

Orthodontic space closure after loss of maxillary incisors and periodontal breakdown of the edentulous area and on adjacent teeth

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ABSTRACT

The closure of an edentulous space with the orthodontic movement of adjacent teeth even if affected by severe loss of periodontal support is a treatment option nowadays supplanted by the implant-born crown substitution and periodontal regenerative/reconstructive therapy. Nevertheless it is important not to forget some fundamentals of dental research that still justify, even more when combined with the most recent innovations in the field of mucogingival surgery and guided tissue regeneration, the alternative of orthodontic space closure. The latter indeed represents a valuable alternative in many malocclusions complicated by lost maxillary incisors, first of all in the growing patients and when the gingival margins are visible during speech and smile.

This article will outline crucial details about the orthodontic management of the reduced periodontal tissues in the pressure area.

Introduction

When one or more maxillary incisors are missing, or hopeless and to be extracted, the goal of treatment is not only to substitute the teeth, but also to best manage the soft tissue, first of all the papillae and gingival margins on the buccal side. This becomes particularly complex when the periodontal tissues are reduced in the edentulous area and on the adjacent teeth.

The most popular treatment alternative is the implant-born crown substitution. The surgical management of the mucogingival area and the procedures of guided bone regeneration (GBR) around an osseointegrated implant have improved dramatically in the last decade, but still are sometimes difficult and unpredictable in terms of long term stability of the soft tissue.¹⁻⁴ Complications arise relating to aesthetics and periodontal health requiring repeated extraordinary, often complex, maintenance procedures. The implant supported prosthetic substitution in the aesthetic zone represents a real challenge in the patients who still are growing and/or show the gingival margins and periodontal tissues while speaking and smiling. On the other hand, the long term periodontal health after orthodontic treatment (OT) and space closure (SC) is supported by strong scientific evidence,⁵⁻¹⁰ and therefore represents a valid alternative.

In cases exhibiting periodontal breakdown of the edentulous area and loss of periodontal support of the adjacent teeth, many clinicians have the opinion that orthodontic SC is not indicated. The edentulous area may be resorbed both vertically and/or bucco-lingually, and the pre-orthodontic periodontal conditions of the adjacent teeth may be

characterized by intrabony defects, interproximal craters, inconsistent margins sometimes hard and soft tissue dehiscences. Questions may be posed as to what effects on the epithelial and connective tissue attachment result from bodily or tipping tooth movement into an intra-osseous defect. Can the bony lesions and the soft tissue be orthodontically manipulated in a positive manner? Can orthodontics alone repair the periodontal tissues or is it necessary to support the orthodontic movements with guided tissue regeneration (GTR) surgical procedures on adjacent teeth? Is it necessary a GBR procedure in the edentulous area?

What are the crucial aspects that can make orthodontic SC effective? The answer to these questions depends on the type of attachment created by the pre-orthodontic periodontal therapy. The literature has demonstrated:

- Teeth move with their periodontal apparatus, i.e. cementum and periodontal ligament (PL).¹¹
- No further attachment loss will occur if the orthodontic movement is performed in a healthy, inflammation-free and, even if reduced, maintainable periodontal environment.¹²⁻¹⁶
- Reduction in vertical bone height is not a contraindication for orthodontic tooth movement.¹⁷
- After periodontal therapy, the repair of a periodontal lesion may result in a variety of mixed healing scenarios: minimal spontaneous regeneration, formation of a long junctional epithelium, connective tissue attachment or adhesion and external root resorption (ERR).^{18,19}

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- After tooth movement into an infra-bony defect, on the pressure side epithelium can line the root surface and be interposed between root surface and bone.²⁰
- Apical propagation of the inflammatory lesion in periodontal disease is unrelated to the presence or absence of the bony component of the periodontium and a dentogingival unit with a long supra-alveolar connective tissue attachment is no more prone to plaque induced attachment loss than a unit with a supra-alveolar fibrous attachment of normal length.²¹
- Orthodontic therapy involving bodily tooth movement when infra-bony pockets are inflamed may enhance the rate of destruction of the connective tissue attachment. The risk for additional attachment loss is particularly evident when the tooth is moved into the infra-bony pocket.²²
- GTR to increase the surface of the periodontal ligament and enhance genuine new periodontal attachment may improve pre-orthodontic conditions for moving teeth into infra-bony defects or for vertical movements of teeth with reduced bone support.^{23–27} On a medium (3–5 years) to long-term basis (5–20 years) the periodontal regenerative/reconstructive therapy in intrabony defects results in shallower residual probing pocket depths (PD) and larger clinical attachment level (CAL) gain compared with open flap debridement (OFD), translating in high rates of tooth survival.²⁸
- Orthodontic space closure can improve the volume and esthetics of the interdental papilla also in the presence of periodontal breakdown by “squeezing” the soft tissue.^{29–30} This effect is greater the more voluminous/thicker the periodontal phenotype.

