Essay I

Orthodontic edentulous space closure in all malocclusions

Outcome evaluation of facial and dental esthetics

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Abstract

In patients with missing maxillary anterior teeth, orthodontic space closure is an evidence-based, effective treatment option, probably the best if the goal is long-term periodontal health. Nowadays, this approach is possible in all malocclusions as the first step of an interdisciplinary approach, which aims not only at an optimum esthetic and functional result, but moreover at reducing the invasiveness of the subsequent restorative treatment. Space closure should be considered the first alternative in growing patients and when the gingival margins are visible. This essay presents the rationale for space closure and provides clinical tips for interdisciplinary treatment planning and finishing.

Keywords: orthodontics, space closure, missing incisors, missing laterals
Introduction

Even if the advent of osseointegrated implants reduced the popularity of the ‘space closure’ alternative, there are still at least three major reasons to consider this alternative as the most appropriate option:

1. From a biologic, esthetic, and periodontal perspective, a natural tooth or a root is almost always better than a foreign body, while the possible negative lifetime side effects are minimal. This is especially the case for the esthetic zone, where the management of the transition zone between white and pink tissue requires an ideal balance of health and esthetics.

2. Considering that, in the vast majority of cases, orthodontic treatment is in any case necessary to correct the spontaneous migration of the adjacent teeth, the overall treatment time is shorter and the cost–benefit ratio superior to all existing alternatives. This is a crucial consideration in the treatment of growing patients and young adults.

3. Nowadays, ‘space closure’ is an evidence-based, long-term-effective treatment. It has been demonstrated that, in the long-term, space closure:
   - produces results that are well accepted by patients;
   - does not impair temporomandibular joint (TMJ) function;
   - preserves periodontal health.

Nordquist and McNeil compared mean 10-years posttreatment of 39 space closure and 19 space opening and prosthetic replacements (13 bridges, 6 removable plates). The authors concluded that:

1. Space closure patients are healthier periodontally than prosthesis patients.
2. There is no difference in occlusal function.
3. The presence or absence of canine rise is not related to periodontal status.
4. There is no evidence that canine Class I relation is the preferred mode of treatment.

Thordarson et al demonstrated that ground canines moved in the area of the lateral incisors are stable and safe in the long term (mean > 10 years).

Robertsson and Mohlin investigated mean 7-years postoperative of 50 adult patients (30 space closure vs 20 space opening and prosthetic replacements) and demonstrated that:

- Space closure patients are more satisfied than prosthesis patients.
- There is no difference in the presence of temporomandibular dysfunction (TMD).
- Prosthesis patients have more plaque and gingivitis.

Czochrowska et al investigated the substitution of a missing maxillary central incisor with the lateral incisor, comparing the space closure site to the contralateral central incisor mean 6-years posttreatment. These authors reported similar position and appearance, with no detrimental effects seen on the radiographs. They concluded that “the substitution of a central incisor with the lateral is a valid treatment modality, if the indications for such treatment are present and careful attention to detail in orthodontic and restorative treatment is exercised.”

Jamilian et al compared the periodontal and esthetic outcome of 17 space closure sites and 14 implants mean 6-year postoperative. These authors reported similar, well-accepted esthetic results, no TMD, and evident infraocclusion in the implant patients, and concluded that space closure patients have better periodontal health.

Rosa et al demonstrated that space closure, including first premolar intrusion and canine extrusion, in patients with missing lateral incisors does not incur the risk of periodontal tissue deterioration or TMD problems in the long term (mean 10-years postoperative).

Josefsson and Lindsten compared the clinical and esthetic outcome of 28 single-implant restorations with 38 space closure sites 5 years after treatment and concluded that “if both treatment alternatives are available, space closure is preferable.”

Besides, a recent systematic review confirmed that the lateral occlusal scheme has minimal impact on patient comfort, biology, and mechanical complications. Canine guidance and group function are equally acceptable.

