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Journal of Contemporary Orthodontics

Journal homepage: https://www.jco-ios.org/

Case Report

Orthopaedic protraction of midface with skeletal anchorage system: Report of two cases and Indian literature review

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Abstract

Early treatment and the need for interceptive care for the patients with Class III malocclusion has always been a dilemma, it is required to prevents damage to the oral tissues and/or significantly reduces the amount or severity of future orthodontic and surgical interventions. To overcome the limitations of tooth-borne appliances in this interceptive treatment of Class III malocclusions, Skeletal anchorage system (SAS) or bone-anchored maxillary protraction (BAMP) appliances had been used. Skeletal anchorage yields greater maxillary protraction and reduces undesirable dental effects. SAS appliances offer the potential for more skeletal changes compare to tooth-borne appliances.

Keywords: Skeletal anchorage system (SAS), Cone-beam computed tomography (CBCT), controlled clinical trials (CCTs)

Received: 20-03-2024; **Accepted:** 06-06-2024; **Available Online**:

1. Introduction

Skeletal Class III malocclusion is a growth-related dentofacial deformity resulting from mandibular prognathism or deficient growth of the maxilla in the downward and forward direction.[1-2] This condition is prevalent, especially in the Asian population, with more than half of cases exhibiting maxillary deficiency.[3] Retrusive/deficient maxilla being amenable to orthopedic forces, is managed with orthopedic protraction in pre-pubertal age. The methodology advocated includes the use of a protraction face mask anchored on maxillary dentition or maxillary basal bone. The traditional approach of using maxillary dentition as anchorage has its own disadvantages.[4] A contemporary approach involves using a skeletal anchorage system (SAS) to overcome these limitations and achieve maximum skeletal effects. Studies comparing skeletal anchored protraction facemasks with control groups among patients with maxillary deficiency have yielded encouraging results.[5] Interestingly, SAS-assisted protraction has been proposed as an alternative to distraction osteogenesis (DO) for midface deficiencies, even among syndromic patients, including those with cleft lip and palate.

This paper presents two clinical cases involving patients diagnosed with developing skeletal Class III malocclusion characterized by maxillary retrusion. The management approach employed orthopedic protraction using a skeletal anchorage system (SAS). Additionally, the paper provides a comprehensive review of similar cases from the Indian literature that were successfully managed using this modality.

2. Case One

An 11-year-old male patient (**Figure 1**) presented with specific facial features, including a straight profile, reduced nose prominence, negative lip step, and an obliterated mento-labial sulcus. Notably, he displayed increased scleral show, midface flattening, decreased malar prominence, and poor smile esthetics with increased lower incisal display. In term

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https://doi.org/10.18231/j.jco.2025.038

of dental development, the patient was in mixed dentition phase, with the mandibular dental midline deviated to the left by 2mm. The molars exhibited a mesial step (Baume's classification) and there was a reverse overjet of 2 mm with an overbite of 3 mm (30%). An orthopantomogram (OPG) (**Figure 1**) revealed permanent teeth at various stages of mineralization, along with unerupted maxillary canines following an unfavorable eruption path.

Lateral cephalogram confirmed the patient in CVMI stage 2, with sagittal skeletal relation as Class III (ANB = -4˚, Wits = -4 mm), and a retrognathic maxilla (SNA = 77˚, A-N vertical = -3mm). The mandible was orthognathic with horizontal growth pattern (GoGn-SN = 28˚, FMA = 23˚). The upper incisors were retroclined, whereas the lower incisors proclined.

The treatment objectives encompassed interception of developing Class III malocclusion, guided eruption of maxillary cuspids, improvement of molar relation, optimizing overjet, and improvement of smile esthetics. In the context of managing maxillary hypoplasia, a comprehensive treatment plan was devised to address the underlying issue. The primary goal was to achieve maximum skeletal correction. To this end, growth modulation therapy was employed using a facemask. Notably, a skeletal anchorage system (SAS) was strategically adopted as the point of force application for the protraction of the maxilla (**Figure 1**).

Following a latency period of two weeks, an orthopedic force of 200 grams was applied at an angle of 30° to the occlusal plane. Gradually, the force was incrementally increased to 350 grams, and the appliance was worn for 14-16 hours daily. Remarkably, within six months of active therapy, favorable outcomes were achieved (**Figure 2**). Lateral cephalogram confirmed an improvement in skeletal relationship (ANB = 0˚, Wits = -2mm) with maxillary protraction (SNA = 81˚, A-N vert = -1 mm). The maxillary incisors along with upper lip displayed an improved position Additionally, cone-beam computed tomography (CBCT) precisely localized both maxillary canines, which were labially positioned with mesial angulation.[6] Customised orthodontic intervention was initiated with "Group A" anchorage, guiding the maxillary canines into occlusion. The patient entered the retention phase, wearing the facemask appliance during nighttime hours.

