capability of teeth with a reduced but healthy periodontium successfully supports a fixed partial prosthesis over time.¹⁻² In the 1980s, Sture Nyman and Dan Lundgren^{3,4} demonstrated that fixed bridges can be placed and successfully maintained on a minimal number of abutment teeth with significantly reduced periodontal support (up to 10 to 20% of the original amount of periodontal support) if the prosthodontic treatment is preceded by adequate periodontal treatment and followed by an effective plaque control program to prevent the recurrence of periodontitis. In the last few decades, implant dentistry has radically changed the treatment of those patients. Periodontal prosthesis seemed to be too complicated and too expensive, while the substitution of periodontally affected teeth with implants seemed a more effective and cost-efficient alternative. Does periodontal prosthesis still make sense? If yes, what are the key factors in order to

get long-term successful results? What is the impact of implants in periodontal prosthesis procedures? The aim of this essay is to try to answer these questions and to give some clinical guidelines regarding the periodontal prosthesis procedures based on the available scientific data and my personal clinical experience.

Periodontal prosthesis and scientific evidence

In order to overcome my personal experience and better answer the moderator's questions with an evidence-based overview of the topics, the present essay has been also based on a systematic review of the literature. To establish an appropriate search strategy, a creation of an initial PICO (Population/intervention/comparison/outcome) assessment worksheet was performed. For the electronic search, MEDLINE (PubMed) and the Cochrane Database of Systematic Reviews were used. The search period was from 1966 to 31st May 2013. The results of these reviews identified case report studies or systematic reviews based on case report/series studies, with a high level of bias. Different populations with different disease se-



Fig 1 Periodontal prosthetic rehabilitation.

verity and susceptibility, but also different endodontic, surgical and restorative procedures, meant that comparing the studies was not possible. As a consequence, very weak evidence can be attributed to these topics, meaning that all the treatment approaches dealing with periodontal prostheses that have been adopted in daily practice cannot be evidence based and therefore depend on the clinician's inclinations and experiences.

The rationale of prosthodontics in the treatment of patients affected by severe periodontal disease

It is well known that periodontitis is usually a chronic infection caused by anaerobic bacteria that destroy the supporting tissues of the teeth and, if not treated or not treated in time, may lead to the breakdown of the periodontium that in later stages of the disease can determine the loss of one or more teeth. In such cases, prosthetic rehabilitation is one of the available options to replace the lost/extracted teeth and to restore function and/or esthetics. In patients affected by advanced periodontitis, where the progressive breakdown

of the supporting tissues is close to the apical level, the residual periodontal tissues can no longer withstand the masticatory forces. Using the teeth as abutments for a fixed splint with a cross-arch design can be a feasible way of preserving teeth with poor support and unfavorable crown-to-root ratio.⁵ The aim of such a bridge construction is to reduce the lever effect of the functional and parafunctional forces and to assure a "normal" or at least non-progressive mobility. Recently, a meta-analysis on data coming from a systematic review⁶ aimed to investigate the impact of severely reduced, but healthy periodontal tissue support on the survival rate and complications of fixed dental prostheses after a mean follow-up time of at least 5 years has been performed. The results revealed a percentage of survival rates of 96.4% after 5 years and 92.9% after 10 years. To properly control periodontal disease, the authors identified that the determinant factors were a strict adherence to a maintenance care program, and the presence of a rigid splint (fixed dental prostheses). However, it should be noted that the data used for this meta-analysis were extrapolated from only six retrospective case series studies, showing a low level of scientific evidence.

