Invisible treatment of an asymmetric adult class II malocclusion related to unilateral upper lateral incisor agenesis with a straight wire lingual appliance, mini-screw and premolar extraction: A case report

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Keywords

Malocclusion Angle Class II Agenesis Adult Camouflage Bicuspid/extraction Lingual appliances Mini-screws Dental veneers

Introduction

Summary

This case report describes a complex full-step class II malocclusion with unilateral upper lateral incisor agenesis in an adult patient treated with lingual straight-wire appliance and premolar extraction, with the two-fold aim of obtaining ideal occlusal relationship and smile aesthetic improvement. In view of this, it underlines how an appropriate treatment strategy, including extraction choice and anchorage control during space closure, is needed to achieve the planned results with a completely invisible lingual appliance combined with aesthetic veneers.

The correction of a class II malocclusion with a lateral incisor agenesis in an adult patient is often challenging. Treatment strategies can include either space reopening for implant insertion on the agenesis site or an extraction and space closure on the contralateral side in order to regain ideal dento-alveolar symmetry [1,2].

In a patient with dental full-step class II malocclusion and underlying skeletal discrepancy, in the absence of growth potential, the first option can be successful only if the patient accepts orthognathic surgery treatment; in the absence of this condition, space opening would not lead to class II correction and would determine an excessive overjet increase [3]. Since not all patients are willing to undergo surgical treatment, [4,5] an orthodontic camouflage with unilateral extraction represents a viable option: the choice of the element to be extracted on the contralateral side is based on mechanical, aesthetic and functional considerations [3].

The two possible treatment strategies are represented by either lateral incisor extraction or one premolar extraction; restorative dentistry treatment with either build-ups or veneers at treatment end is necessary for the best aesthetic and functional result.

The complexity of the case is further increased if the patient requests a completely invisible appliance. Thankfully, lingual orthodontics make it possible to plan the final result in the set-up, inserting individualized overcorrections and analysing the critical aesthetic and functional factors of the new occlusal pattern from the start of the treatment.

In this article, an adult class II case with upper right lateral incisor agenesis is treated by a combination of lingual straight-wire appliance, contralateral second premolar extraction and prosthetic dentistry treatment.

Case report

This paper presents a complex case of class II upper right lateral incisor agenesis in an adult patient treated with a lingual straight

wire appliance, in which the diagnostic strategy and management of the anchorage for non-surgical treatment was of paramount importance in achieving occlusion and improving smile aesthetics.

Diagnosis and aetiology

The patient presented at the age of 20 years with a request to have her teeth aligned by means of an aesthetic appliance. The face, from a frontal view, evidenced a decreased lower third, a quite good symmetry despite an upper midline deviation towards the right side (*figure 1*).



FIGURE 1 Initial extraoral and intraoral photographs



FIGURE 2

Initial lateral cephalometric and panoramic X-rays; McLaughlin and Tweed cephalometric analysis

From a lateral view, the profile appeared well-balanced, with a small nose, a 90° nasolabial angle, a marked labiomental sulcus, a slightly retruded mandibular position but a well-represented chin with nevertheless, a difficulty in closing the lips without contraction (*figure 1*).

The orthopantomography revealed the agenesis of the upper right lateral incisor, the absence of the lower third molars and an important condylar asymmetry (*figure 2*). Cephalometric values confirmed a skeletal class II (ANB = 6°) with the mandible in a retruded position (SNB = 73°), (*figure 2*). The vertical skeletal pattern is normodivergent (SN/MP = 24°), with the occlusal plane oriented counter clockwise. The upper incisors appeared normo-inclined (109°) while the lower turned out to be proclined (103°).

In the intraoral frontal view, the midlines appeared non-coincident (deviation of the upper, towards the right-side), with the upper right canine in substitution of the lateral incisor (agenesis); a negative torque of buccal and posterior elements in both upper and lower arches was noticeable. An anterior deep-bite and an accentuated lower curve of Spee were also present. Lateral views evidenced a bilateral canine and molar class II relationship while the occlusal views revealed crowding in the upper and lower lateral incisors in retruded position. The upper arch was also slightly contracted from a transverse point of view, while the lower curve of Wilson was accentuated. The periodontal biotype turned out to be thin. (*figure 1, figure 3*).