If health and function are not under discussion, then esthetics becomes a major focus for orthodontists. After space closure, smile esthetics is not ideal,
even if reshaping of the mesialized canine has been performed. Apart from a tendency for space reopening, the periodontal profile is altered, the canine appears too yellowish, and the premolar is undersized for an adequate substitution of the mesialized canine. To overcome those limitations, a new method was introduced to finalize orthodontic space closure and optimize the overall esthetic outcome.\textsuperscript{9,12}

The key points are:

- Space closure with correction of the malocclusion.
- Orthodontic extrusion of the canine and intrusion of the first premolar to correctly level the gingival margins.
- Detailed torque control during extrusion and intrusion to keep the roots in the dentoalveolar envelope.
- Minor restoration and vital leaching of the yellowish extruded canine moved into the place of the lateral incisor.
- Restoration and enlargement of the intruded first premolar so that it resembles and works as a canine.
- Localized gingivectomy and periodontal surgical recontouring for selected patients.\textsuperscript{9,12}
- Restoration not only of a lateral incisor substituting a missing central incisor, but also in patients with congenitally missing lateral incisors (CMLI) because their entire maxillary dentition is undersized.\textsuperscript{13-18}

These improvements introduced a significant change of approach in the treatment of missing teeth in the esthetic zone: no longer a mere ‘canine substitution,’ but an interdisciplinary treatment seeking excellence. The orthodontic treatment is the first fundamental phase, with the aim not only of closing the spaces and correcting the malocclusion, but also of creating the correct anatomic conditions (roots and periodontal tissue) to allow the dentist to perform minimally invasive restorations on the anterior teeth.

**Space closure irrespective of the craniofacial classification**

Traditionally, the ‘space closure’ alternative is indicated in Class II malocclusions, in cases of mandibular crowding and incisor protrusion, while the main esthetic procedure is to grind the canine so that it resembles a lateral incisor. On the other hand, space closure would be contraindicated in Class III maloclusions, in patients with a short face/concave profile, and in the patients with large-sized canines.

Nowadays, by combining carefully detailed orthodontic, periodontal, and reconstructive procedures, it is possible to close the spaces and achieve a functional, esthetic, and long-term stable outcome in all malocclusions.\textsuperscript{9,12,19}

Active treatment is to be planned in three steps:

- Space closure and correction of the malocclusion.
- Orthodontic finishing in the esthetic zone.
- Minimally invasive or noninvasive restorations on the anterior teeth.

**1. Space closure should be performed with fixed appliances**

Active orthodontic treatment should be performed in the permanent dentition. Even with the increased effectiveness of aligners, fixed appliances treatment is still the gold standard. Diagnosis in the early mixed dentition, combined with a serial extraction protocol, can be efficient for promoting spontaneous space closure and favorable migration of the adjacent teeth during the eruption period and reduces the difficulty of subsequent active orthodontic treatment. Maxillary space closure in Class I or III molar/canine malocclusions is usually less complicated when extractions in the mandible are planned. If patient collaboration is satisfactory, closure of the maxillary spaces can also be performed without mandibular extractions by pushing coil springs, supported by the diligent wearing of Class III elastics.\textsuperscript{9,10}

