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# Successful 2 phase treatment of growing skeletal Class III malocclusion based upon cephalometric prognostic factor: A case report

Tabassum Qureshi and Prabhat K. Chaudhari

## Abstract

Early treatment of Class III malocclusion provides an improvement in facial appearance and corrects the reverse bite. Orthopedic protraction of maxilla is considered best approach in growing Class III patients with maxillary deficiency. Present case report describes the management of a growing 10-year-old boy with skeletal Class III malocclusion using facemask therapy (Phase 1) followed by fixed orthodontic treatment (Phase 2) based upon cephalometric prognostic findings of growth treatment response vector (GTRV). With the successful orthopedic phase of maxillary protraction with facemask therapy for 7 months of period, a significant improvement in profile had been achieved along with the correction in reverse overjet. This was followed by retention with chin cup therapy for a period of 20 months. After a period of 20 months retention, a fixed orthodontic treatment was started with the objective to achieve stable functional occlusion. After 11 months of treatment with fixed appliance therapy a stable functional occlusion was achieved. The patient was placed on Hawleys retainer in maxillary arch and bonded fixed spiral wire (FSW) retainer in mandibular arch. Successful management of growing Class III patient was done using facemask and fixed orthodontic therapy based upon cephalometric prognostic findings of growth treatment response vector (GTRV).

## Keywords:

Class III, GTRV, two phase

## Introduction

Class III malocclusion is growth related dentofacial deformity, which developed from maxillary deficiency, mandibular prognathism or combination of both.<sup>[1-3]</sup> It has been reported that 30-40% of skeletal Class III malocclusion have a significant component of maxillary deficiency.<sup>[4]</sup> Early treatment for orthopedic maxillary protraction is advocated primarily in maxillary deficiency cases. Reverse pull headgear or facemask therapy with palatal expansion provide promising results if the treatment starts at the age of 6-9 years.<sup>[5-7]</sup> However, orthodontists are reluctant to

render early orthopedic treatment in Class III patients due to the inability to predict mandibular growth and to predict the long-term prognosis.<sup>[8]</sup> It is essential to assess the direction and magnitude to maxillary and mandibular growth.

Growth treatment response vectors (GTRV) analysis predicts the early mandibular growth after interception of orthopedic treatment in growing Class III children.<sup>[9,10]</sup> For successful cases, GTRV ranges from 0.33-0.88 (mean 0.45). This suggest that subject with mild to moderate Class III malocclusion can be camouflaged orthodontically after successful early interceptive treatment, if GTRV ratio ranges between 0.33-0.88. Patient should be warned

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Division of Orthodontics  
and Dentofacial  
Deformities-Centre for  
Dental Education and  
Research, All India  
Institute of Medical  
Sciences, New Delhi, India

### Address for correspondence:

Dr. Prabhat K. Chaudhari,  
Additional Professor,  
Division of Orthodontics  
and Dentofacial  
Deformities-Centre  
for Dental Education  
and Research, All  
India Institute of  
Medical Sciences,  
New Delhi - 110 029,  
India.  
E-mail: dr.prabhatkc@  
gmail.com

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for possible surgical intervention in future if GTRV ratio is  $<0.38$ .

The treatment planning and management of a 10-year-old boy with class III malocclusion has been presented in this report based upon GTRV analysis after first phase of orthopedic treatment to predict the future mandibular growth for orthodontic camouflage using fixed orthodontic appliance treatment.

### Case Report

A 10-year-old boy reported to our division of Orthodontics and Dentofacial Deformities with the chief complaint of forwardly placed lower jaw. His medical and dental history was not significant. On extraoral examination, there was bilaterally symmetrical face with leptoprosopic facial form. The profile was concave with anterior divergence. There was increased nasolabial angle with protrusive lower lip and prognathic chin. On smile analysis, there was non-consonant, cuspid type of smile with asymmetric lip elevation on right and left side. The upper midline was co-incident with facial midline [Figure 1]. Intraoral examination showed that patient was in late mixed dentition stage. There was bilateral Class III molar relationships. On functional examination, there was no functional shift. He had normal swallowing and oronasal breathing. He had overjet of -2 mm and overbite of -4 mm. Lower midline was shifted towards left side by 2 mm ([Figure 2]. Intermolar width in first molar region was 46 mm and intercanine width was 30 mm in the maxillary arch. In the mandibular arch intermolar width was 45 mm thus requiring maxillary arch expansion of 3 mm for buccal overjet and 2 mm for overcorrection. A total of 5 mm maxillary expansion was required. Evaluation of digital models [Figure 3] confirmed the clinical findings. Screening of orthopantomogram (OPG) radiograph showed normal condyle glenoid fossa relationship [Figure 4a].