FIGURE 3 Initial intraoral models

Treatment objectives

The primary objectives were dental class II correction, upper midline deviation resolution and dental aesthetic improvement. Additional goals were crowding resolution, reduction of black buccal corridors during smile, ideal overjet and overbite achievement, upper and lower curve of Wilson correction.

Treatment alternatives

The ideal orthodontic-surgical treatment which would have allowed upper right lateral incisor space opening and mandibular advancement was illustrated to the patient without success. Considering the profile features of the patient (90° nasolabial angle, mandibular retrusion and well-represented chin), the skeletal and dental class II, the anterior crowding and the deviation of upper midline towards the right side, an upper contralateral second premolar extraction treatment was chosen. No space opening treatment was considered without surgery: the entity of skeletal and dental class II in the absence of mandibular growth made this option unsuccessful.

Two treatment strategies were considered: either upper left lateral incisor extraction in order to obtain symmetry with canine substitution on both sides or upper left second premolar extraction with progressive left side teeth retraction and upper midline correction.

The second option was chosen, considering that the upper left lateral incisor had an ideal root and periodontal support and that

the upper left canine had a distally-inclined root. In addition, the upper left lateral incisor extraction was an aesthetic problem for the patient in terms of the visible anterior space.

Treatment progress

The orthodontic treatment was performed by lingual technique: that choice was determined by the patient's request for an invisible appliance.

The orthodontic treatment was performed by lingual "straightwire" technique [6,7] with OrmcoTM Stb brackets, after a manual and individualised set up (*figure 4*). The following tip and torque overcorrections for unilateral second premolar extraction case were included in the set-up prescriptions:

- extra anterior labial crown torque to their maxillary incisors (+5° beyond the desired outcome) to counteract their retroclination during upper left second premolar space closure;
- positive extra torque (+2°) on left maxillary canine in order to avoid cortical bone impaction;
- distal root tipping for maxillary left first premolar (6°) and mesial root tipping for maxillary left first molar (6°) to facilitate the distal bodily movement during the space closure;
- maxillary left second molar tipping backward (2°) to increase posterior anchorage, to prevent vertical bowing effect during space closure mechanics and to achieve root paralleling;
- 2° distal root tip on maxillary left central incisor and 3° distal root tip on maxillary left lateral incisor to achieve root parallelism.



FIGURE 4 Manual set-up



Figure 5

1st month: lower arch bonding with 0.013 CuNiTi LSW Small. Insertion of 32-34,42-44 open coil springs 5th month: insertion of $0.018\,^{*}0.018$ CuNiTi LSW Medium in the upper arch. Bonding and alignment of the 43

Overcorrections for canine substitution (selective upper right canine extrusion and lingual root-torque; upper right first premolar intrusion, mesial-rotation and buccal root-torque) and for deep-bite correction (minimum overbite) were also included in the set-up prescriptions.

The brackets' bonding was carried out by "single jigs", following the "Komori system" technique, after the assembling of arches performed with "Kommon base" philosophy [8].

Lower arch bonding was performed first. A 0.013 CuNiTi LSW (Lingual Straight Wire) Ormco Stb Small was inserted for the initial alignment. Open coil springs were inserted bilaterally between lower lateral incisors and first premolars, in order to create space for lower canines bonding (*figure 5*).

Three months after treatment start, the upper arch bonding was carried out; a 0.013 CuNiTi LSW Ormco Stb Medium was inserted for the initial alignment. Occlusal build-ups were bonded on

upper second molars with the purpose of obtaining a tripodic contact. Lower left canine bonding was performed, while open coil spring between lower right lateral incisor and first premolar was reactivated

Following a two-month period, a 0.018*0.018 CuNiTi LSW Ormco Stb Medium was inserted in the upper arch for levelling and torque establishment. Lower right canine bonding was performed. A closed elastic chain was inserted between lower right canine and second premolar to facilitate lower right canine rotation (*figure 6*).