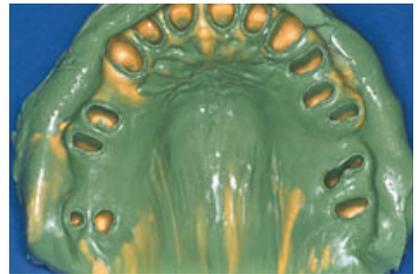
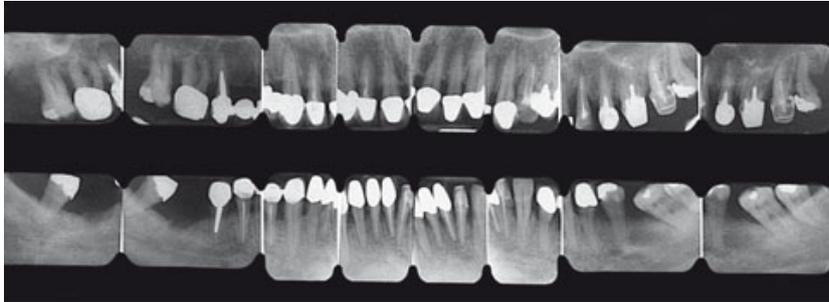




Fig 2 Full mouth periprosthetic rehabilitation with long-term follow-up of a patient treated by using separated/resected molars as distal abutments.

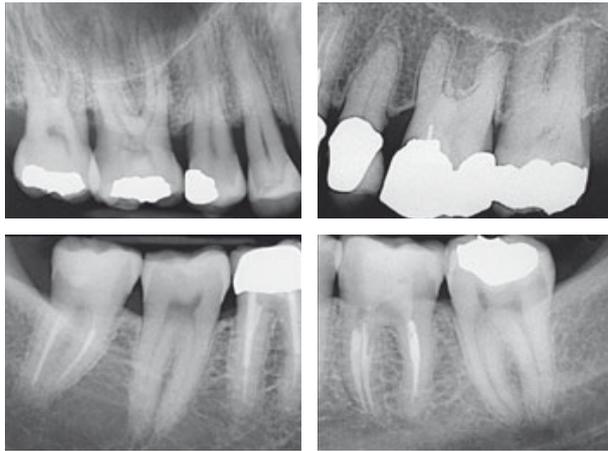


Fig 3 Different root/root trunk length and divergence in maxillary and mandibular molars. Long trunk and/or short or fused roots molars are not suitable for root separation/resection procedure.

In the periodontal prosthesis approach proposed by Carnevale and Di Febo,^{7,8} prosthetic treatment became an essential part of periodontal treatment and not only a therapeutic aid. In this philosophy, all the modifiable tooth/site risk factors must be eliminated by both bone/tooth resective surgery in order to get rid of the residual periodontal infection and to ensure an easier, effective professional and self-performed plaque removal. In molars with a furcation involvement, the presence of a three-dimensional defect within the inter-radicular area creates a bacterial ecological niche that cannot be properly debrided with both domiciliary and professional oral hygiene procedures. The peculiar morphological feature of molars with a furcation involvement could explain the significantly reduced efficacy of both nonsurgical and conservative surgical therapy in multi-rooted furcated teeth if compared to single-rooted teeth.⁹⁻¹¹ From a periodontal perspective, root separation/resection is

the only procedure that can eliminate in every respect class III (class II and III in maxillary molars) three-dimensional furcation molar defects and untreatable periodontal, endodontic and restorative problems affecting one or two molar roots.¹² Over a long period of time, this procedure can successfully treat peculiar furcation defects that cannot be solved by either surgical or nonsurgical therapeutic modalities, especially when adjacent molars are involved by both horizontal and vertical intrabony defects. The long-term prognosis of separated/resected molars seems to be comparable to implants inserted in the posterior areas of the mouth and this procedure might even postpone the use of implants.¹³⁻¹⁴

Key factors in periodontal prosthesis

Periodontal prosthesis is a sensitive technique procedure that requires a careful multidisciplinary approach, a widespread knowledge of prosthodontics, endodontics, periodontology, and an accurate evaluation of the cost/benefit ratio with respect to the treatment alternatives. The need for endodontic treatment (quite often), prosthetic rehabilitation and periodontal surgery actually makes this therapeutic modality a time-consuming and demanding treatment both in terms of economic and biological cost. A careful patient's selection first and then a correct diagnosis and a precise sequence and the correct execution of each phase of the therapeutic protocol are crucial to the long-term success of the procedure.

