ISSN: 1849-3858 (ONLINE)
ISSN: 1849-5249 (PRINT)

www.sejodr.org

South European Journal of Orthodontics and Dentofacial Research

SEJODR

DENTITIO • ZAGREB

VOLUME 8
NUMBER 1-2
YEAR 2021

Case report

SEJODR

Management of Class II Division 1 Subdivision malocclusion using unilateral bicuspid extractions and fixed functional appliance: A Two Year Follow-Up

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ABSTRACT

Introduction: Management of Class II Subdivision cases pose a clinical dilemma and require a careful diagnosis to ascertain the source of asymmetry. Various treatment modalities involving: different protocols of tooth extractions; molar distalization; fixed functional appliances, or orthognathic surgery have been proposed for the same.

Case presentation: This article reports a unique approach for management of a severe skeletal Class II with Angle's Class II Division 1 subdivision malocclusion using unilateral bicuspid extractions in mandibular and maxillary arches and a fixed functional appliance.

Results: A 13 year 1-month-old male in CVMI transition stage was successfully treated. Extraction of #44 was done to alleviate crowding in the mandibular anterior region and #15 was extracted to protract #16 to achieve a Class II molar relationship. A pre-functional Class II molar and canine relationship with co-incident midlines were achieved. The functional phase consisted of a fixed functional appliance (Forsus FRD) for mandibular advancement to correct the severe skeletal Class II. Class I molar and canine relationships were achieved with the reduction of facial convexity and overjet. The result remained stable 24 months after treatment. The improvement can be quantified by the reduction in scores of orthodontic indices measured pre and post-treatment.

Conclusions: Management of Class II subdivision malocclusion requires careful planning. This paper presents a unique approach utilizing unilateral extractions and fixed functional appliances to address severe skeletal Class II discrepancy and the subdivision dilemma.

Sarvraj SK, Virinder SK, Gagan DK.Management of Class II Division 1 Subdivision malocclusion using unilateral bicuspid extractions and fixed functional appliance: A Two Year Follow-Up. South Eur J Orthod Dentofac Res. 2021;8(1):12-19.

INTRODUCTION

Asymmetric malocclusions have always posed a challenge to clinicians because of difficulties encountered in treatment planning and the underlying complexity related to the origin of the malocclusion. The Angle's Class II subdivision, defined as a malocclusion with a Class II molar relationship on one side and a Class I relationship on the other side, is one such classic example of an asymmetric malocclusion.

Alkofide EA[1] found that 45% of their examined Class II Division 1 patients had subdivisions. The most commonly affected side in their study group was the right. Anderson WM et al.[2] found that in their study sample, 22.9% of Class II Division 1 patients and 50% of Class II Division 2 patients had subdivisions. This shows the high prevalence of subdivision characteristics in Class II malocclusions.

Etiology of the Class II subdivision, may encompass skeletal asymmetry, dentoalveolar asymmetry and functional deviations. Earlier investigations by Janson GR et al.[3], Kurt G et al.[4], Rose JM et al.[5] using two-dimensional radiographs inferred the absence of mandibular asymmetries as an aetiological factor in Class II subdivision malocclusions, while studies by Azvedo AR et al.[6] and Alavi DG et al.[7] proved conclusively that dentoalveolar asymmetry counts as a primary contributing factor in the origin of Class II subdivision malocclusions. Upon assessment of the dentoalveolar complex, most studies show that

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Class II subdivision malocclusion is primarily caused by distal positioning of the mandibular first molar in relation to the maxillary first molar on the Class II side. Secondarily, it can be consequent to mesial positioning of the maxillary first molar, in relation to the mandibular first molar, on the Class II side. However, Sanders DA et al.[8] conclusively proved that the primary contributing factor responsible for a Class II subdivision malocclusion is a deficient mandible, due to either a reduced ramal height and/or mandibular length, on the Class II side. In another study, Minich et al.[9] proposed that the position of the maxilla is asymmetric in relation to the cranial base. Another factor contributing to the origin of the Class II subdivision malocclusion is functional deviations. A cone-beam computed tomography by Li J et al.[10] showed that functional factors (deviations) occurred in 33% of their subdivision group. This is attributed to the disharmonious arch width between maxillary and mandibular dental arches in the bicuspid region. They also noted that the glenoid fossa on the Class I side is more anteriorly positioned than the Class II side, this could also be a contributing factor in Class II subdivision malocclusion. It can therefore be said that skeletal and dental factors, as well as functional factors, are often involved in combination in the etiology of a Class II Subdivision.