In light of the evidence summarized above, in the presence of an edentulous area and missing maxillary incisor(s), the guidelines for an effective orthodontic space closure by moving together the adjacent teeth with reduced periodontal support can be defined as follow:

- The connective unit (PL and cementum) attached to the root, even if severely reduced, is able to trigger the remodeling of the alveolar bone tissue, which effectively regenerates in the tension areas. Reduction in vertical bone height is not a contraindication for orthodontic tooth movement.
- The absence of inflammation at the level of the epithelial attachment (i.e. bottom of the sulcus), especially at the pressure side of the orthodontic movement, is mandatory in order to prevent further attachment loss and periodontal destruction. Meticulous oral hygiene at home and professional root planing every 4–6 weeks is a non-negotiable pre-condition in order to optimize the final outcome.
- The soft tissue will be “squeezed” in the pressure side and a papilla will appear to substitute the edentulous area. The length of the papilla is correlated to the distance between the contact point and the bone crests and to the volume of “squeezed” soft tissue. In the patients with a thick periodontal phenotype the papilla will improve even more.
- On the surface of the root in the pressure side, after the orthodontic treatment, we can expect to have a long epithelial attachment so close to the root that PD can be within the normal limits. It is not possible to exclude that new cementum formation and fibrous reattachment occurred in the supra-alveolar area between the marginal bone crest and the junctional epithelium. This long epithelial (and connective?) attachment is sufficient to prevent further attachment loss.
- When the anatomical morphology of the periodontal breakdown indicates a regenerative/reconstructive surgical procedure in order to regenerate new cementum, new periodontal ligament and new alveolar bone, the periodontal surgery should be done before the OT so that orthodontic movement will be more effective, being able to remodel a wider surface of connective tissue attachment and alveolar bone.

This article will present two clinical cases, treated following the guidelines above. In a minimally invasive way, satisfactory and predictably stable results were achieved in both growing and adult patients,

whose lost maxillary incisors were treated by orthodontic SC despite movement into and through a vertical defect of the adjacent teeth affected by advanced periodontal destruction.

GTR and space closure in a growing patient with hopeless maxillary central incisors

A 12 years old boy presented with a dental class II subdivision malocclusion, with mild U/L crowding, complicated by the maxillary central incisors severely damaged as a result of a traumatic injury which occurred two years ago. (Fig. 1) Both central incisors showed a marked root resorption and the periodontal support was reduced due to a chronic infection that flared up periodically. The adjacent lateral incisors were also partially compromised but felt to be saveable. The right lateral incisor was unresponsive to vitality-tests and showed bleeding on probing (BoP), a deep (PD 8 mm) and angular defect on the mesial aspect of the root. (Fig. 1E,F) It was impossible to assess the amount and morphology of the attachment loss on the mesio-buccal aspect because of the crowding and tight contact between with the central incisor. The upper left lateral incisor was necrotic and x-rays showed a periapical lesion, while PD was within the normal range. (Fig. 1H,I) The periodontal phenotype, also considering that the patient still had to grow, was considered “thick” even though recession was noticeable on lower left central incisor. The patient didn’t show the upper central incisors while speaking and the gingival margins are also hidden by the vertical deficit of the upper jaw and by the infraoccluded position due to ankylosis of the central resorbed incisors. (Fig. 1G) The skeletal pattern was a normo-divergent, mild class III with dentoalveolar compensation of the upper incisors, which were tipped buccally. (Fig. 1D)

The discussion about the treatment plan and alternatives was carried out between the periodontist, the prosthodontist and the orthodontist. Everyone agreed on the need to urgently extract the central incisors and perform orthodontic treatment to correct the malocclusion and crowding so as to meet the expectations of the parents and the patient. One priorities was obviously the replacement of the upper central incisors after the OT. Their prosthetic replacement could not be supported by osseointegrated implants, as the patient was still in the growth phase, so it was only possible to perform two single-wing adhesive bridges,³² or a cantilever crown replacement supported by palatal mini-implants.³³ Another problem was the periodontal collapse of the edentulous area following the extraction of the hopeless incisors and the consequent difficulties in producing a satisfactory aesthetic result at the level of the transition zone. But the biggest concern was the treatment time, i.e. the need to take care of the patient with prosthetic procedures (and periodontal surgery?) repeated at least for the next 10 or more years. The alternative of orthodontic closure of the spaces was a challenge, but it would have been able to solve almost all the problems mentioned above: the periodontal soft tissues in the edentulous area will remodel and increase in volume during SC; the prosthetic phase will be minimally invasive; the treatment time coincides with the orthodontic treatment time; the global treatment is closed in pre-adolescence and the chances of having to carry out complex long-term maintenance procedures are very low. On the other hand, the element that makes the prognosis uncertain was the apparent non-integrity and state of health of the periodontal tissues in the areas of pressure during SC.

Having having discussed in detail the alternatives, an orthodontic treatment was proposed aimed to correct the malocclusion and move the upper lateral incisors in the place of the centrals, the upper canines in the place of the laterals and the upper first premolars in the place of the canines. Lower second premolars extractions were planned to correct the crowding without any expansion of the lower arch, as well as provide 2–3 mm of overjet, that will allow some uprighting/extrusion of the upper incisors’ crowns aimed to improve the smile line. At the end of the orthodontic treatment six composite, no-prep restorations would have been necessary to change the anatomy of the first premolar to let them resemble canines, of the canines to let them resemble lateral