After two months, a 0.018*0.018 CuNiTi LSW Ormco Stb Small was inserted in the lower arch for levelling and torque establishment.

One month later, a 0.0175*0.0175TMA LSW Ormco Stb Small was inserted in the lower arch with slight anti Spee curve for obtaining a complete lower arch levelling.

Thirteen months after treatment start, upper interradicular palatal miniscrews were inserted in combination with a 0.018*0.018 SS LSW Ormco Stb Medium posted for starting



FIGURE 7

15th month: After insertion of interradicular palatal miniscrews, insertion of 0.018^{*}0.018 SS LSW Medium posted in the upper arch. Addition of 13-23 open elastic chain and miniscrews-hooks closed elastic chains. Twenty-five was extracted



Figure 8

25th month: after removal of miniscrews, Insertion of 0.0175*0.0175TMA LSW Medium in the upper arch. Refinement bends performed. Addition of 16-26 closed elastic chain

anterior retraction by closed elastic chains. An open elastic chain was added between upper canines to avoid spaces opening. Upper left second premolar was progressively sliced in order to allow space closure. After two other months, upper left second premolar extraction was performed. During the following months, elastic chains were reactivated in order to complete upper left second space closure (figure 7).

Twenty-three months after treatment start, miniscrews were removed and a new 0.018*0.018 SS LSW Ormco Stb Medium was inserted in the upper arch with 21-22, 22-23 open coil springs to create spaces mesial and distal to upper left lateral incisor. Two months later, a 0.0175*0.0175 TMA LSW Ormco Stb Medium was inserted in the upper arch with the addition of refinement bends: upper right canine step-down and step-in. 21-22, 22-23

closed coil springs were inserted for space maintenance and a closed elastic chain between upper first molars was inserted in order to complete posterior space closure (*figure 8*).

FIGURE 9

28th month: refinement bends performed. Thirteen palatal grinding. Thirteen distal 0.3 m IPR. Insertion of 21-22 open coil spring. Addition of 16-21,22-26 closed elastic chains

After one month, the following bends were added: upper right canine step-down and step-in increase (in combination with palatal grinding), upper left canine step-down and step-in. 0.3 mm IPR was performed distal to 13.

Following a two-month period, further refinement bends were performed: upper left canine step-down and step-in increase; upper right first premolar step-in. 21-22 open coil spring was inserted to increase the space mesial to upper left lateral incisor and 16-21, 22-26 closed elastic chains were added to close posterior spaces (figure 9).

Treatment results

After 28 months of treatment, upper and lower arch debonding was performed. Upper and lower essix were delivered and final treatment radiographies were prescribed.

The frontal and lateral extraoral photographs show the facial balance maintained in respect of treatment start. From final treatment frontal photographs, a correct smile arch could be noticed.

The lateral photographs evidenced that the profile was maintained (*figure 10*).

A solid upper first premolar/lower canine class I and molar class II on the right side, canine class I molar class II on the left side were obtained, with crowding resolution, lower curve of Spee flattening and deep bite relation correction. The light contact resulted ideal at this point (figures 10 and 11).

The final orthopantomography showed the root parallelism between the elements. Cephalometric analysis evidenced the improvement of facial and dental relations (figure 24, figure 24a). Upper incisor torgue turned out to be increased (from 109° to 116°) and lower incisors unchanged (103° to 104°). Ricketts E line [9], was maintained unvaried despite the extraction decision (figure 12, table I).

The superimpositions highlighted that no growth occurred and the correction was mainly obtained by means of dento-alveolar movements. The upper molars were intruded and vertically controlled. No increase in the lower face height was encountered. The upper incisors were retruded with an increased rootpalatal torque (figure 13).