Several treatment strategies exist for Class II subdivision correction. These include: symmetric and asymmetric extractions, usage of fixed functional appliances, molar distalization, orthognathic surgery, etc. A retrospective study by Cassidy SE et al.[11] on the treatment results of Class II subdivision patients concluded that: ideal midline correction was not always achieved; 30% of the cases were under-corrected; and mandibular incisor proclination increased when fixed functional appliances were used to correct the Class II relationship.

This case report attempts to describe a unique management protocol of a Class II Division 1 subdivision malocclusion with a severe skeletal Class II attributable to a deficient mandible in a young male in CVMI transition stage utilizing unilateral extractions of tooth numbers #15 and 44 and a Forsus FRD (3M Unitek, Monrovia, CA, USA) fixed functional appliance with a 2-year post-treatment follow-up.

CASE REPORT

SECTION A: CASE EVALUATION, DIAGNOSIS AND DEVELOPMENT OF THE PROBLEM LIST

Pre-Treatment Evaluation

A 13 year 1-month-old male A.C., presented with a chief complaint of inability to bite into hard food items and crooked lower teeth. His parents were concerned with the appearance of a small chin. There was no contributory medical or dental history.

Extraoral examination revealed a mesocephalic and mesoprosopic shape of the head and facial form, respectively. His facial profile was noted to be severely convex with a deficient mandible and normodivergent growth pattern. Lips were incompetent with a 3 mm interlabial gap at rest. The nasolabial angle was acute and the mentolabial sulcus was deep. His smile analysis revealed a non-consonant smile arc. His maxillary midline matched with the facial midline, gingival components of the smile were normal. (Figure 1)

Figure 1. *Pre-Treatment Extraoral View: Frontal at Rest, Profile, Frontal Smiling*

Figure 2. *Pre-Treatment Intraoral View: Left Buccal View, Frontal, Right Buccal View*

Figure 3. *Pre-Treatment Intraoral View: Maxillary Occlusal View, Mandibular Occlusal View*

Intraorally, the molar relationship was Class I on the right side and Class II on the left. The maxillary archform were tapered while the mandibular archform was ovoid. The upper and lower dental midlines did not match, the lower midline was shifted to the right by 3 mm. The maxillary anteriors appeared to be proclined. The mandibular arch revealed a collapsed right quadrant due to a blocked out canine (# 43). Overjet and overbite upon measurement were 11 mm and 4 mm respectively. The gingiva appeared normal. The size and shape of tongue was normal. (Figure 2, 3)

Radiographic Examination

An Orthopantamogram (OPG) and Lateral Cephalogram were ordered for patient A.C. The OPG revealed the presence of all permanent teeth till the second molars. The presence of developing maxillary and mandibular third molars was also noted. The root apices of all erupted teeth appeared normal. The bony borders of the mandible and maxilla were normal. The temporomandibular joint appeared normal with a normal size and shape of the condylar head and glenoid fossa. (Figure 4)

Figure 4. *Pre-Treatment Orthopantamogram*

The lateral cephalogram (Figure 5A, 5B, Table 1) demonstrated severe skeletal Class II with orthognathic maxilla and a retrognathic mandible and an average growth pattern. The effective mandibular length was reduced with respect to maxillary length. Both upper and lower incisors were proclined The overjet was increased to 11 mm, with a deep bite of 4 mm. Soft tissue analysis revealed an acute nasolabial angle and protruded lower lip relative to the Ricketts E plane.

Skeletal Maturity Indicators: It is seen that concavities are developing at the inferior border of C2, C3 and C4 and the bodies of C3 and C4 appear rectangular in shape. These findings indicate Stage 3, i.e., Transition. This implies that adolescent growth is still accelerating towards peak height velocity. 25% to 65% of adolescent growth is expected.[12] According to McNamara JA, Franchi L et al.[13], it was observed that notches were visible in inferior borders of C2 and C3 and C3 and C4 bodies are trapezoidal in shape. Thus, it can be inferred that the patient is in CS3 stage, i.e. circumpubertal growth (maximum craniofacial growth velocity is expected).