Patient selection

This is the first, fundamental step of the sequence because not all patients are equally suitable for periodontal prosthesis procedures. Poor patient compliance, high caries susceptibility and limited financial resources are the most frequent factors limiting the use of this therapeutic modality.

Tooth selection

Teeth with deep intrabony defects and/or molars with long trunks and/or short or fused roots cannot be successfully treated with bone/tooth resective procedures and therefore are often not good candidates for serving as abutments in periodontal prosthesis rehabilitation. In order to obtain correct data, which is essential for a successful treatment plan, parallelizing periapical radiographs should always be taken after the clinical examination in order to confirm the information obtained through the periodontal probing. It should also be considered that tissue inflammation and increased tooth mobility determined by periodontal disease may produce a demineralization of the supporting tissues, and consequently the defects of the affected teeth usually appear more severe at the radiological evaluation when compared with the clinical examination. Correlating radiographic findings with the data obtained with the clinical examination (especially periodontal probing) is therefore of utmost importance.

Endodontic treatment

Since root and/or build-up fracture have often been reported as one of the most

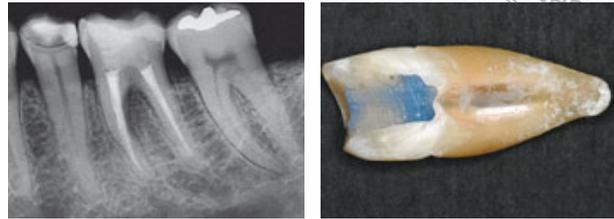


Fig 4 Mandibular mesial root stripping following inadequate instrumentation of radicular canals. Note the presence of a deep concavity in the distal aspect of the root.

frequent reasons for the failure of periodontal prosthesis procedure, correct endodontic treatments must preserve as much tooth structure as possible in both coronal (access opening should be kept as small as possible) and radicular level (conservative instrumentation).¹⁵ Excessive instrumentation of radicular canals and/or immoderate pressure during gutta-percha condensation should be avoided. In molars with furcation involvement, if it is not possible to positively identify in advance the root/roots to be resected clinically and radiologically, each root has to be endodontically treated/re-treated.

Crown build-up

At the completion of the endodontic therapy, the crown of the abutments, the pulp chamber, and in the molars, almost 2 to 3 mm of the canals apical to the furcation entrance are slightly prepared, etched and filled with light or chemically cured composite by using a dentin adhesive to improve the retention of the material. This step is of utmost importance because the replacement of the missing coronal and radicular tooth structure



Figs 5 and 6 In molars planed for root separation/resection crown build-up must be retentive in each single root. Bendable posts are required in order to compensate for the difference of the radicular axis.

should provide a complete marginal seal and proper retention to the abutments and resistance for the subsequent full coverage restoration. The crown build-up of a molar to be separated/resected presents some peculiar requirements. The restoration should be retentive in each single root.¹⁶ Usually, if the crown structure is not missing, this objective can be reached by utilizing 2 to 3 mm of root canal for retention and by properly using the latest generation of dentin adhesives. If an adequate retention for the restorative material is not achievable because of the loss of the crown structure, a prefabricated parallel-sided well-adapted and passively cemented endodontic post should be used.¹⁵ Unfortunately, in molars that have to be

separated/resected, carbon fiber posts often cannot be successfully used because of the different axis of the roots. In the maxillary molars, the mesiobuccal root is normally vertically positioned, while the distobuccal and the palatal roots are inclined distally and palatally, respectively. In mandibular molars, the mesial root is mainly vertical, while the distal projects distally. If the posts cannot be bent before the cementation (carbon fiber posts are not bendable) they will follow the radicular axis rather than the prosthetic one, and therefore they will not contribute to build-up retention because the coronal part of their length will be almost completely eliminated during tooth separation/resection procedure. Thus, when root resection/separation of