Lateral cephalogram revealed skeletal Class III malocclusion ( $ANB = -5.5^\circ$ ) with retrognathic maxilla ( $SNA = 76.7^\circ$ ) and normal mandible ( $SNB = 82.2^\circ$ ).

He had concave profile (Angle of convexity =  $-12.4$ ) and average growth pattern ( $FMA = 23.6^\circ$ ), normally positioned maxillary incisors ( $UI-NA = 24^\circ$ , 4.9 mm) and mandibular incisors ( $LI-NB = 16.2^\circ$ , 2.3mm). He had a nasolabial angle ( $110^\circ$ ), retrusive upper lip ( $UL-E$  line = -3 mm) and protrusive lower lip ( $LL-E$  line = 3.9 mm) [Figure 4b,



Figure 1: Pretreatment extraoral photographs. Patient reported with the chief complaint of forwardly placed lower jaw



Figure 2: Pretreatment intraoral photographs with poor anterior relationship with Class III malocclusion

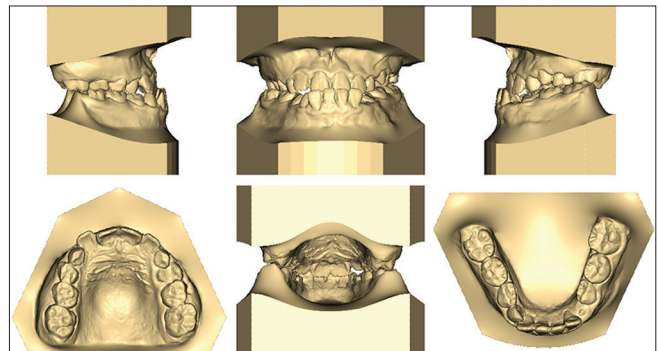


Figure 3: Pretreatment digital models

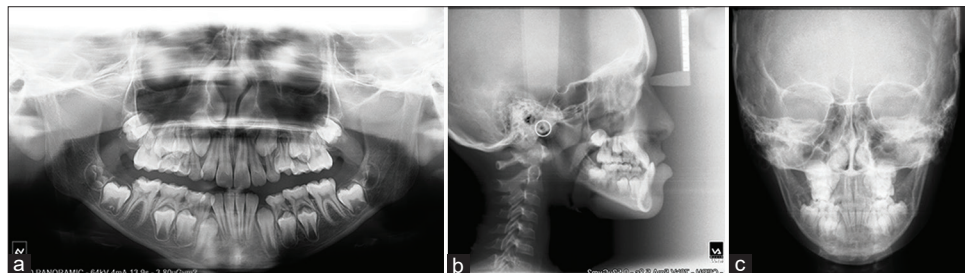


Figure 4: Pretreatment radiographs of the patient. (a)-Pretreatment orthopantomogram of patient at mixed dentition stage. (b)-Pretreatment lateral cephalogram showing skeletal Class III patient (c) Pretreatment posteroanterior cephalogram of patient

Table 1]. Postero-anterior cephalogram revealed no gross asymmetry but showed skeletal constriction of maxilla (J-J)/Ag-Ag = 74%) [Figure 4c]. Based upon clinical examination, model analysis and radiographic findings, the patient was diagnosed as a case of growing skeletal Class III malocclusion with sagittal and transverse maxillary deficiency.

### Treatment objectives

The main objective was the orthopedic protraction and expansion of maxilla followed by evaluation for fixed mechanotherapy or wait for completion of growth based upon GTRV analysis.

### Treatment alternatives

Based on objectives there were two options

1. Patient to be treated in 2 phases with phase 1 include early phase of interceptive orthopedic treatment to induce harmonious skeletal growth by conventional facemask therapy followed by evaluation for phase 2. This might eliminate the need of surgery by successful phase II fixed orthodontic therapy based upon favorable mandibular growth treatment response vector (GTRV).
2. Another option was to wait until all growth is completed and final decision of treatment with fixed mechanotherapy as camouflage or combination of surgery and orthodontics based upon the severity of malocclusion.