Diagnosis

A.C. a 13 year 1-month-old boy presented with a Angle's Class II Division 1 subdivision right malocclusion on a severe Class II skeletal base attributable to a retrognathic mandible with a decreased facial height ratio. He presented with a severely convex profile, incompetent lips, and clinically recessive chin. He also displayed a clinically positive VTO on forward protraction of mandible. Intraorally he presented with a Class II molar relation on the left, but a Class I molar on the right side. In addition, tooth number 43 was displaced (blocked) out of the arch. The upper and lower anterior teeth were proclined over their respective skeletal bases. There was associated soft tissue imbalance.

Treatment Objectives

The treatment objectives were:- (1) Achieving lips competency, (2) Improving smile, (3) Improving profile, (4) Correction of skeletal discrepancy (5) Levelling and Alignment, (6) Improvement of axial inclination of upper and lower anteriors, (7) Correction of lower dental midline, (8) Achieving Class I molar and canine relation on left side, (9) Achieving Class I incisor relationship, (10) Correction of overjet and openbite, (11) Retention of corrected results.

Figure 5A. *Pre-Treatment Lateral Cephalogram*

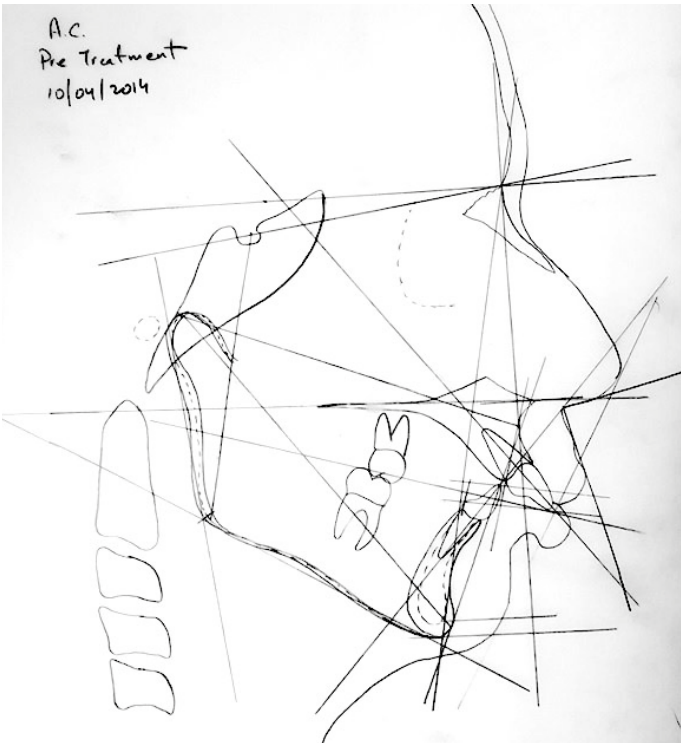

Figure 5B. *Pre-Treatment Lateral Cephalometric Analysis*

Table 1. Pre and Post Treatment Composite Lateral Cephalometric Analysis

Variable	Pre-Treatment	Pre-Debonding	Normal
Sagittal Skeletal Relationship			
SNA *(degree)*	83	83	82
SNB *(degree)*	72	77	80
ANB *(degree)*	11	6	2
Wits Appraisal *(mm)*	+8	+4	0
Beta Angle	21	29	27-35
Dental Base Relationship			
Upper Incisor to NA *(mm/degree)*	5/38	3/20	4/22
Lower Incisor to NB *(mm/degree)*	7/31	8/35	4/25
Upper Incisor to SN Plane *(degree)*	120	102	102
Lower Incisor to Mandibular Plane angle (IMPA) *(degree)*	100	111	92 +/- 5
Dental Relationship			
Inter-incisal Angle *(degree)*	102	112	131
Lower Incisor to APo line *(mm)*	0	3	0-2
Over bite *(mm)*	4	1	2
Overjet *(mm)*	11	1	2
Vertical Skeletal Relationships			
Maxillary Mandibular Plane Angles *(degree)*	27	29	27 +/- 5
SN Plane – Mand Plane *(degree)*	34	32	32
Upper Anterior Face Height *(mm)*	46	47	
Lower Anterior Face Height *(mm)*	49	53	
Face Height Ratio	51	53	55%
Jarabak Ratio	63	65	62-65%
Maxillary Length *(mm)*	78	78	
Mandibular Length - effective (Mc Namara) *(mm)*	88	91	
Soft Tissues			
Lower lip to Rickett's E Plane *(mm)*	+4	+1	-2
Nasolabial Angle *(degree)*	82	106	102-110

Treatment Progress

The active treatment can be divided into pre-functional and functional phases.