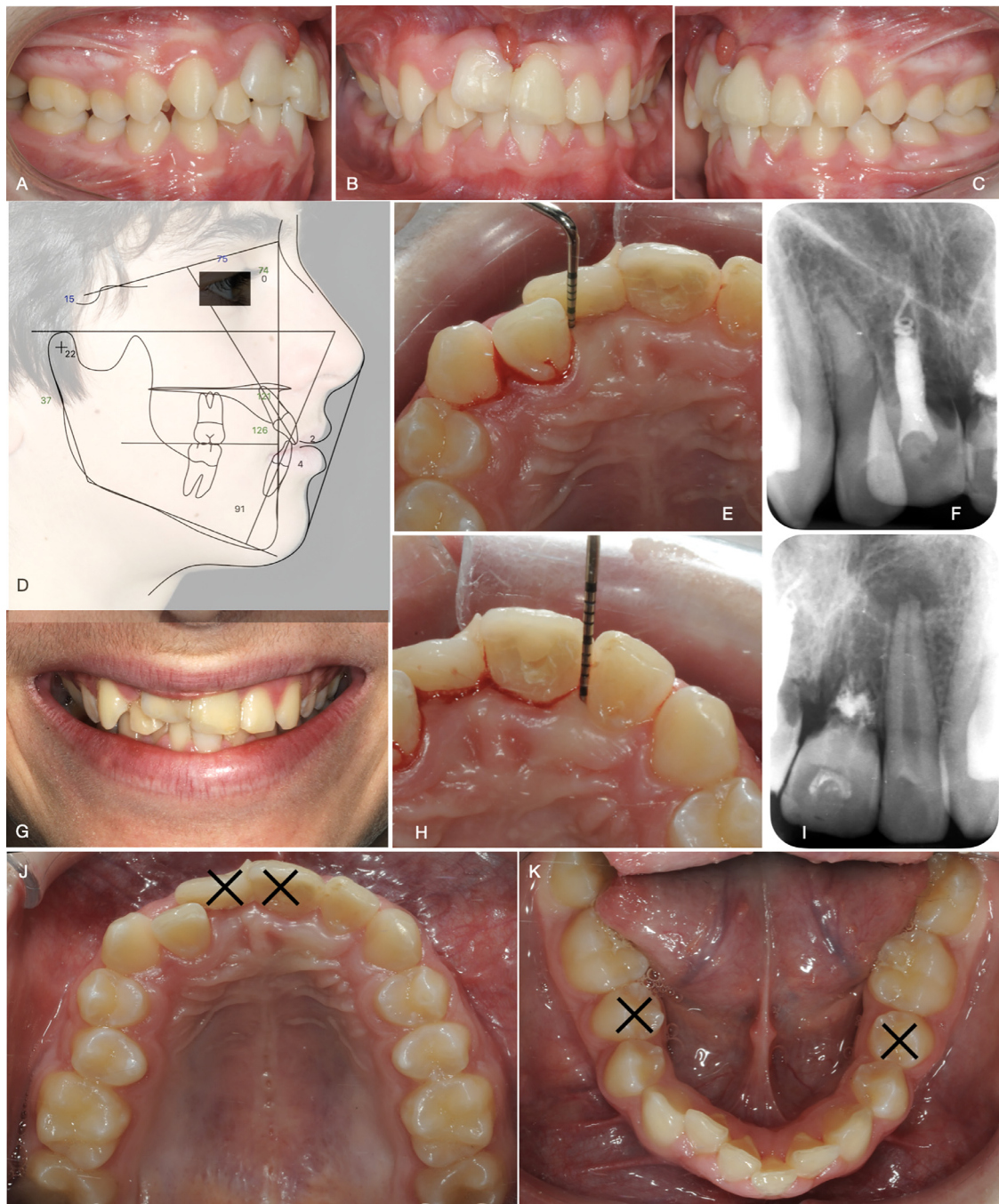


Fig. 1. A 12 years old boy showed a class II malocclusion with U/L crowding, complicated by the hopeless maxillary central incisors severely damaged as a sequela of a traumatic injury occurred two years before. (Fig. 1A-K) Both central incisors showed a wide root resorption and the periodontal support was widely lost due to a chronic infection that flared up periodically. The adjacent lateral incisors were also partially compromised but maintainable. The right lateral incisor was insensitive to vitality tests and showed a deep (PD 8 mm) and bleeding angular defect on the mesial aspect. (Fig. 1E,F) The upper left lateral incisor was necrotic with a radiographically evident periapical lesion. (Fig. 1H,I) Treatment plan involved the extraction of the upper central incisors / lower second premolars and the orthodontic space closure to move the upper lateral incisors in the place of the centrals.

incisors and of the lateral incisors and let them resemble central incisors and improve the smile arc.

One of the main issues, before starting the orthodontic therapy, was the periodontal condition at the mesial aspect of the lateral incisors, i.e. the area which will become the pressure area during space closure. The mesial vertical defect on the upper right lateral was 8 mm deep which would be impossible to maintain bacteria and inflammation free, so that a further attachment loss would have occurred. Nevertheless it was impossible to define the morphology of the vertical defect. It was therefore planned to extract the resorbed central incisors using an open flap

surgery, which will also allow a direct examination of the periodontal defect and, if indicated, contextually perform a regenerative procedure on the upper right lateral incisor. After the healing of the periodontal tissue, in the presence of a wider connective supporting apparatus and a within the normal range PD with no inflammation, the orthodontic movement could have been more effective and managed with less risk.