Maxillary space closure is nowadays not only possible but also faster and predictable (without cooperation) in a short active treatment time (10 to 14 months) by using skeletal anchorage.\textsuperscript{19-21} Two temporary mini implants (temporary anchorage devices, TADs) placed in the palate are sufficient and effective to support a sliding mechanism, which moves all the posterior teeth mesially. This system does not require appliances in the mandible or Class III elastics as additional anchorage. The skeletal anchorage also allows for the closure of the space unilaterally with no cooperation (Fig 1).
Fig 1  (a) A 12-year-old female had the maxillary right central incisor traumatically lost 4 years before the first observation. (b) Before treatment, the overjet and overbite were within normal range. The maxillary midline was correct. Periodontal support was normal on the teeth adjacent to the edentulous area. No crowding was present in the mandibular arch. The occlusion and TMJs were stable. (c) The buccal cortical plate was slightly reduced in the missing area of tooth 11. (d) Two 8 mm mini implants (temporary anchorage devices, TADS) were placed in the palatal basal bone, on which a mesial slider was anchored that aimed to push forward the maxillary right permanent first molar. On the left side, the appliance was passively anchored on the incisors, canine, and first molar. (e) The unilateral space closure was performed over 10 months, without the patient’s collaboration. (f) The premolars, canine, and lateral incisor were pushed mesially by buccal mechanics, without any appliance in the mandibular arch. The maxillary right first premolar and the lateral incisors were intruded, while the canine was extruded to ideally level the gingival margins. (g) Orthodontic finishing lasted 9 more months with fixed appliances also in the mandibular arch. (h) Three years after the end of treatment, the lateral incisor in the right side replaced the central incisor, the canine substituted the lateral incisor, and the first premolar was in the place of the canine. The molars occluded in a Class II relationship. (i) Three years after treatment, the occlusion was normal on the left side. The natural roots of the right lateral incisor and canine ideally supported the periodontal buccal plate.
Three years after the end of treatment, the periodontal profile was stable after orthodontic manipulation by the intrusion of the right first premolar and lateral incisor associated with the extrusion and torque control of the right canine. Four composite restorations were performed by Dr Patrizia Lucchi on teeth 14, 13, 12, and fractured tooth 21. (k) Three years after treatment, a bonded retention persisted on five anterior teeth. (l) The periodontal support was within the normal range on the critical mesial portion of the mesialized and intruded lateral incisor. (m) The apically displaced mesiodistal bone crests of the intruded lateral incisor did not interfere with periodontal health. (n) Three years after treatment, the smile was natural looking. Space closure did not negatively interfere with facial esthetics.
2. Orthodontic finishing in the esthetic zone

Finishing starts from a detailed diagnosis, treatment plan, and positioning of the braces. The goal is to optimize the smile line and place the anterior teeth in such a way that minimally invasive or noninvasive restorations can be made. Orthodontic finishing in the anterior maxilla is particularly crucial when the gingival margins are exposed and in patients with thin periodontal phenotypes.

The starting point is the position of the maxillary incisors: the maxillary midline should coincide with the philtrum of the upper lip, and the long axis of the central incisors must be parallel to the long axis of the face, irrespective of the mandibular midline (Figs 2f and 2j). The vertical display of the maxillary incisors should be planned not only on the upper lip at rest, but also considering the smile line and the relation between the gingival margins and the upper lip during conversation and smile. The gingival margins should be visible according to the skeletal pattern, age, and sex of the patient.

The gingival profile can be adjusted orthodontically by extrusion of the mesialized canine and intrusion of the first premolar until the cementoenamel junction (CEJ) of the intruded first premolars is leveled with the central incisor, while the CEJ of the canine should be positioned 2 to 3 mm lower. Following the intrusion/extrusion movements, uneven bone peaks will become evident radiologically at the contact point (radiological vertical defect). The vertical movements are effective in remodeling the periodontal profile and do not compromise periodontal health in the long term.

Especially in case of a thin periodontal phenotype, it is crucial to keep the roots inside the dentoalveolar envelope by precise torque control. To prevent a possible space reopening, the roots should be placed with a distal angulation of 5 to 10 degrees. The mesiodistal stripping and palatal grinding of the canine should be finalized during the orthodontic finishing phase and will ensure optimum occlusion without any functional interference.

During this last phase of orthodontic treatment, close communication and decision making with the prosthodontist and the periodontist is of utmost importance for achieving the best possible interdisciplinary result for the individual patient.