### Treatment planning

Based upon the discussion with the patient and parents about both the options, patient and parents opted for first option. Hence it was decided to treat the patient in 2 phases with phase 1 include early phase of interceptive orthopedic treatment with hyrax and facemask appliance followed by phase 2 with fixed orthodontic mechanotherapy.

### Orthopedic phase

The objective of phase 1 treatment was to achieve transverse expansion and protraction of maxilla using facemask with bonded hyrax. A bonded hyrax with facemask was delivered to the patient [Figure 5]. Hyrax rapid palatal expansion appliance was activated 90 degree twice a day for duration of 20 days to achieve the expansion of 5 mm. Delaire's facemask was used for 12-14 hours per day. Initially, the patient was guided for wearing training elastics of 8oz force bilaterally for a week. Later, heavy extraoral elastics of total of 14oz bilaterally were delivered to the patient directing 20 degree downward and forward with respect to occlusal plane to minimize the tipping of palatal plane.<sup>[11,12]</sup>

After 7 months of facemask therapy, patient profile and smile esthetics improved. Antero posterior bite

was corrected, and positive overjet was achieved [Figures 6-8 and Table 1]. After the facemask therapy, the chin-cup appliance was given as a retention appliance to redirect the mandibular growth [Figure 9]. GTRV ratio of the patient was evaluated with the progressive cephalogram after 18 months of the facemask therapy. Horizontal changes of maxilla and mandible were determined by locating the point A and point B on cephalogram [Figure 10]. The GTRV ratio of the patient was 1.0. In this case the GTRV ratio of 1.0 indicate normal growth pattern after the interceptive orthopedic treatment.

### Orthodontic phase

Before proceeding to the Phase 2 treatment, we waited for all the permanent teeth to erupt. Once eruption of permanent teeth had occurred, the patient was assessed for the fixed orthodontic treatment with the aim of coordinating upper



Figure 5: Hyrax expansion during first phase of orthopedic treatment

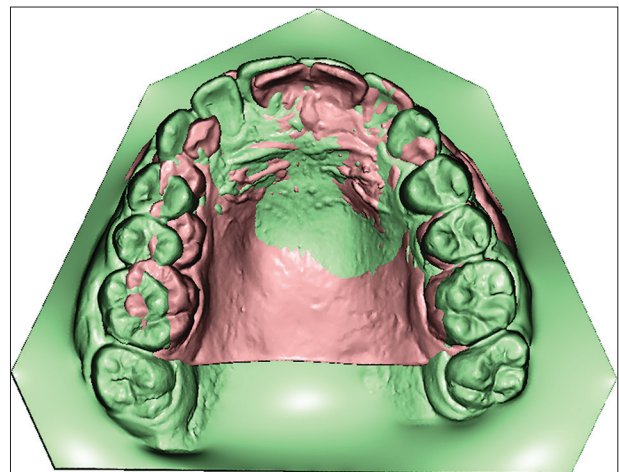


Figure 6: Superimposition of digital model showing pre and post-orthopedic transverse expansion



Figure 7: Post orthopedic extraoral photographs exhibiting improvement in profile