Treatment started with root planing, meticulous oral hygiene education and plaque control. After the extraction of the resorbed central incisors, the open-flap surgery (dr.Francesca Manfrini) allowed identification of a wide periodontal defect on the mesio-buccal aspect of the



Fig. 2. After the extraction of the central reabsorbed central incisors, a detailed diagnosis was possible of the vertical defect. (Fig. 2A) Contextually to the hopeless central incisors extraction, a GTR procedure was intended to regenerate new periodontal ligament and new alveolar bone and make the orthodontic movement more effective. (Fig. 2B) The healing was good on the palatal side and mesial to the upper left lateral incisor, (Fig. 2C,D,F-H) while is not complete at the bucco-mesial portion of the upper right lateral incisor, where CAL was 7 mm and PD was 4 mm. During orthodontic SC a great care was necessary to prevent plaque accumulation especially in the pressure areas, (Fig. 2I,J) where the patient was instructed to floss at least twice a day. 12 months were necessary for the space closure. (Fig. 2M-O) The orthodontic finishing phase also had the objective of maintaining the roots in the alveolar bone. (Fig. 2P-U).

upper right lateral incisor where the CAL was 9 mm. (Fig. 2A) It was decided to add a regenerative procedure (bovine spongy granules 0.25–0.1 mm covered for a 6–8 months bioresorbable collagen bovine membrane) aimed to increase the surface of the connective supporting tissue and regenerate some amount of alveolar bone. (Fig. 2B) The absence of walls around the vertical defect made the surgery very difficult and the prognosis of the GTR uncertain. Indeed, after healing and clinical improvement, a maintainable recession (CAL 7 mm / PD 4 mm / NO BoP) remained mesio-buccally on the upper right lateral incisor. (Fig. 2E,F)

The orthodontic movements started 7 months after GTR. (Fig. 2E-L) During orthodontic treatment, above all in the pressure side areas, a meticulous probing searching for absence of inflammation (BoP) was made at each clinical check-up, while the patient was motivated and instructed in maintaining the oral hygiene and plaque control at home. (Fig. 2I-J) The endodontic treatment of both upper lateral incisors was performed in the first months of the orthodontic treatment. At the end of the space closure, the papilla was within the normal limits, made of the “squeezed” soft tissue of the previous large edentulous area. (Fig. 2M,N) The alveolar bone crests in the pressure areas, mesial to the