Fig 2  (a) A 28-year-old male complained of esthetic discomfort due to interdental spaces, protruded central incisors, and two congenitally missing maxillary lateral incisors. (b) The malocclusion was a dentoskeletal Class II division 1 with normal periodontal support. There was mild crowding in the mandible, and the occlusion and TMJs were stable. (c) The maxillary incisors protrusion and interdental spaces were corrected with lingual fixed appliances. (d) Four years after treatment, and 6 months after the suspension of the maxillary retention, small interdental spaces re-opened as well as a 4 mm overjet. The teeth were stable in this position. (e) Following that, no further movement was noticeable, the composite buildups were substituted with ceramic restorations (Dr Giovanni Sammarco) on the anterior teeth and resolved the interdental spaces. The palatal surface of the central incisors and canines was restored to ‘fill’ the overjet and recreate a functional overjet. Nine years after treatment, the result was stable without any retention.
Fig 2 cont  (f) Fourteen years after orthodontic space closure, the dental esthetics was good and the interdental spaces had not reopened. The mandibular midline was deviated to the left due to the mandibular asymmetry. (g) The occlusal Class II molar relationship was stable. The first premolar was the substitute for the canine, while the canine was in the place of the lateral incisor. The esthetic balance of the teeth was within the normal range. (h) The maxillary incisors were orthodontically uprighted on the palatal plane, but the overjet was not fully corrected in order to prevent an excessive, unstable dentoalveolar compensation and retrusion of the lips. (i) The anteroposterior of the maxillary incisors was ideal on the palatal plane, and the overjet correction was partial. The orthodontic full correction of the overjet would have required a further retrusion of the maxillary incisors, with consequent worsening of the smile esthetics. (j) The maxillary midline was symmetric and centered on the upper lip philtrum. The overall smile and facial esthetics were acceptable (despite the narrow maxillary arch) due to the maxillary arch occluding on the retrusive mandible.
3. Minimally invasive or noninvasive restorations

Beyond the mere grinding of the canine so that it resembles a lateral incisor, multiple restorations are often necessary, not only for the compensation of existing anatomic variations in length, width, and thickness, but also to achieve long-term esthetics and function.

Restorative enlargement of the intruded first crown is almost always necessary to achieve balanced smile esthetics and a proper occlusion. The restoration will provide a new cusp, new contact points, and a new palatal working surface. The premolar’s palatal cusp should not be ground. Restoration of the central incisor is mandatory when this tooth is substituted by a lateral incisor, but also in patients with CMLI because their entire maxillary dentition is undersized.13-18

Outcome evaluation of facial esthetics

The esthetic benefits for the smile and profile are among the main goals of orthodontic treatment. Do extractions necessarily result in a flat face and narrow smiles? No, when properly indicated extraction is fundamental to improve the profile (Figs 3b and i)25-27 and the smile (Figs 3a and h)28-32 as well as to promote periodontal health33,34 and long-term stability.34,35 The success of orthodontic treatment depends on the careful analysis of all diagnostic elements and the establishment of a correct treatment plan.

Many dentists and orthodontists are convinced that in patients with missing maxillary incisors whose malocclusion does not require an orthodontic extraction treatment, space closure should be avoided because it may compromise the facial profile and narrow the smile. Conversely, they share the view that space opening in patients with a flat/concave profile will improve the posture of the lips, enhance the profile, and provide a ‘wider’ smile. This is a very superficial way to approach the issue. Actually, space closure could affect facial esthetics in both areas: the profile and the smile width. Important details are briefly outlined below.

![Fig 3](a) An 8-year-old female was missing the maxillary lateral incisors and showed a narrow retrusive maxilla with buccal corridors. (b) The strain of the peri-oral muscles, protrusive lower lip, and post-rotated chin defined the Class III hyperdivergent skeletal pattern. (c) The congenitally missing maxillary lateral incisors were diagnosed in the mixed dentition. (d and e) In the last stage of the mixed dentition, after the orthopedic palatal expansion, the orthodontic treatment plan was space closure in the maxillary arch and the extraction of the mandibular first premolars to resolve the minor crowding and promote ideal counterclockwise growth of the mandible as well as profile improvement.
Fig 3 cont. (f and g) At the end of treatment, performed with fixed appliances and composite restorations (Dr Patrizia Lucchi) on the six maxillary anterior teeth, the first premolar substituted the canine, while the canine was in the place of the lateral incisor. The occlusal contacts and periodontal profile were within the normal range. (h) At the end of treatment, the smile line and smile arc were within the normal range. The smile was full, despite the extraction treatment. The enlarged central incisors were in good balance with the adjacent teeth and the face. (i) The soft tissue profile improved significantly, the lips were relaxed, and the peri-oral soft tissue were well defined. (j) The impressive improvement of the soft tissue profile is also due to the extraction therapy and slight uprighting of the incisors.
**Space closure and profile**

A widespread opinion is that the anteroposterior position of the maxillary incisor crowns is the main focus when planning soft tissue profile changes. Indeed, at the end of any orthodontic treatment, when occlusion is normal, the lips are resting on the crown of the maxillary incisors. Thus, if overjet is normal, what makes the profile more or less convex/concave is the position of the mandibular incisors and their relationship to the chin (Pogonion and Menton): skeletal pattern, vertical dimension, as well as the anatomy and position of the symphysis. In the absence of surgical procedures, the orthodontic treatment can tip the incisors at any age, while the position of the chin can be affected, mainly during growth, by the vertical control of the posterior teeth.