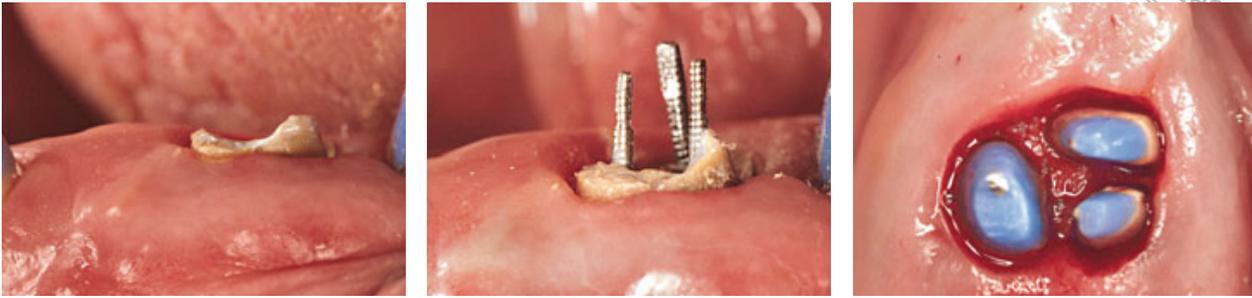


Fig 6

a molar is planned, steel posts should be preferred because, before cementation, it is possible to bend and shorten them in order to incorporate the posts in the build-up of each single root.

In molars planed for root separation/resection, crown build-up must be retentive in each single root. Bendable posts are required in order to compensate for the difference of the radicular axis.

Root separation/resection during preliminary prosthetic preparation

Root separation/resection may be performed as part of the initial tooth preparation for the prosthetic rehabilitation (“prosthetic preparation”) when a prefabricated shell provisional restoration is relined and temporarily cemented. Performing root separation/resection prior to and not during periodontal surgery⁷ presents several important clinical advantages:

- Accurate evaluation of the periodontal condition of the molar and thus the possibility to change the treatment plan in an early phase of the treatment plan. In molars with furcation involvement, it is quite often impossible to precisely assess the inter-radicular

attachment loss before root separation, and therefore any conclusive clinical decision about the prognosis of the tooth can be made prior to this procedure.

- Creating access for plaque removal in an otherwise inaccessible area.
- Earlier elimination/reduction of the inter-radicular periodontal infection and earlier extraction of hopeless roots. This can enhance the healing of the infrabony lesions that might be present in the inter-radicular area at the extraction site and therefore generate an osseous morphology more favorable to be corrected at the time of resective bone surgery.
- Possibility to reduce dental mobility before the surgery by splinting the teeth with the provisional restoration.
- If the root trunk is short and infrabony defects are not present, periodontal surgery can often be avoided.

Root separation or resection can otherwise be performed following the same technique during the surgical periodontal phase, if there is a diagnostic dilemma or difficult access.

Considering the reduced diameter and thickness of the roots, the preparation must be as conservative as pos-