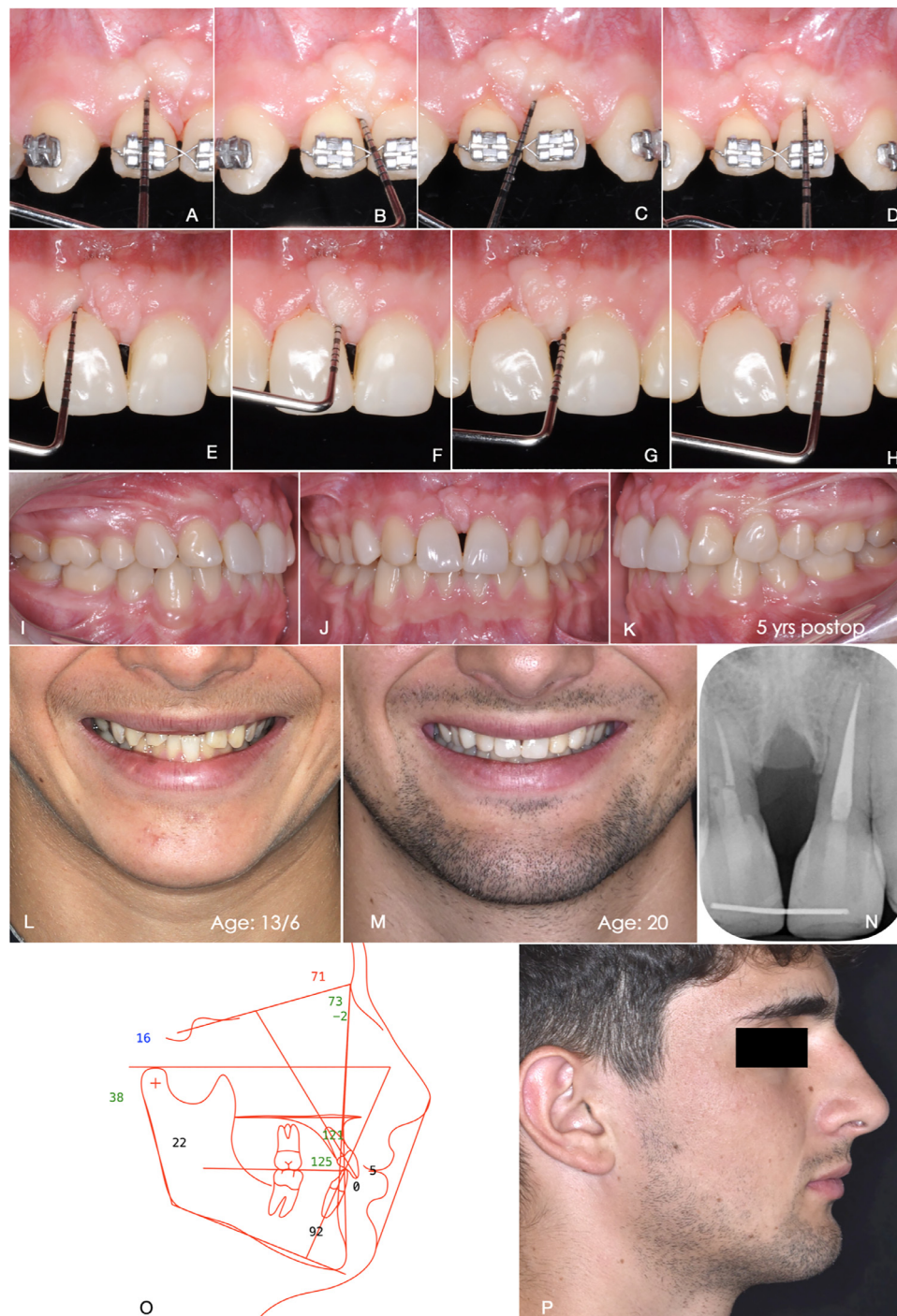


Fig. 3. During treatment PD and BoP were evaluated at every appointment. (Fig. 3A-D) 5 years after treatment the result is stable and the periodontal health is within the normal range. (Fig. 3E-K). The mesial bony crests, which faced the bacterial and mechanical stress of the pressure area during the orthodontic SC, radiologically improved in the years after the OT. More in detail, the mesial bone crest of the upper right lateral incisor, which was severely reduced before the OT due to the vertical defect, is now similar to the contra-lateral one. (Fig. 3N) The smile arc improvement is mainly due to the restoration of the upper lateral incisors and to a minor orthodontic extrusion. (Fig. 3M) The cephalometric assessments show a good control of the lower incisors' position and some proclination of the upper incisors (necessary to maintain their roots inside the maxillary alveolar bone. (Fig. 3O).

lateral incisors were maintained and were radiologically located apically to the portion of the planed root, (Fig. 2O) while the alveolar bone at the center of the edentulous area is vertically absent, as it was before the orthodontic space closure. During the finishing phase of the OT, the lateral incisors and the first premolars were intruded while the canines were extruded in order to improve the level of the gingival margins.^{34,35} Precise torque control was applied by means of third order bends on the rectangular ss archwires to keep the roots of the upper lateral incisors,

canines and first premolars inside the alveolar bone. (Fig. 2P-U) No BoP and no inflammation were found on the pressure side areas during and at the end of the orthodontic treatment. (Fig. 3A-H) Direct composite restorations were performed (dr.Patrizia Lucchi) the day of the debonding on the six maxillary front teeth. The contact point between the central incisors was not extended in the apical portion in order to allow, if possible, some further maturation and growth of the papilla. The soft tissue are bunched up and a non-bleeding epithelialized fissure resting at

the 2 mm recession on the labial surface of the upper right lateral incisor was maintainable and there was no indication for corrective mucogingival surgery. (Fig. 3A-H) During the OT the jaws grew in a counterclockwise direction and the symphysis became more prominent. (Fig. 3O,P) The cephalometric assessments show a good control of the lower incisors' position and a mild proclination of the upper incisors (necessary to maintain their roots inside the alveolar bone), which may be not pleasant, but can be corrected with new, more uprighted restorations. The smile arc improved and the incisal margins of the upper incisors are consonant to the lower lip, (Fig. 3M) mainly following the restoration of the upper lateral incisors and a mild orthodontic extrusion. The hidden smile line is of course the reason why the persistent black triangle between the new central incisors doesn't represent an aesthetic problem.

For retention, the patient was asked to use an Essix retainer in both arches, while a short bonded splint was made only on the upper central incisors. A strict protocol of professional oral hygiene, plaque control and periodical check-ups was established.

5 years after the end of active treatment the overall stability is satisfactory both occlusally and aesthetically. (Fig. 3I-K) The periodontal health is within the normal limits, (Fig. 3E,H) despite the less than ideal cooperation of the patient: PD on the front teeth is between 2 and 4 mm with maintainable BoP only at the bottom of the small labial recession of the upper right lateral incisors substituting the central one. The bone crests, which faced all the bacterial and mechanical stress of the pressure area during the orthodontic space closure, radiologically improved in the years after the orthodontic treatment. The mesial bone crest of the upper right lateral incisor, which was severely reduced before the orthodontic treatment due to the vertical defect, (Fig. 2K) is now similar to the contra-lateral one. (Fig. 3N) The patient still uses the Essix retainer during sporting activity as a retainer and mouthguard.

Space closure in an adult patient after the extraction of the u/l central incisor with severe periodontal breakdown

A 44 years old woman was referred by her dentist for orthodontic implant site development (OISD) and space re-opening in the area of the crowded upper left central incisor. This tooth was considered hopeless due to the severe loss of periodontal support. The occlusal migration was compensated by grinding the incisal portion of the crown. (Fig. 4A,B,L)

The patient showed a class II malocclusion and a skeletal hyperdivergency with high smile line and "gummy smile". (Fig. 4C)

The adjacent teeth also showed loss of periodontal support at the mesial surfaces: PD was 6 mm, CAL was 8 mm with BoP on the upper right central incisor, while on the left upper lateral PD was 8 mm, CAL 12 mm with bleeding on probing. Due to the thick periodontal phenotype, the gingival margin of the hopeless upper left central incisor didn't migrate apically and was located at the level of the contralateral tooth. The papillae between the central incisors and between the upper left central and lateral incisors were absent due to the severe loss of periodontal support.