In a mild Class III case with a short face and concave profile, space opening with proclination of the incisors and prosthetic replacement of the missing incisors does not majorly affect the profile and lip posture. In patients with short faces (concave profile), what is relevant instead is an increase of the vertical dimension by means of extrusion of the molars, with consequent post rotation of the mandibular plane and profile convexity. This will also allow some extrusion and uprighting of the maxillary anterior teeth leading to a consequent improvement of the smile arc (Fig 4).

On the contrary, in hyperdivergent skeletal Class II cases with a convex profile, the overjet correction may require an excessive dentoalveolar compensation, ie, palatal tip and retrusion of the maxillary incisors. This will increase the nasolabial angle and flatten the profile. Moreover, a molar distalization and expansion procedure in the mandible should be avoided to prevent a mandibular post rotation and an increase of the anterior facial height. Both the maxillary incisors’ palatal tip and mandibular post rotation could produce an evident decline of the profile and worsening of the lip posture. In Class II cases with a convex profile and retruded mandible, after the maxillary incisors are well uprighted on the palatal plane, it is better to leave some overjet to be ‘filled’ and compensated for by the restorations (Fig 2).

![Fig 4](image-url)  
(a) An 11-year-old female was missing the maxillary lateral incisors and as a consequence of that showed a narrow retrusive maxilla with buccal corridors and large interdental spaces in the maxillary arch. The smile arc was flat, and the smile line was hidden due to the vertical deficiency of the maxillary basal bone. (b) The profile was flat mainly because of the short face. The expected counterclockwise growth of the jaws will worsen the Class III profile in future.
Fig 4 cont (c) Before treatment, the maxillary central incisors were protruded, while the premolars were in a Class III relationship. The treatment plan was to perform orthopedic palatal expansion and orthodontic space closure in the maxilla without any extraction in the mandible. (d) The superimposition shows the mesial movement of the maxillary molars to a Class II relationship, and the post-rotation of the occlusal and mandibular planes due to the molar extrusion. The maxillary incisors were extruded and uprighted to improve their exposure, smile line, and smile arc. The soft tissue profile improved despite the space closure. (e) At the end of the orthodontic treatment, the occlusion was a stable Class II molar relationship. Mesialized/intruded first premolars replaced the canines, and the extruded canines were in place of the lateral incisors. Immediately after the appliance removal, composite direct restorations were made by Dr Patrizia Lucchi on the six anterior teeth. The central incisors were elongated to improve the smile arc. (f) Fifteen years after treatment, the soft tissue profile is within the normal range, despite the maxillary space closure and the counterclockwise growth pattern. (g) Fifteen years after treatment, the overall smile is full, and the smile arc is correct. The composite restorations had not been renewed or replaced and had deteriorated. A small diastema reopened between the central incisors.
Space closure and smile width

The existing data show that if orthodontic treatment has been carried out with a thorough diagnosis and careful planning, the choice of extraction treatment will not necessarily result in a buccal corridor that negatively affects frontal facial attractiveness. Conversely, nonextraction orthodontic treatment – by broadening the anterior sweep of the maxillary arch and increasing the buccal tip of the maxillary teeth – might flatten the smile arc, reduce the incisor display, and make the smile less youthful and attractive. Thus, once again, in case of missing maxillary incisors, the space opening alternative will not necessarily improve the smile esthetics; ‘expanding’ it could result in the opposite effect.

To improve the facial esthetics of the smile, it is recommended to expand the maxillary basal bone transversally and sagittally, to upright/extrude the maxillary teeth by respecting the periodontal envelope, to increase the vertical display of the maxillary anterior teeth, and to reduce the vertical exposure of the mandibular incisors and canines.