Pre Functional Phase A Pre-adjusted Edgewise Appliance 0.022 x 0.028 inch slot MBT prescription was bonded. Tooth 44 was extracted and decrowding was carried using 0.014 inch Nickel Titanium archwires.. As tooth 43 was getting aligned, tooth 15 was extracted to protract 16. Molar protraction was done by slenderising the archwire just mesial to #16. Once #16 was protracted to a Class II relationship and the lower arch de-crowded. Both arches were levelled and aligned till 0.019 x 0.025 in stainless steel archwires. A positive VTO was evident on mandibular advancement (Figure 6, 7). The molars and canines were now in a Class II relationship with an overjet of 9 mm and the upper and lower midlines matched. The arch forms were matched and a transpalatal arch placed (Figure 8, 9). Treatment records were obtained at this stage that included an OPG (Figure 10) and lateral cephalogram (Figure 11).

Functional Phase Upon passive engagement of 0.019 x 0.025 in stainless steel archwires in both arches, a Forsus FRD (3M Unitek, Monrovia, CA, USA) appliance was placed to advance the mandible to address the skeletal and dental Class II discrepancy (Figure 12). The size of the Forsus FRD appliance was determined using the gauge provided. This resulted in mandibular advancement. Once Class I molar, canine and incisor relationship was achieved, settling was begun (Figure 13). After settling pre-debonding OPG (Figure 14) and lateral cephalometric radiograph (Figure 15) and were obtained to assess skeletal correction and root parallelism. Upon achievement of all treatment objectives the fixed appliance was de-bonded. Total treatment duration was 20 months.

Retention Fixed lingual bonded retainers were placed on tooth 33,32,31,41,42,43,45 and a wraparound retainer was given in the upper arch.

No adverse events were recorded during treatment

Figure 6. Pre-Functional Extraoral View: Frontal at Rest, Profile

Figure 7. *Pre-Functional Extraoral View: Frontal Smiling, VTO*

Figure 8. *Pre-Functional Intraoral View: Right Buccal View, Frontal, Left Buccal View*

Figure 9. *Pre-Functional Intraoral View: Maxillary Occlusal View, Mandibular Occlusal View*

RESULTS

Post Treatment Assessment

Clinical

All treatment objectives were achieved at the end of treatment. The facial profile was improved at the end of treatment with a consonant smile arc (Figure 17). There was good interdigitation in right and left buccal segments with Class I molar, canine and incisor relationships. The maxillary and mandibular midlines were co-incident at the end of treatment. A normal overjet and overbite was achieved (Figure 18, 19).

The change in occlusal indices also reflects the improvement achieved by orthodontic treatment. (Table 2)

Radiographic Appraisal

Since the pre-debonding radiographs were obtained 2 weeks before debonding and all treatment objectives had been achieved, no further radiographs were obtained to minimise patient's radiation exposure.

Figure 10. *Pre-Functional Orthopantamogram*

Figure 11. *Pre-Functional Lateral Cephalogram*

Figure 12. *Forsus FRD in-situ Intraoral View: Right Buccal View, Frontal, Left Buccal View*

Figure 13. *Settling Intraoral View: Right Buccal View, Frontal, Left Buccal View*

Figure 14. *Pre-Debonding Orthopantamogram*

Figure 15. *Pre-Debonding Lateral Cephalogram*

Orthopantogram: The roots of all permanent were placed ideally with respect to each other. No bone loss was noticed at the end of treatment. No root resorption was noticed at the end of active treatment (Figure 14).

Post-treatment lateral cephalogram (Figure 15, 16, Table 1) demonstrated marked improved of skeletal relationship. The lower anterior facial height improved with the treatment. Improvement of inclination of both upper and lower incisors resulted in improvement of interincisal relationship The molars on tracing also showed a Class I relationship. The nasolabial angle and lower lip position improved with the treatment

The skeletal Class II correction and correction of a Class II malocclusion can be appraised on perusing the super-imposition (Figure 20).