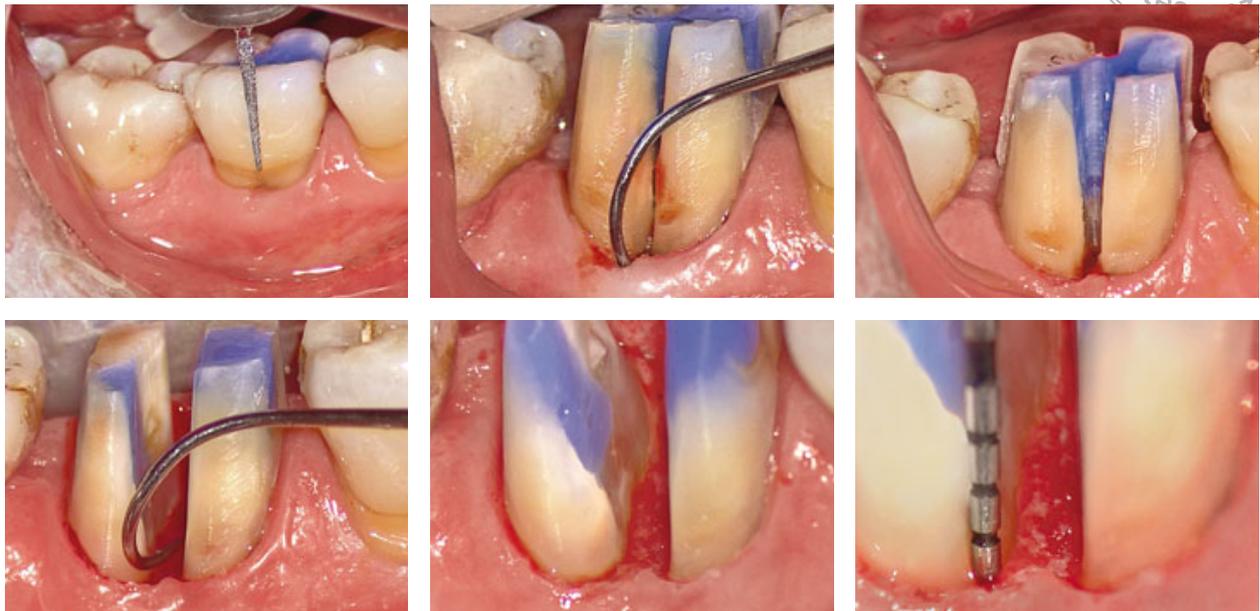


Fig 7 Mandibular molar root separation during preliminary prosthetic preparation.

sible. For this reason, the tooth-structure saving knife-edge finishing line should be preferred. The teeth/roots affected by pockets should be prepared up to the bottom of the pocket, ie, the bur should be moved apically to the same depth that was previously measured with the periodontal probe. With the aim to facilitate provisional relining and domiciliary plaque removal in the exposed root surfaces, at the end of tooth preparation/resection, root surfaces should be made smooth and even by using fine and extra-fine diamond burs and the line angles of the abutment should be rounded. At the end of tooth preparation/resection, a pre-fabricated shell provisional restoration is relined and temporarily cemented. Tooth preparation/resection of teeth with deep pockets and furcated molars are prepared with the bur up to the bottom of the pocket, ie, the bur is moved apically to the same depth measured before with

the periodontal probe. In order to allow soft and hard tissues to heal without any disturbance, the margins of the relined temporary must not be located deeply to the bottom of the pocket but shortened at the gingival level. Do not forget that this is a shoulderless preparation and therefore the margin can be shortened independently of the finishing line.

Periodontal surgery

The aim of this phase of the therapy is to eliminate both supra/intrabony defects and recreate a positive bone architecture with the purpose to obtain an environment conducive to good hygiene and easy dental care. In order to achieve those objectives, bone resective surgery procedures should be performed (see also Pontoriero, in this supplement). To facilitate both soft tissue adaptation and domiciliary plaque removal, the roots'