Nine months later, upper 13-23 veneers were bonded. In addition, lower 33-43 fixed lingual retainer was bonded. At this point new upper and lower essix were delivered. The frontal and lateral extraoral photographs show the facial balance was maintained in respect of treatment start and the smile improvement with the absence of black corridors and a pleasant smile arch (fiaures 14 and 15).

The follow-up photographs, performed one year after treatment end, show the stability of the treatment (figures 16 and 17).





FIGURE 10

Upper and lower arch debonding. End of treatment extraoral and intra-oral photographs





FIGURE 11 Final intraoral models



FIGURE 12 Final lateral cephalometric and panoramic X-rays; McLaughlin and Tweed cephalometric analysis

Table I

Pre and post treatment cephalometric values.

	Mean SD	Pre-treatment	Post-treatment
Sagittal skeletal relations			
Maxillary position S-N-A	$82^{\circ}\pm$ 3.5°	79.0°	77.6°
Mandibular position S-N-B	$80^{\circ}\pm$ 3.5°	73.2°	71.8°
Sagittal jaw relation A-N-B	2°± 2.5°	5.7°	5.8°
Vertical skeletal relations			
Maxillary inclination S-N/ANS-PNS	$8^{\circ}\pm$ 3.0 $^{\circ}$	10.1°	8.5°
Mandibular inclination S-N/Go-Gn	$33^{\circ}\pm$ 2.5°	33.3°	34.3°
Vertical jaw relation ANS-PNS/Go-Gn	$25^{\circ}\pm~6.0^{\circ}$	23.2°	25.8°
Dento-Basal relations			
Maxillary incisor inclination 1 - PP	$110^{\circ}\pm 6.0^{\circ}$	109.1°	116.0°
Mandibular incisor inclination 1 - Go-Gn	$94^{\circ}\pm~7.0^{\circ}$	103.0°	103.8°
Mandibular incisor compensation 1 - A-Pg (mm)	2± 2.0	6.3 mm	6.2 mm
Dental relations			
Overjet (mm)	3.5± 2.5	1.5 mm	1.4 mm
Overbite (mm)	2± 2.5	4.2 mm	1.8 mm
Interincisal angle 1/1	$132^{\circ}\pm~6.0^{\circ}$	124.7°	114.0°







FIGURE 14

Nine-month post-treatment follow-up: dynamic extraoral and intraoral photographs. 33-43 fixed lingual retainer bonding





Nine-month follow-up: static intraoral extraoral photographs (occlusal and particular)



FIGURE 16

One year post-treatment follow-up intraoral photographs (frontal, lateral, occlusal and particular)





Discussion

In this case report, a patient with a class II malocclusion and agenesis of the upper right lateral incisor was treated with a straight wire lingual appliance, with a straight wire lingual appliance, extraction of the left upper second premolar and closure of the space with mini screws. After the retention phase, veneers were bonded to the six upper anterior teeth to achieve the best aesthetic and functional result.

As the patient had a skeletal class II due to a mandibular retrusion, a space opening strategy combined with orthognathic surgery was considered as the first option: the patient, however, refused this solution, requesting a less invasive treatment. In order to compensate for the skeletal and dental class II, an extraction on the contralateral side of the agenesis was considered necessary. Two options were available: either the extraction of a lateral incisor or the extraction of a premolar.

Although the extraction of the left upper lateral incisor could have determined an ideal final result, the root of the left upper canine was distally oriented at the start of treatment: closing the space with ideal root parallelism (to avoid relapse) would have been difficult and less rapid. The left upper lateral incisor, although slightly reduced in size, had ideal root and periodontal support. The second option was also preferred by the patient for aesthetic reasons during treatment. She had required completely invisible treatment and the lateral incisor extraction could have resulted in a large space in an anterior area that was difficult to camouflage at some stage of space closure.