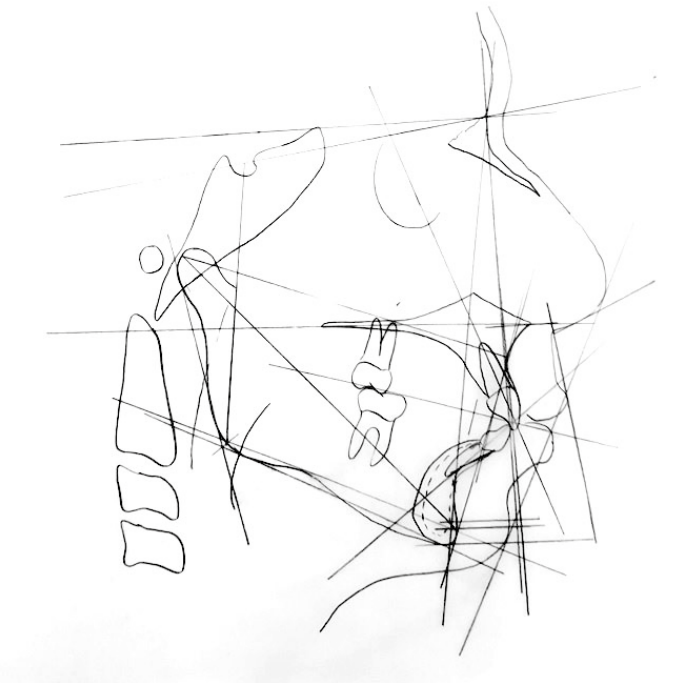

Figure 16. *Pre-Debonding Lateral Cephalometric Analysis*

Figure 17. *Post-Treatment Extraoral View: Frontal at Rest, Profile, Smiling*

Figure 18. *Post-Treatment Intraoral View: Right Buccal View, Frontal, Left Buccal View*

Figure 19. *Post-Treatment Intraoral View: Maxillary Occlusal View, Mandibular Occlusal View*

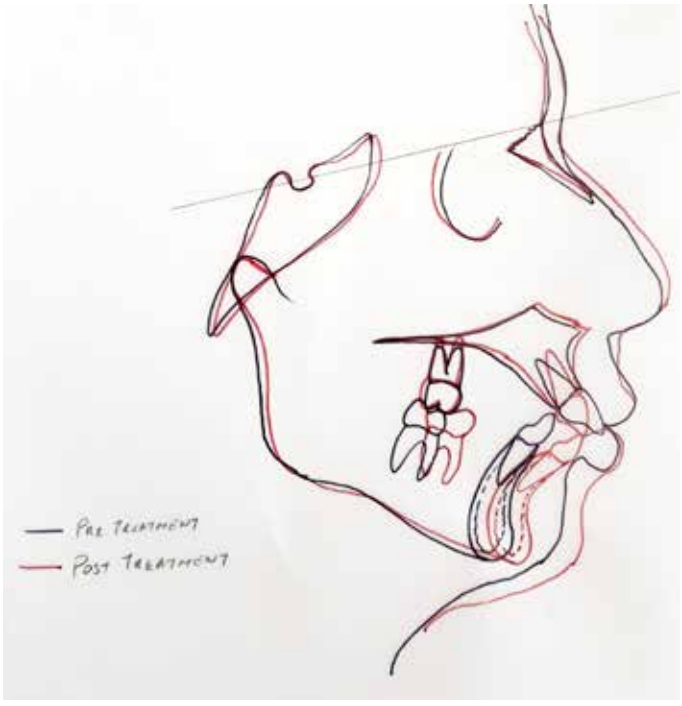

Figure 20. *Lateral Cephalometric Superimposition (SN plane at Sella)*

Figure 21. *Two Year Recall Extraoral View: Frontal at Rest, Profile, Frontal Smiling*

Figure 22. *Two Year Recall Intraoral View: Right Buccal View, Frontal, Left Buccal View*

Figure 23. *Two Year Recall Intraoral View: Maxillary Occlusal View, Mandibular Occlusal View*

24 Months Post-Treatment Assessment

A.C. was reviewed 24 months (2 years) after treatment. All treatment results were found to be stable. There no unanticipated in the movement of any of the teeth. The treatment results at the end of 18 months after treatment were stable (Figure 21, 22, 23). The patient has been advised to report every 6 months for a review for the next 2 years. He was also advised that he might need to undergo extractions of third molars at a later date.