**Table 1: Cephalometric measurement of pre, post orthopedic and post orthodontic treatment**

Cephalometric measurements	Norms	Pre-treatment	Post orthopedic phase	Post- treatment	Follow-up
<b>Maxilla</b>					
SNA angle (degree)	82	76.7	81.7	82	82
Pt A to nasion perp (mm)	1.1	-4.6	0.9	1.0	1.5
Co-Pt A (mm)	99.8	83.7	87	89	89
<b>Mandible</b>					
SNB angle (degree)	80	82.2	80.2	81	81
Pog to nasion perp (mm)	-0.3	0.9	0.8	0.8	1.0
Co-Gn (mm)	134.3	112.3	112	112	112
Facial angle (degree)	87.8	90.5	90.5	90.5	90.5
<b>Maxillo-Mandibular relationship</b>					
ANB angle (degree)	2.0	-5.5	1.5	1.0	1.0
Wits (mm)	-1.0	-7.9	0.6	0.6	1
Maxillary/Mandibular difference (mm)	34.5	28.3	25	25	25
<b>Vertical Parameters</b>					
FMA	21.3	23.6	27.6	28	28
SN-GoGn	32	31.8	33.9	34	35
Y-axis (degree)	59.4	56.7	57.3	58.1	58.1
Facial axis (degree)	0.5	-1.0	-3.0	-3.1	-3.1
Jarabak ratio (%)	62-65%	64	63	63	65
ANS to Me (mm)	74.6	51.4	59.5	60	60
Ar- Go (mm)	45.5	37	38.9	40	40
N- Me	121.5	102.1	107.6	109	109
Gonial angle (degree)	124.3	125.5	126.7	128	128
FH to occlusal plane (degree)	9.3	5.0	6.1	6.1	6.0
SN to occlusal plane (degree)	14.4	13.2	14	14	14
<b>Maxillary Incisors</b>					
Upper incisor to NA (UI-NA) (mm)	4.3	4.9	5.4	5.6	5.0
Upper incisor to NA (UI-NA) (degree)	22.8	24.0	25.0	25.5	25
Upper incisor to A-Pog (UI- A-Pog) (mm)	2.7	0.9	5.8	5.8	6.0
Upper incisor to SN (UI -SN) (degree)	102	105.7	106.7	107.1	107
<b>Mandibular Incisors</b>					
Lower incisor to NB (LI-NB) (mm)	4.0	2.3	2.5	2.5	2.5
Lower incisor to NB (LI-NB) (degree)	25.3	16.2	17.2	17.5	17.5
IMPA (degree)	91.4	79.7	80.2	80.0	90
Lower incisor to A-Pog (LI- A-Pog) (mm)	2.3	5.4	1.1	2.2	3.0
<b>Interdental</b>					
Overbite (mm)	2.0	-4.0	2.0	2.0	3.0
Overjet (mm)	2.0	-2.0	4.0	3.0	3.0
Interincisal angle (degree)	135.4	140.3	136.3	135.2	132
Inter canine width of maxilla		30	32	32	32
Intermolar width of maxilla		46	53	51	51
<b>Soft tissue</b>					
Angle of Convexity (degree)	0.0	-12.4	1.1	1.1	1.1
Nasolabial angle (degree)	106	110	106	105	105
Upper lip to E line (UL-E line) (mm)	-2.0	-3.0	-1.3	-2.0	-2.0
Lower lip to E line (LL-E-line) (mm)	-1.0	3.9	2.0	2.0	2.0
H angle (degree)	10	9.6	17.0	17.0	17.0

and lower arches and achieving stable functional occlusion. Based upon the findings of GTRV (1.0), the phase 2 of orthodontic treatment was started after 18 months of phase 1. Complete records including extraoral, intraoral photographs and radiographs were taken at this stage [Figure 11]. On intraoral examination, there was crossbite with mesioangular rotation of upper left canine with presence of Class II canine relationship. Thus, the main

objectives of phase 2 were to align and level the upper and lower arches to achieve maximum intercuspation with Class I canine relationship.

The patient was treated with Roth prescription with 0.022 by 0.028-inch slot size bracket. The maxillary and mandibular first molars were banded. After leveling and alignment, the occlusion was detailed and finished. Debonding was done



Figure 8: Post orthopedic Photographs and lateral cephalogram showing correction of overbite



Figure 9: Chin cup retention after orthopedic phase

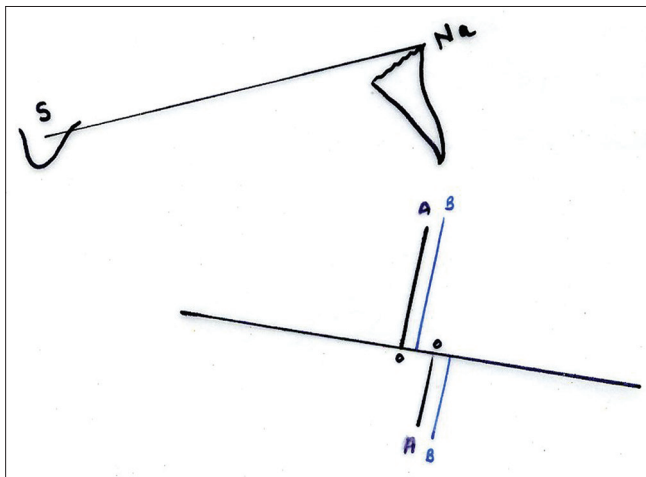


Figure 10: GTRV ratio of the patient

after a period of 11 months of fixed orthodontic therapy. Hawley retainer was given in maxillary arch and fixed spiral wire (FSW) was bonded in mandibular arch.