In order to get the best result in the lingual set-up, all overcorrections were included: upper right canine lingual-root torque in order to look like a lateral incisor reducing the root eminence; upper right canine extrusion for proper gingival margin position; upper right first premolar buccal root-torque to appear similar to a canine for aesthetic and functional reasons; upper right first premolar intrusion for proper gingival margin position; upper right first premolar mesial-rotation to improve the "cuspid" look from the front; upper left first premolar and first molar tip for extraction space closure [3].

The canine is normally longer and larger than the lateral incisor it will replace. For this reason, it is necessary to reduce it mesiodistally and labiolingually. In the former case, it has to be reduced mainly on the distal surface, which may be too convex compared to a lateral incisor. The mesial margins may also be too convex, but this can be corrected with either veneers or composite resin "corners" [10–17]. A less mesial and greater distal interproximal reduction of the upper left canine was performed in this case.

Regarding the labiolingual aspect, a palatal grinding was performed: the cuspids being thicker than the lateral incisors, their extrusion may create an excessive occlusal contact with the mandibular incisors. This should be corrected by increasing their lingual root torque: this correction was inserted in the set-up.

For the maintained lateral incisor, it is necessary at the same time to create spaces to obtain symmetry: mesial and distal diastemas were opened to allow a correct dimension of the veneer. The first premolar is generally shorter and narrower than the contralateral canine. An increase of space is, in some cases, necessary to obtain the correct proportions [18–21]. Since in this case we had almost equal mesio-distal canine and first premolar dimensions, it was possible to plan an asymmetric extraction of the second premolars for the resolution of the case and to minimally increase the dimension of the right side premolars with prosthetic restorations.

In addition, the placement of inter-radicular mini-screws allowed symmetrical retraction of the anterior teeth, moving them predominantly to the left side to correct the dentoalveolar asymmetry and midline discordance.

It is also interesting to point out that hypodontia is often associated with other disruptions of the dental lamina and maxillofacial skeletal imbalances [22]. The occurrence of tooth agenesis and microform teeth have been found to occur together much more frequently than would be expected by chance alone [22,23].

When there is a peg-shaped lateral incisor on one side and agenesis of the lateral incisor on the other it may be difficult to obtain aesthetically pleasing results. The best solution in such cases is to combine the space closure with a good porcelain laminate veneer on the peg tooth [3].

In this case, the upper left lateral incisor was only slightly microdontic; however, its dimension needed to be increased to achieve the same mesio-distal dimension as the left upper canine.

Porcelain veneers on the canines and first premolars [3,24] and on the central incisors, if these are to be widened or lengthened [25,26], although more expensive for the patient than grinding and build-ups, represent the best aesthetic and functional solution in the long term. With this in mind, veneers were placed on all six upper anterior teeth to achieve the best aesthetic and functional result.

The most common objections to closing orthodontic spaces are that the treatment result may not look "natural", that retention is difficult and that functional occlusion may be compromised [3].

With regard to the latter, intraoral photographs show the presence of the correct guides at the end of treatment.

In this case, the upper fixed lingual retainer was not bonded at the patient's request for hygienic reasons, but upper and lower night time essix were delivered and the one year follow-up showed a stable result.

Conclusions

The success of this clinical case shows the possibility of an acceptable compromise of therapeutic molar class II, camouflaging a mandibular skeletal class II. The highly aesthetic orthodontic and cosmetic management of the agenesis of the right upper lateral incisor was achieved by extraction of a contralateral second premolar to obtain a class I and coordination of the deviated maxillary midline. This was done with a completely invisible appliance, as requested by the patient.

The use of the lingual appliance combined with a unilateral premolar extraction, an appropriate biomechanical strategy, set-up overcorrections and prosthodontic finalization with veneers allowed the achievement of an ideal symmetry between right and left sides, despite the altered occlusal schema and of the best aesthetic and functional result in the short and long-term.

Contribution: Dr. Enrico Albertini treated the case.

Dr. Paolo Albertini, Dr. Anna Colonna and Dr. Luca Lombardo contributed in the article preparation. Dr. Simone Vaccari contributed as prosthodontist in the case finalization.

Disclosure of interest: the authors declare that they have no competing interest.

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