DISCUSSION

A pre-treatment IOTN score of 5a (dental component) and 9 (aesthetic component); and a PAR index of 41 are suggestive of the immediate need for orthodontic treatment (Table 2). The patient and his parents expressed a concern for forwardly placed upper teeth, a small chin, as well as poor smile aesthetics. Oral hygiene was average to begin with.

Upon clinical examination and deliberation of diagnostic records, A.C. was diagnosed as having a severe skeletal Class II attributable to a retrognathic mandible, and an average growth pattern and a reduced face height ratio. Dental relationship was Angle's Class II Division 1 subdivision, with 9 mm crowding in the lower arch, and an increased overjet of 11 mm and an overbite of 3 mm. there was associated soft tissue imbalance with everted upper and lower lips and lip incompetency.

Upon assessing the records, it was decided to incorporate skeletal Class II correction (mandibular advancement) to obtain optimal treatment results. However this was complicated with the presence of a Class I molar relationship on the right side and 9 mm crowding in the lower arch. In order to obtain a bilateral Class II molar and canine relationship, it was decided to extract tooth

Table 2. *Occlusal Indices*

Index	Parameter	Value
Index of Treatment Need		
Dental Health Component	Start	5a
	Finish	1
Aesthetic Component	Start	9
	Finish	1
Peer Assessment Rating		
	Treatment Stage	
	Start	41
	Finish	0
	Change	41
	% change	100%

numbers: 15 (to allow for protraction of 16), and 44 to relieve crowding in the lower arch. Once both arches were co-ordinated till 0.019 x 0.025 inch Stainless Steel archwires, a fixed functional appliance was placed. The fixed functional appliance used in this case was a Forsus Fatigue Resistant Device (Forsus FRD, 3M Unitek, Monrovia, CA, USA). To achieve these objectives, a pre-adjusted edgewise appliance of MBT prescription with 0.022 x 0.028 inch slot fixed orthodontic appliance was chosen.

This appliance was chosen as it is known to stimulate mandibular growth and has a headgear like effect.[14] This study's findings corroborated with lateral cephalometric values obtained in our case (increase in face height ratio and increase in mandibular length). However there was an increase in proclination in lower incisors (despite placing upper and lower 0.019 x 0.025 inch Stainless Steel wires and incorporating lingual crown torque in the lower anterior segment of the archwire). These findings were in agreement with Cassidy SE [11], Gulec A et al [15] and Franchi L et al.[16]

Retention strategy involved placing a circumferential Begg's wraparound retainer in the maxillary arch to allow for physiologic settling and fixed lingual bonded retainer with 45, 43, 42, 41, 31, 32, 33 to prevent extraction sites from opening up.

A.C. was successfully treated with orthodontic treatment in a span of 20 months. All treatment objectives were realised. The patient's chief complaints were addressed. The patient and family were pleased with treatment progress and the results obtained. Aesthetic and occlusal goals as envisaged at the beginning of treatment were met. This is reflected in the drastic decrease in IOTN (pre-treatment: DHC: 5a, AC: 9; post-treatment: DHC: 1, AC:1) and PAR (Start: 41, Finish: 0) scores. The pre-treatment IOTN and PAR scores also emphasise an immediate need for orthodontic treatment.

The post-treatment smile is attractive and confirms to a study by Janson GR [17] that demonstrates that smile attractiveness is similar in one, two and three premolar extraction protocols in the management of Class II subdivision cases and sizes of Buccal Corridors did not differ between patients treated with one, three and four premolar extractions.

CONCLUSION

This case report presents a unique approach towards the management of a Class II subdivision in a growing male. The authors were not able to find a similar treatment protocol published in orthodontic literature. The unilateral extractions in this case augur well in decompensating the presenting malocclusion to achieve bilateral Class II molar and canine relationships to make it amenable to fixed functional therapy by mandibular advancement. This also helped in addressing the mandibular deficiency, severe convex profile and Class II subdivision problems by way of mandibular advancement. Since the patient was in a CVMI transition stage, growth modification was a viable option. If not treated at this stage he would have required more a more complex treatment approach in the future.

Consent: Written informed consent to use case records (photographs, radiographs, etc.) for publication was obtained from the patient's parents as the patient is a minor for publication in scientific books and/or periodicals.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest with this manuscript.

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