When the goal is a full smile, the most challenging malocclusions are:
- Skeletal Class II patients with a retruded mandible and the maxillary arch in good occlusion;
- Patients with maxillary vertical deficiency and those who do not show the maxillary gingival margins.

For these patients, orthodontics and/or prosthetic rehabilitation are not capable of providing adequate treatment. In the case of a growing young patient who shows these features, orthodontic space closure in the context of a surgical approach could be one of the best investments (Fig 5).

Outcome evaluation of dental esthetics

After orthodontic space closure, the esthetic appeal of the maxillary anterior teeth is suboptimal due to the different form and size of the mesialized dentition and to the anomalous periodontal profile: the gingival margins of the canines are higher than the gingival margin of the central incisors, while the short first premolars display a lower gingival contour. Without orthodontic normalization of the unnatural-looking periodontal profile and cosmetic restorations, it is impossible to obtain an ideal esthetic and functional result. This is even more difficult when a significant difference in size and color is evident among the canines and incisors.

However, for some patients with congenitally missing maxillary lateral incisors (CMLI), the final esthetic outcome could be acceptable by only reshaping the canines, even with no restorations and orthodontic remodeling of the periodontal profile. There is some evidence that laypeople do not notice all the aesthetic details that are relevant to professionals (dentists, orthodontists, prosthodontists) and that mere space closure is evaluated more positively esthetically than prosthetic replacements.

There is general agreement that the most disturbing dental esthetic features are interdental spaces (black triangles) and asymmetric alterations. A unilateral crown width discrepancy of > 2 mm, and the discrepancy between the root angulation and the facial midline, are noticeable to all observers, while asymmetric alterations of the gingival exposure and cant of the occlusal plane seem to be more acceptable. These are the main reasons why in patients with unilateral CMLI, the extraction of the contralateral, especially when peg-shaped and smaller, is often better than unilateral space closure.

Tooth size is another major issue that may greatly influence esthetic treatment outcomes. While previous research assessed a close relationship between the degree of agenesis and the reduction in tooth width in patients affected by multiple congenitally missing teeth, recently an association between smaller teeth (eg, central incisors) and tooth agenesis has also been reported in subjects with CMLI as a single dental anomaly. Sometimes, differences in size and shape between the right lateral incisors are also present.

Small teeth (most importantly, the central incisors) should be recognized before treatment. When a patient presents large canines, the first question should be: Are the canines large or are all the teeth, including the central incisors, small? Often in cases where there are missing teeth, the central incisors are small and the canines are an ideal size, to substitute for the later-
al incisors. The ‘art of seeing’ rather than scientific evidence may be fundamental in the diagnostic phase. Patients should be informed that if their teeth are small, some side effects are very likely to become noticeable after orthodontic treatment, these being:

- Reopening of the spaces and embrasures in case of space closure.
- Inadequate space for the implant in case of orthodontic implant site development.
- Inadequate vertical display of the central incisors and smile arc.
- Some overjet palatal to the maxillary central incisors.
- An unnatural-looking and unbalanced smile.
Yellowish canines are to be ground palatally, mesially, and distally during the orthodontic finishing phase. The convex labial surface should be flattened after the torque correction: when the root is properly placed in the alveolar bone, the canine will be ground mainly in the incisal half, where the enamel layer is thicker. Small direct restorations are often necessary to fill the black triangle and embrasure mesially on the ground cusp of the canine. If the vital bleaching of the yellowish canine is planned, then a more whitish-colored composite should be used so that the vital bleaching will adapt to the white composite, and not vice versa.9

A common mistake during the extrusion of the canine with labial appliances is the buccal root torque, with the consequent thinning of the buccal cortical plate and a higher risk of bone dehiscences or gingival recessions. These side effects can be prevented by detailed orthodontic palatal root control during extrusion.

Intruded first premolars do not need to be ground on the palatal cusp, while they should be restored in length and thickness, and sometimes mesiodistally if contact points are absent. The restorations will provide proper esthetics, while the guiding surfaces will be provided by the palatal sides.9,12 A common mistake during the intrusion of the first premolar by means of labial biomechanics is the buccal tip of the crown, resulting in an evident excessive overjet in the canine area. This will cause great difficulties for the dentist performing the restoration that aims to change the morphology of the crown of the intruded premolar into a canine.