Her general dentist was asking to develop an implant site by orthodontic extrusion until extraction of the U/L central incisor and to open the space for an implant supported prosthetic substitution. The minimum residual alveolar bone was not a contraindication for the OISD by extrusion,³⁶ but the effectiveness of the orthodontic increment of alveolar bone, even if supported by a detailed guided bone regeneration (GBR) would have been limited by the severe apical migration of the mesial bone crests of the adjacent teeth. Therefore, the risk of not being able to obtain a sufficient result at the level of the gingival margins, papillae and vestibular thickness of the periodontal tissues was significant, even more so considering the patient's smile line. The alternative of bridges seemed even less likely to provide acceptable aesthetics of the soft issue, which would be severely reduced following the incisor

extraction. As the patient had poor financial means and that she needed orthodontic treatment anyway, it was decided to extract the lost tooth and close the space by moving the U/L lateral incisor into the place of the central and the canine in place of the lateral incisor. This solution would have made it possible to avoid prosthetic replacement and to support the thickness of the periodontal tissues on the buccal side with greater predictability, even if it was difficult to predict how the severely compromised periodontal tissues would respond to orthodontic treatment. The possibility of performing a GTR on the mesial root surfaces of the right central incisor and the left lateral incisor before the orthodontic movement was also discussed, but the morphology of the bone defect (no wall to support the GTR) led us to speculate a minimal benefit and an unfavorable cost-benefit ratio.

The patient understood the severity of the periodontal damage, the pros and cons of the different therapeutic alternatives and was motivated and cooperative to undertake orthodontic treatment with fixed appliances.

The interdisciplinary treatment started with the extraction of the upper left central incisor, the etiologic therapy, meticulous oral hygiene and professional root planing. No open-flap surgical procedures were necessary to heal the inflammation of the periodontal tissue.

The orthodontic treatment started when the periodontal tissues, even if severely reduced on the mesial side of the adjacent teeth, were healthy and inflammation free. During the SC crucial care was taken to prevent inflammation and plaque accumulation on the pressure sides. (Fig. 4E,F) The patient was cooperative by also flossing the pressure areas at least once a day. Professional oral hygiene and root planing was scheduled every three months. Space closure was carried out with 0.018 x 0.025 slot brackets and 0.016 x .022NiTi and ss rectangular wires by pushing and pulling in ten months. (Fig. 4A-J) The orthodontic finishing phase lasted 8 more months. The cemento enamel junction (CEJ) and gingival margins of the upper left front teeth were properly leveled by orthodontic extrusion of the canine and intrusion of the lateral incisor (substituting the central one) and of the first premolar which replaces the canine. (Fig. 4K) During the space closure, the upper left lateral incisor was reshaped by a no-prep composite build up, (Fig. 4G) which was substituted at the end of the OT together with a new composite restorations of the U/L canine and first premolar. (Fig. 4K,M) A flexible spiral wire retainer was bonded palatally on the six front teeth. (Fig. 4I,M) The thickness of the periodontal tissues on the buccal side didn't change during the space closure, (Fig. 4K,M) and guarantees optimal aesthetics of the gingival margin and the soft tissue. (Fig. 4M) The papillae have improved even if the one between the 2 central incisors still is short. A further approximation of the roots would have further reduced the black triangle but would not have been able to lengthen the papilla.

The orthodontic space closure couldn't improve the surface of the periodontal ligament and the bony crests remained where they were before treatment, thus a radiological vertical defect was evident during and after treatment. (Fig. 4H,I)

Two years after the orthodontic space closure, the CAL (4mmR / 3mmL) and PD (2mmR / 1mmL) have improved enormously and are now within normal limits, (Fig. 5B,C) supporting the hypothesis that, following the compression of the soft tissue induced by the orthodontic movement, a long epithelial attachment is strictly lining to the root surface.²⁰ The radiologic aspect of the mesial/distal bony crests remained stable. (Fig. 5A)

Eleven years after the treatment, still PD (3 mm) and CAL (4 mm) are within the normal range, (Fig. 5E,F). The radiological vertical defect at the mesial aspect of the upper left mesialized lateral incisor, it now filled by new alveolar bone, which regenerated as a slow response to a probable migration of connective tissue in the coronal direction during and after orthodontic SC.¹⁸

In this period of time the patient, satisfied with the aesthetic result, never took up our advice to renew or replace the composite restorations, nor to reconstruct the papilla and reduce/fill the black triangle that remains between the central incisors.



Fig. 4. The upper left central incisor of a 44 yrs of age woman was hopeless and to be extracted due to the severe periodontal breakdown, which involved the adjacent teeth. The patient showed a “gummy smile”, thus the management of the soft periodontal tissue was crucial. (Fig. 4A-C) After etiologic therapy, the orthodontic SC, under meticulous prevention of inflammation, moved the lateral incisor in the place of the central, while upper left canine and first premolars were moved in the area of the lateral incisor and canine. (Fig. 4J,K,M) At the end of the orthodontic treatment the soft periodontal tissues improved, (Fig. 4K,M) while the radiological aspect of the alveolar bony crest didn't worsen. (Fig. 4H,I).