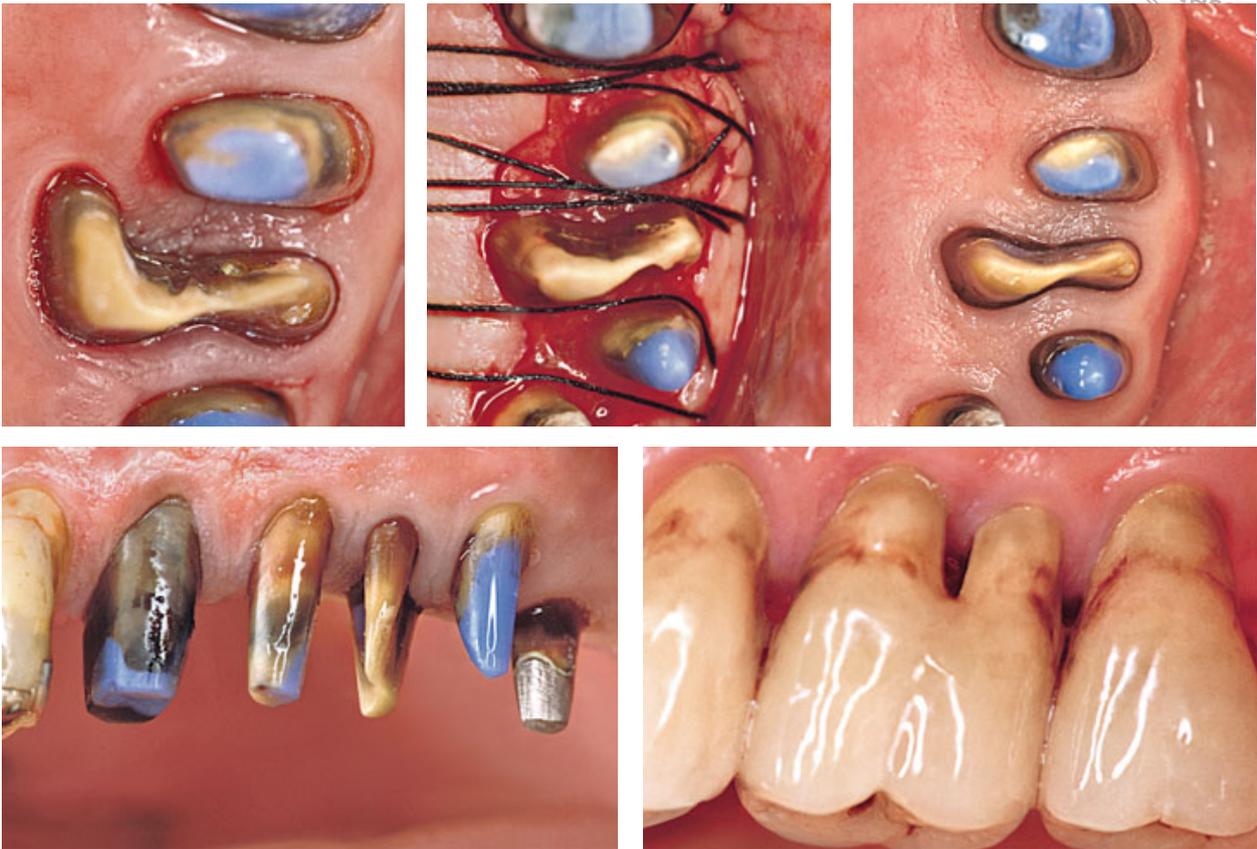


Fig 8 Intrasurgical tooth preparation. The aim of this procedure is to eliminate residual undercuts and to reduce the natural anatomical concavities present on the root surfaces.



Fig 9 The strength and stability of the metal framework should compensate for the structural weakness of the abutments.



Fig 10 Interproximal spaces should be created in order to facilitate as much as possible oral hygiene and the patient should be taught to correctly use self-performed plaque removal devices.

contours might be modified through intrasurgical preparation of prosthetic abutments.¹⁷⁻¹⁸ Following flap elevation, the maintained roots and the other non-vital abutments are newly prepared with the purpose of removing the residual plaque and calculus, improving the space between the roots, eliminating any residual undercuts and reducing the natural anatomical concavities present on the root surfaces.

Following bone resective surgery and apically positioned flap procedures during the healing period, soft tissues grow up coronally about 3 mm in the interproximal spaces and about 2 mm buccally and lingually. To avoid disturbing this healing process at the end of the surgery, the relined temporary margins must be shortened by about 3 mm from the bone crest.

Final prosthesis

After the healing period has been completed, and before the impression for the definitive prosthesis can be taken, the endodontic, periodontal and provisional prosthetic treatments have to be clinically and radiographically re-evaluated. If

the treatments have achieved successful outcomes, the abutments can be refined and polished and the final impression can be taken without or with extra thin retraction cords.

The design and construction of the metal framework – in combination with a good crown fitting and sitting – plays a fundamental role in the long-term success of fixed bridges using root-separated or root-resected abutments.^{7,19,20} The strength and stability of the metal framework should compensate for the structural weakness of the abutments, and for the high tooth mobility that is often present in severely involved periodontal patients. For the same mechanical reasons, occlusion should be designed and set to minimize occlusal lateral forces.

Interproximal spaces should be created in order to facilitate oral hygiene as much as possible and the patient should be taught to correctly use plaque removal devices. At the completion of therapy, the patients are enrolled in a personalized maintenance recall program that generally includes 3-month interval appointments.



Fig 11 Radiolucency in a first mandibular molar root complex re-mineralized following occlusal adjustment.