### Treatment results

The post treatment records showed that the facial esthetics significantly improved [Figure 12] by forward positioning of the maxilla leading to less prognathic appearance of the mandible. Intraorally, the Class I molar and Class I canine relationship was achieved bilaterally. Upper and lower arches were aligned and transverse

expansion of 5 mm in molar region and 2 mm in canine region was achieved [Figures 13]. The maxillary midline was coincident with facial midline, but the mandibular midline was 2.0 mm left to the maxillary midline. As the mean threshold for acceptable dental midline deviation is  $2.2 \pm 1.5$  mm,<sup>[13]</sup> so 2.0 mm of midline was considered as acceptable in this case. The patient achieved a good functional occlusion with acceptable interdigitation as evident by post treatment digital models [Figure 14].

Cephalometrically, maxillo-mandibular relationship was improved significantly with the change of ANB angle from  $-5.5^\circ$  to  $1.5^\circ$  and change in wits appraisal from  $-7.9$  mm to  $0.6$  mm. SNA angle improved from  $76.7^\circ$  to  $82^\circ$  and mandibular reading remained constant. The soft tissue profile was improved significantly with reduction in soft tissue convexity from  $-12.4^\circ$  to  $+1.1^\circ$ . Mandible was slightly rotated downwards and backward with change in FMA from  $23.6^\circ$  to  $28^\circ$  [Figure 15 and Table 1]. Post treatment orthopantomogram showed acceptable parallelism of roots and marginal ridge relationship [Figure 16]. Superimposition showed marked improvement in sagittal positioning of maxilla. The upper lip and lower lip showed significant anteroposterior change, creating a more straight and esthetic profile. Maxillary regional superimposition showed mesial tooth movement of maxillary molars and the mandibular superimposition showed mesial and extrusive movement of mandibular molars [Figure 17].

Follow-up cephalogram of patient showed that soft tissue and hard tissue relationship were maintained even after 2 years [Figure 18, Table 1].

### Discussion

Class III malocclusion developed from combination of skeletal, dentoalveolar and functional components.<sup>[14,15]</sup> Delaire shown that forward positioning of skeletal maxilla can be achieved with reverse headgear if treatment is started at an early age.<sup>[16]</sup> According to Mc Namara and Baccetti,<sup>[5,17]</sup> early mixed dentition is the best time to begin orthopedic treatment in children with Class III malocclusion. Proffit and Fields<sup>[18]</sup> also recommended that a child with maxillary deficiency need a complete evaluation as early as possible.

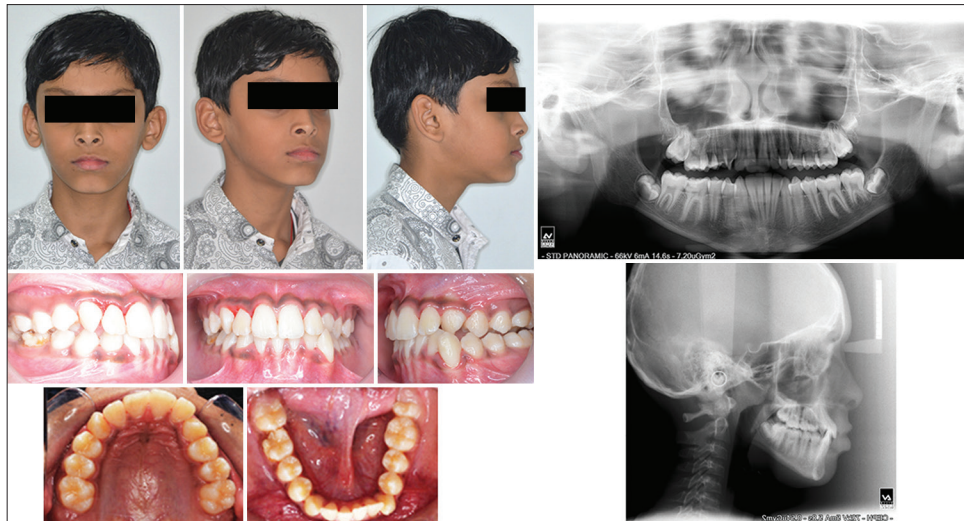


Figure 11: Record of patient before orthodontic treatment



Figure 12: Pre(a) and post(b) treatment extraoral photographs of the patient

A survey of diplomats of American board of orthodontics revealed that early treatment in Class III patients has greater ability to modify growth, improve patient self-concept and parental satisfaction. Later therapy required is less extensive.<sup>[19]</sup> In contrast, a study reported the similar results in younger (5-8 years) and older (9-12 years) patients.<sup>[20]</sup> Another study by Suguwara reported that saggital growth of maxilla was more in treated twin sister as compared to untreated twin sister by the age of 14 years. However, no difference in maxillary lengths was observed at the age of 18.<sup>[21]</sup>