Discussion

Orthodontic substitution of one or more maxillary missing incisor(s) by space closure of the adjacent teeth with reduced periodontal support can be done also into and through a vertical defect. The goal of the treatment is the stable improvement of the PD, CAL, the volume of the papilla, the leveling of the gingival margins and the overall aesthetics of the soft tissues. On the

pressure side the bone crests can be maintained by careful orthodontic movements and meticulous prevention of plaque and bacteria accumulation, while the soft tissue orthodontically “squeezed” become the papilla and also improve in their relationship with the supracrestal root surface, giving rise to an long epithelial (perhaps also connective in the apical portion) attachment.

The volume of the alveolar bone can be increased by GTR procedures to be done before the orthodontic movements.

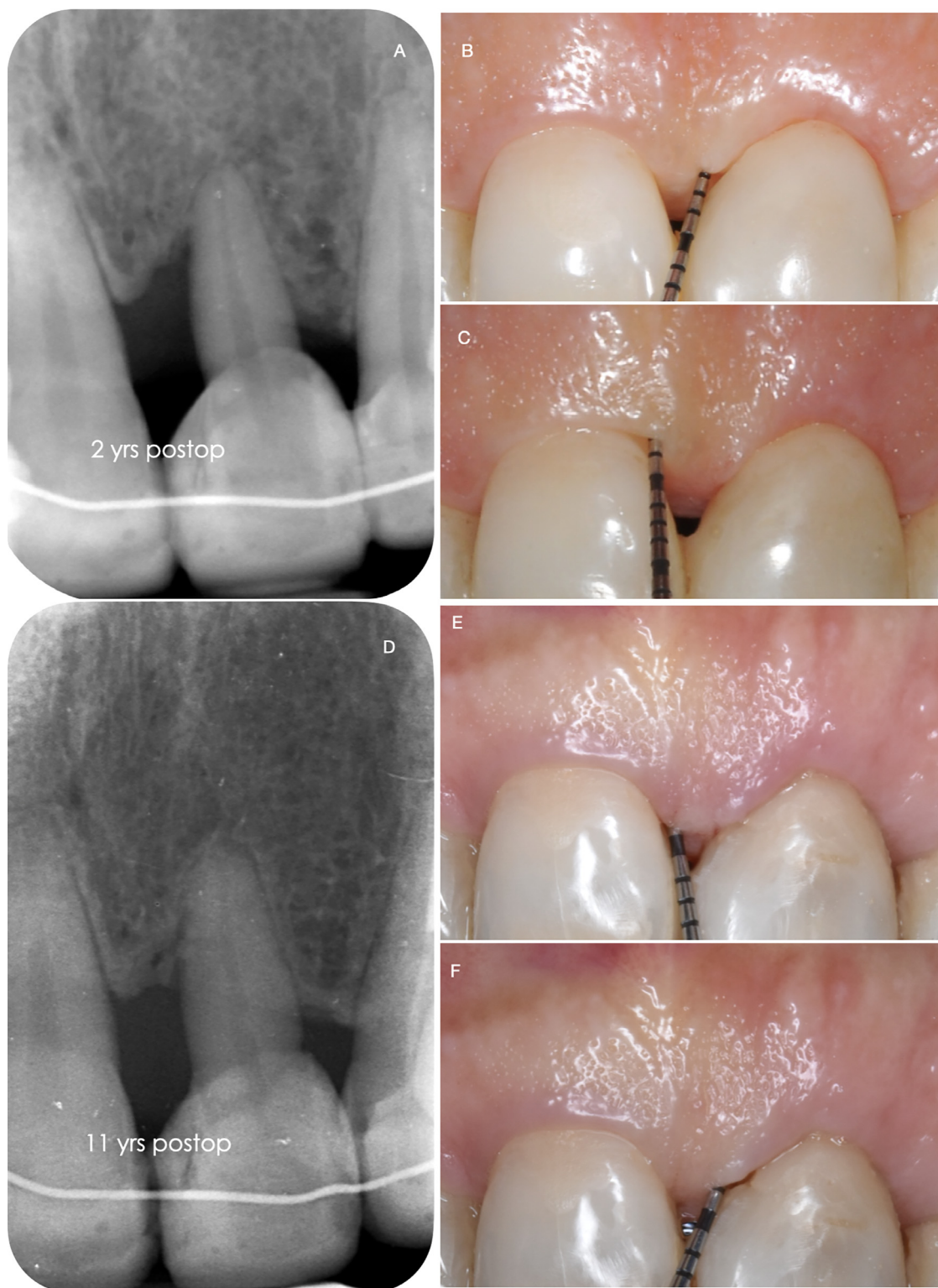


Fig. 5. Two years after the orthodontic space closure, the CAL (4mmR / 3mmL) and PD (2mmR / 1mmL) have improved enormously and were within normal limits, (Fig. 5B,C) supporting the hypothesis that, following the compression of the soft tissue induced by the orthodontic movement, a long epithelial attachment is lining to the root surface. The radiologic aspect of the mesial/distal bone crests remained stable. (Fig. 5A). Eleven years after the end of treatment, still PD (3 mm) and CAL (4 mm) are within the normal range. (Fig. 5E,F) The vertical defect at the mesial aspect of the upper left lateral incisor is now filled by new alveolar bone which regenerated as a late response to a probable migration of connective tissue in the coronal direction during and after orthodontic SC. (Fig. 5D).

Two different treatment protocols have to be shortly discussed: the orthodontic movement with or without GTR aimed to obtain different outcomes on the periodontal tissues.