The role of tooth mobility in the decision-making process

For many decades, increased tooth mobility per se has been considered as a pathological sign and a negative prognostic factor, predicting poor tooth longevity. It seems opportune to remember that in teeth with a healthy periodontium, two factors determine the entity of tooth mobility: the height of the surrounding supporting tissues, and the width of the periodontal ligament.²¹ In a tooth with an increased mobility due to a previous periodontal treatment, if the height of the supporting tissues is reduced but the width of the periodontal ligament is unchanged, it should be realized that the amplitude of root mobility within the remaining periodontium is the same as in a tooth with normal periodontal bone height. As a consequence, the hypermobility of a periodontally healthy tooth with reduced support but with a normal periodontal ligament width should be considered as physiological.

On the other hand, in the presence of mechanical forces applied to the crown

of periodontally healthy teeth, as typically observed in orthodontics, it is possible to observe an increased mobility associated with the widening of the ligament space (also diagnosed radiographically). In such a case, the increased tooth mobility should also be considered as a physiological adaptation to altered functional demands and not a sign of pathology.

To summarize, in the majority of clinical situations, increased tooth mobility should be considered as an adaptation sign rather than a pathological one.

Soft tissue recession and its clinical significance

Gingival recession is defined as “the location of the gingival margin apical to the CEJ” and may involve one or more tooth surfaces. Recessions are frequent clinical features in population with both good and poor standards of oral hygiene, as reported in some large-scale epidemiological studies. Kassab and Cohen²² reported that 88% of 65-year-old patients show recessions, while 50% of the 18- to 64-year-old patient group



Fig 12 Mucogingival procedures with the aim to increase the amount/volume of keratinized and attached tissues are widely used in dentistry but there is no scientific evidence that these surgeries are really needed to enhance soft tissues resistance and long-term abutment survival.

had recessions. Several conditions may be associated with the presence of buccal recessions, such as anatomical factors, traumatic tooth brushing, occlusion, tobacco use, imprecise restorations, orthodontic treatment, piercing, and chemical agents. The treatment of gingival recession is mainly indicated to improve esthetics and to reduce or eliminate dental hypersensitivity due to root exposure.²³

Regarding the role and the importance of the soft tissue environment, despite the fact that for many years the presence of an “adequate” amount of gingiva had been considered essential for the maintenance of periodontal health, several studies failed to support that hypothesis and showed that in the presence of optimal plaque control, it is possible to maintain periodontal health even in sites with reduced or missing keratinized gingiva.²²⁻²⁸ Although scientific evidence in most part is lacking, the majority of expert clinicians agrees with the concept that when a tooth is planned to be restored with a full crown, soft tissue augmentation could be suitable in order to avoid or limit the tissue shrinkage related to the tooth restoration

(preparation, provisional, gingival retraction, impression, etc) and to improve esthetics.

Preprosthetic orthodontics and its impact on the overall success of the periodontal health

As reported by Diedrich²⁹ preprosthetic orthodontic interventions are often an integral part of comprehensive oral rehabilitation. The purpose of these approaches is mainly focused on avoiding/reducing the need for endodontic treatment, improving the masticatory function, facilitating the domiciliary oral hygiene procedures and optimizing the esthetics of the final rehabilitations.

If we consider the orthodontic treatment within an interdisciplinary approach in order to improve or solve periodontal defects, Rotundo et al³⁰ reported in a systematic review that the current evidence is based on only 29 case reports studies, and in particular 22 studies deal with infrabony defects, one deals with gingival recession, and six deal with furcation defect treatments.

Therefore, the lack of evidence coming from the current literature suggests that clinicians should apply this scarce and weak knowledge in their clinical practice with great caution.

Consequently, clinicians' skills and experiences rather than scientific evidence seem to be the determinant for the positive resolution of each clinical case and the risk (overall furcation defects worsening, root resorption, soft tissue recession)/benefit ratio of performing an orthodontic treatment in patients affected by severe periodontal disease must always be carefully evaluated. It is my personal opinion that in the treatment of patients affected by severe periodontal disease, orthodontics should be considered as a fantastic procedure for keeping patients' natural dentition and avoiding prosthetic rehabilitation.