The earlier the phase 1 started the better is scope of achieving desired dental and skeletal correction,

however good results are still possible in older individuals. When we talk about Class III malocclusion, correct diagnosis and long-term stability is especially important. Therefore, GTRV analysis was done after phase 1 of orthopedic treatment to predict the future mandibular growth for orthodontic camouflage using fixed orthodontic appliance treatment. Phase 1 treatment was started during mixed dentition phase with face mask and rapid palatal expansion appliance followed by a phase 2 of comprehensive fixed orthodontic therapy. Transverse expansion was done to achieve optimum maxilla-mandibular relationship and it also promoted maxillary protraction by disrupting the maxillary sutural system.<sup>[22,23]</sup> A study reported that the maxilla grew the same as in untreated Class III patients but less than in Class I patients after orthopedic treatment.<sup>[24]</sup> But in our case maxilla showed growth with SNA angle increased by 5° in phase 1, in contrast to 0.3° during the phase 2. Thus, significant growth of maxilla was observed in phase 1 which followed the standard of Mc Namara analysis<sup>[25]</sup> of normal maxillary-mandibular differential for Class I patient. This suggested that maxilla grew similar like Class I patients after interception of orthopedic appliance in present case.

After the phase I therapy, GTRV of the patient was evaluated, two progressive lateral cephalograms were taken after the orthopedic phase in a duration of 18 months. Horizontal growth changes of maxilla and mandible were evaluated. For an individual with the age range of 6–16 and with normal growth pattern, the GTRV ratio is 0.77. This suggests that the horizontal growth of mandible exceeds 23% as compared to the maxilla to maintain a normal skeletal relationship. The patient showed the GTRV ratio of 1.0, which indicated that camouflage treatment could be done successfully as both are growing as same rate. Based





Figure 13: Pre(a) and post(b) treatment intraoral photographs of the patient

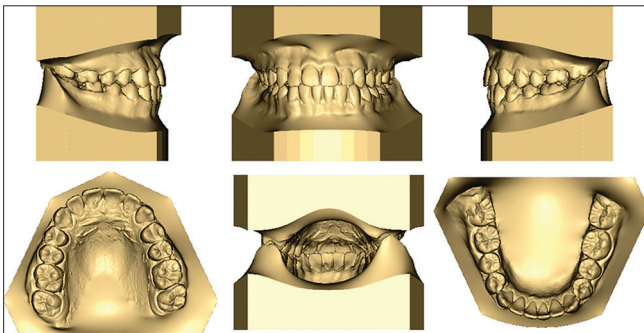


Figure 14: Post orthodontic digital models of the patient

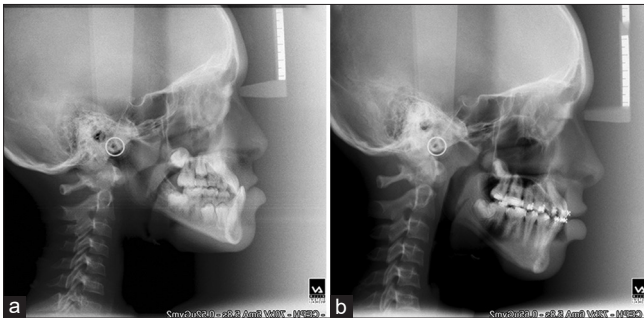


Figure 15: Pre(a) and post(b) treatment lateral cephalogram of the patient

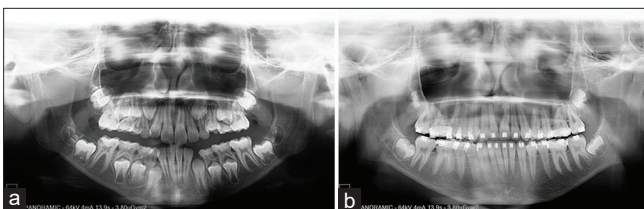


Figure 16: Pre (a) and post (b) orthopantamogram of the patient

on the favorable GTRV ratio, fixed mechanotherapy was done in phase 2.