Remodeling of periodontal tissues as a result of the orthodontic space closure alone

The scientific rationale for the orthodontic substitution of missing incisor(s) and periodontal destruction of the edentulous area by moving the adjacent teeth with reduced periodontal apparatus, comes from the studies published between 1974 and 1993, which investigated the reaction of the periodontal tissue to such a challenging movement.^{12-15,17-22}

We expect that the alveolar bone will remain at the same level only where the residual periodontal ligament is healthy. In the supra-alveolar bony crest area a long junctional epithelium should line on the root surface.²⁰ Some amount of new cementum formation and fibrous reattachment could occur and create a long supracrestal connective tissue attachment between the marginal bone crest and the apical portion of the long junctional epithelium. It is impossible to exclude that also some amount of alveolar bone could regenerate to or close to the apical portion of the junctional epithelium.¹⁸ This last phenomenon could take years after the end of the OT if the plaque control is adequate before, during and after treatment. All that is shown in the second case presented in this article.(Fig. 4,5)

The orthodontic movement alone can produce a satisfactory and effective result also in the cases where the anatomy of the vertical defect (one wall vertical defect or horizontal bone loss) doesn't indicate a periodontal regenerative/reconstructive surgical therapy and when the periodontal support of the adjacent teeth is reduced, but healthy and maintainable.

GTR before orthodontic space closure

If the orthodontic movement alone can produce a satisfactory and effective result, the extra benefits of the GTR is evident in the literature.²⁴⁻²⁸

The bone volume and the surface of the periodontal ligament can be increased by a GTR procedure that should be done before the orthodontic movement on the teeth adjacent to the edentulous area. GTR is indeed the only way to regenerate new genuine cementum, periodontal ligament and alveolar bone. The periodontal ligament is the tissue necessary to trigger orthodontic remodeling of the alveolar bone, thus the larger the surface of the periodontal ligament, the greater the volume of alveolar bone manipulated and remodeled by the orthodontic movement.

What is mandatory is a correct diagnosis of the periodontal defect in order to define whether a periodontal regenerative/reconstructive therapy is indicated and how significant can the benefit be for the patient. The horizontal bone loss and vertical defects with only one or two walls are not ideal indications for a GTR procedure, while a 3 or 4 walls vertical defect allow to predictably regenerate a clinically significant amount of new cementum, periodontal ligament and alveolar bone. The GTR and mucogingival surgical procedures are operator-dependent and the skill of the surgeon is a crucial point for the success and the prognosis.

After the GTR, when should the orthodontic movement start, is still a controversial point (few days? few months?) and nowadays there is no clear evidence to allow a precise answer.^{26,31, 37-39} Some authors have the opinion that orthodontic movement can begin even a few days after the GTR surgical procedure, but waiting three to six months may be a wise decision and doesn't compromise the effectiveness of the therapy. As shown in the first case presented in this article, the quality of the alveolar bone crests can improve in the years after the end of the orthodontic treatment.(Fig. 2G,H,O and Fig. 3N)

Both in the case of GTR being carried out before OT, and when the orthodontic space closure is the only treatment, the periodontal phenotype and the soft tissue thickness is an important factor to evaluate in assigning prognosis. Before the orthodontic therapy is initiated, one

should therefore carefully consider if the bucco-lingual thickness of the soft tissue on the pressure side is "thin" and to be increased surgically.⁴⁰

During the orthodontic space closure it is crucial to keep the roots inside the periodontal envelope having 1–2 mm of alveolar bone thickness on the buccal side. (Fig. 2P-U) Possible complications of the orthodontic therapy must be identified before they become clinically relevant. Inflammation on the pressure side must be searched at each appointment by probing and, in case of BoP the orthodontic movement must be suspended and professional root instrumentation performed. Apical and/or external root resorption (E/ARR) must be looked for by means of periapical xRays every four-six months. In case of E/ARR, the orthodontic movement should be stopped and teeth immobilized for at least six months.

The cooperation of the patient is fundamental. Instructions in adequate oral hygiene maintenance should be given and controlled before, during and after the completion of the orthodontic therapy to avoid plaque and bacteria accumulation, periodontal tissues inflammation and unnecessary trauma to the soft tissues margins.

The orthodontic SC even in case of severe periodontal breakdown, should be considered as a valid alternative in the context of a comprehensive orthodontic treatment aimed to the malocclusion's correction, especially in the growing patients and in all patients, who show the gingival margins while talking and smiling. On the contrary, in the patient with no malocclusion, in the adults and in the patients who don't show the gingival margins, the orthodontic SC is an option which should be carefully evaluated in terms of its pros and cons.

Conclusion

The orthodontic movement of teeth with reduced periodontal support into and through a vertical defect and edentulous area can be a valid treatment option provided that meticulous oral hygiene, absence of inflammation and a detailed biomechanics are under strict control.

The main indications are two groups of cooperative patients with a malocclusion to be corrected during the SC: first of all the growing patients, but also all those who show the gingival margins while talking and smiling.

The orthodontic movement alone could improve the gingival aesthetics and the quality of the attachment of the soft tissues to the root surface.

The bone volume and the available surface of the periodontal ligament can be increased by periodontal regenerative/reconstructive therapy to be done before the orthodontic movement.

Patient consent

Patient consent was obtained.

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Author contributions

All authors attest that they meet the current ICMJE criteria for authorship.

Declaration of competing interest

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