Classic versus contemporary periodontal prosthesis: what has been changed?

In the last decades, implant dentistry has also radically changed the treatment of patients affected by severe periodontal disease. The concept of extraction of periodontally involved teeth and their replacement with dental implants is based on a perceived advantage of implants over teeth, in terms of unpredictability of tooth survival following treatment of periodontal disease, better long-term prognosis of implant-supported restoration in comparison with teeth-supported, better long-term cost-benefit, better esthetics and better patient satisfaction. However, it is questionable to which extent these



Fig 13 The use of orthodontics procedures in the treatment of patient affected by severe periodontal disease might be considered the best way for avoiding perio-prosthetic or implant-prosthetic rehabilitations.

postulations are supported by the current evidence; it should be emphasized that the extraction of periodontitis-affected teeth does not influence the underlying host-related response that may have contributed to the development of periodontal disease and which could be a predisposing factor also for the devel-



Fig 14 The use of implants can reduce the prosthetic span and avoid or limit the need for preparing natural teeth.

opment of peri-implantitis.³¹ It should also be kept in mind that at the moment we do not have any proven therapy for peri-implant diseases.³² On the other hand, it should be admitted that the use of implants as abutments in patients with severe bone loss has dramatically reduced the need for preparing and splinting natural teeth in order to withstand the masticatory forces (secondary occlusal trauma). The benefit from both biological (tooth preparation avoided ie, reduced risk of tooth loss) and economical point of view can be important if an extensive prosthetic fixed splint is needed due to an unfavorable crown-to-root ratio. It should also be considered that in the traditional periodontal prosthesis, the loss of one strategic abutment could determine the failure of the entire cross-arch structure with hardly any possibility to partially re-treat the patient. However, there is no evidence that a single clinical parameter can reliably forecast periodontal disease activity, tooth loss, or conversely, long-term tooth retention. The use of a number of implants larger

than what would be strictly necessary might be a way to improve the chance to partially re-treat the prosthesis,³³ but the higher cost both economical and biological (more implants = less inter-implant distance = more risk to bone loss) should be considered.

Conclusions

- A “traditional” approach for treating patients affected by severe periodontal disease is an effective procedure over time. Long-term follow-up studies have clearly demonstrated that the treatment of periodontal disease associated with prosthetic stabilization can be successful in arresting disease progression and minimizing or even preventing tooth loss.
- On the other hand, a prosthesis may be *per se* a risk factor that might increase the probability of tooth loss (dental pulp injuries, root fracture, secondary caries, etc).
- Implants can be successfully used in the treatment of patients affected by severe periodontal disease and can be useful for reducing prosthetic span and avoiding or limiting the need for preparing natural teeth.
- The risk of bone loss around implants seems to be higher in patients with a history of periodontitis,³⁴ and at the moment no proven therapy for peri-implant diseases is available.³²
- Our knowledge on implant survival beyond 10 years is limited and is based on implant systems that are no longer available.
- The hypermobility of teeth with reduced but healthy periodontium

should be considered as a physiological adaptation and not pathological. Therefore, splinting the teeth does not seem to be opportune if the mobility does not increase over time and/or does not disturb the patient's function.

- Despite the fact that for many years the presence of an “adequate” amount of gingiva had been considered essential for the maintenance of periodontal health, several studies failed to support that hypothesis and showed that in the presence of optimal plaque control, it is possible to maintain periodontal health even in sites with reduced or missing keratinized gingiva.
- Despite the fact that orthodontics is widely used to avoid or reduce the need for endodontic treatment when treating periodontally affected patients to improve masticatory function and to optimize the esthetics of the final rehabilitations, there is a lack of evidence for supporting the benefits of this procedure and therefore the cost/benefit ratio in the comprehensive treatment plan should be carefully evaluated. On the other hand, in some patients orthodontic treatment can allow clinicians to avoid the need for a prosthetic rehabilitation, and this seems to be its major advantage.

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