After the successful treatment with 2 phase therapy, Class I skeletal base was achieved and maintained. Class I canine and molar relation was also achieved. The positive overjet was achieved with the correction of anterior crossbite. The soft tissue profile showed significant treatment changes in the horizontal and vertical dimensions resulting in greater

convexity and increased facial height. Finally, the stable functional occlusion was achieved.

In the present case an extra oral elastic of total of 14 oz bilaterally directing 20 degrees downward and forward with respect to occlusal plane were used to minimize the tipping of palatal plane. But this elastic leads to downward and forward movement of maxilla, which lead to clockwise rotation of mandible. Bonded hyrax was given for the control of vertical dimensions. Following face mask therapy there was an increase vertical dimension (change in FMA  $23.6^\circ - 27.6^\circ$ ). It led to downward and backward rotation of mandible. As the change in the vertical dimension was in the average range (FMA =  $23.49 \pm 4.23$  degree)<sup>[26]</sup> so it did not have deleterious effect on vertical dimension and favoured Class III profile correction.

It appears that the final favorable correction of the Class III skeletal disharmony is mostly due to orthopedic correction achieved during the phase 1 of treatment. This is because the patient was skeletal Class III. When a well-balanced profile was achieved after facemask therapy and the patient had favorable GTRV, it led us to decide dental camouflage after successful orthopedic therapy. The final outcome of the patient was a combination of skeletal modification and orthodontic camouflage. Further longitudinal studies are required to evaluate the long-term stability of Class III management.

## Conclusion

The successful management of growing Class III patient was done using facemask and fixed orthodontic therapy. Decision to continue for fixed orthodontic therapy was based upon favorable GTRV ratio.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that names and initials will not be published

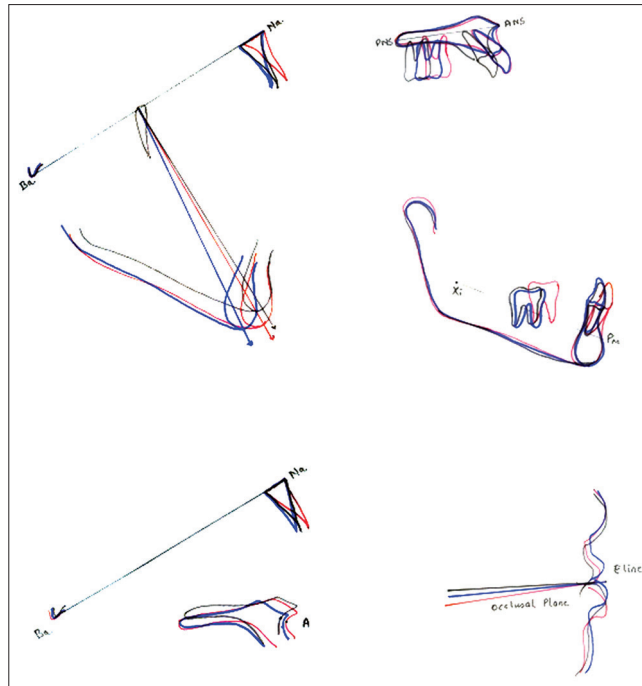


Figure 17: Ricketts superimposition showing pre, mid and post treatment changes

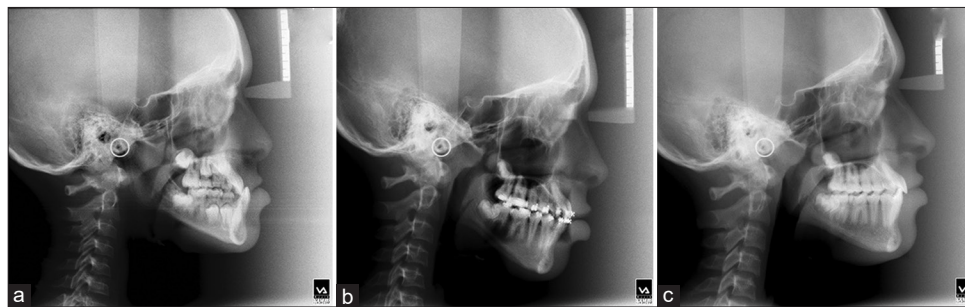


Figure 18: A comparison of Two- years followup of radiograph of the patient. (a)-Pretreatment cephalogram of patient at mixed dentition stage. (b)-Post Orthodontic cephalogram of the patient. (c)-2 years followup cephalogram of patient

and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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