Central incisors often need to be built up because patients with congenitally missing teeth have an undersized dentition, and sometimes the central incisors are different in size and morphology. The central incisors need to be enlarged, both in width and length, to obtain a correct thickness and smile arc:

- In Class II cases, some overjet may persist after the orthodontic correction and will need to be corrected by the restoration on the palatal side of the central incisors (Fig 2d and e).
- Conversely, in Class III cases it is often necessary to grind the canines palatally to achieve a correct overjet and anterior guidance. The restorations will preferably also increase the volume of the small central incisors on the buccal side.

When a lateral incisor is moved to the place of the central incisor, all aspects described above become even more difficult to manage. In any case, the lateral incisor should be intruded until the CEJ is at the level of the contralateral normal central incisor. This will allow the prosthodontist to place the limit of the restoration at the level of maximum circumference and reduce the unavoidable undercut between root and crown (Fig 1j, l, and m). To place the zenith properly, the root should be angulated 5 to 7 degrees distally. To reduce the risk of a black triangle, the crown of the lateral incisor should be no more than 2 mm from the adjacent contralateral central incisor. The angulation of the root and the amount of space closure should be planned with the prosthodontist, considering the periodontal phenotype, the smile line, and the possible reaction of the soft tissue to the planned restoration.

Soft tissue reaction to orthodontic intrusion and extrusion cannot be easily predicted in detail. If the periodontal support is intact and mature, soft tissue (the gingival margin) follows the vertical movements by 60% to 80% during intrusion, and 90% during extrusion. There is a wide individual variation in the behavior of the soft tissue: the main difference is between adolescents and adults. In adolescents, it is common to observe a hypertrophy of the marginal gingiva due to poor oral hygiene. Besides, the altered passive or active eruption could jeopardize the response of the gingival margins to the vertical orthodontic movements. In a limited number of patients, a gингivectomy (and rarely, resective surgery) is necessary to remodel the soft and hard tissue. Patients with periodontal breakdown and attachment loss are expected to react in a different way.

According to the established occlusal requirements (overjet/overbite/anterior guidance) and esthetics (exposure of the anterior teeth/smile line/smile arc), the orthodontist and restorative dentist have to individually plan and adjust the size and position of the anterior teeth. The procedures to be considered and eventually planned in detail are:

- Mesiodistal stripping and palatal grinding of the crown of the canine, while its buccal surface is usually ground after the removal of the fixed appliances, in the context of the cosmetic restorations.
Stripping of the mandibular incisors.

- Whether to leave some interproximal space (in case of small teeth).
- Whether to leave some overjet between the palatal surface of the well-aligned central incisors and the incisal edges of the mandibular incisors.

The timing of the restorations is crucial for the success of the interdisciplinary treatment. Composite direct or semi-direct restorations should be done immediately after removal of the orthodontic appliance, together with the retention (fixed and/or removable). Eventual ceramic restorations should be performed after the settling of the occlusion, and at least 6 months after any retention of the maxillary anterior teeth. A group function is the preferable mode of occlusal finishing on anterior teeth. A removable retention may be planned together with the orthodontist, considering the original malocclusion.

Conclusions

1. Space closure offers the great advantage that the entire treatment is finished immediately after the removal of the orthodontic appliances. This is fundamental in growing patients.

2. Space closure is an effective treatment modality with excellent evidence-based long-term stability.

3. Periodontal health is more predictable in the long term after space closure compared with any prosthetic substitution.

4. Space closure should be the preferred approach in growing patients, young adults, and patients with gingival margin display.

5. Nowadays, space closure is possible in all malocclusions.

6. If based on a correct diagnosis and a comprehensive treatment plan, space closure does not worsen the profile or the smile width.

7. Patients with CMLI have an undersized dentition with small teeth (eg, the central incisors).

8. Optimum care for patients with missing maxillary incisors requires an interdisciplinary comprehensive treatment approach.

9. Multiple restorations may be indicated after orthodontic space closure to achieve pleasing aesthetics, good function, and long-term stability.

10. Direct no-prep composite restorations could be a valid mid- to long-term restorative option.

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