Figure 1: Pre-treatment records, SAS placement & facemask - Case 1

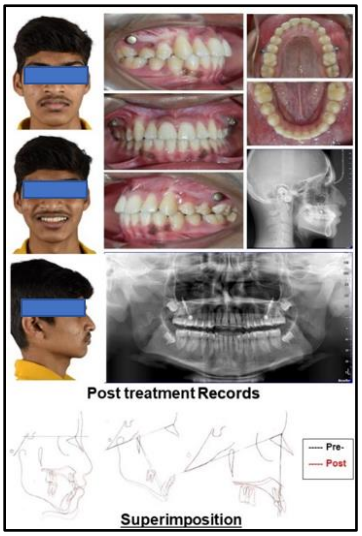

Figure 2: Post treatment records, superimposition - case 1

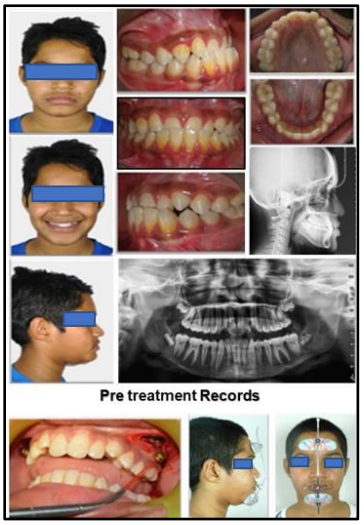

Figure 3: Pretreatment records, SAS placement & facemask - case 2

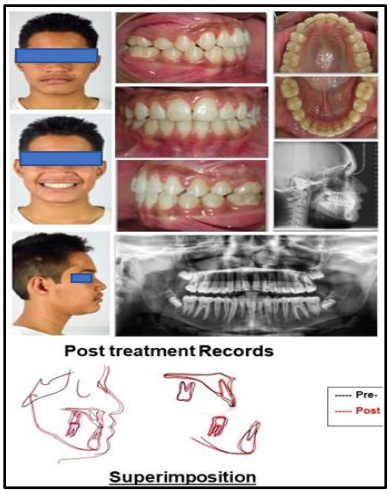

Figure 4: Post treatment records, superimposition - Case 2

Post-treatment, patient exhibited significant enhancements in facial and smile esthetics with midface fullness, pronounced malar prominence, a convex profile, and an optimally defined mento-labial sulcus. Additionally, the patient demonstrated bilateral Class I molar and canine relationships, with midlines aligning precisely. The overjet and overbite were within optimal parameters. Fixed retainers were securely bonded from canine to canine in both dental arches.

3. Case Two

A 12-year-old male patient (**Figure 3**) presented with a concave profile, maxillary deficiency, orthognathic mandible, an acute nasolabial angle, and a protrusive lower lip with anterior divergence. Additionally, he exhibited an increased lower anterior facial height. His dental occlusion revealed bilaterally super Class I, and Class III canine relationships, along with retroclined mandibular incisors, and a 2 mm reverse overjet. OPG indicated a full complement of permanent teeth, including third molars at various stages of mineralization. The lateral cephalogram revealed a skeletal Class III relationship characterized by a hypoplastic maxilla (Wits = -6mm) and a vertical growth pattern. The treatment plan involved initiating dentofacial orthopedics using a SAS supported Face Mask to protract the maxilla and correct the skeletal relationship. Subsequently, fixed mechanotherapy was employed. The treatment achieved all intended objectives with face mask therapy over an 8-months period, followed by fixed orthodontic therapy spanning 12 months (**Figure 4**). Finally, the patient received a bonded retainer in both dental arches.

4. Materials and Methods

A comprehensive literature review was conducted to investigate SAS-assisted midface protraction. The search spanned from January 2000 to December 2023 and focused on English-language publications by Indian authors. The databases explored included Scientific Electronic Library Online (SciELO), the Cochrane Library, SCOPUS, and PubMed. The process of inclusion and exclusion was meticulously carried out by two senior orthodontists independently.

The literature search encompassed all relevant studies, including randomized controlled trials (RCTs), prospective or retrospective controlled clinical trials (CCTs), case reports, case series, and review articles. These studies specifically investigated midface protraction using a facemask anchored to the maxillary skeletal base (rather than relying on dentition) through various means such as miniplates, implants, and SAS. Notably, patients with syndromes or cleft lip and palate were excluded from the analysis. The summary of the literature review findings is presented in (**Table 2**). Among the retrieved studies, there were no RCTs, prospective trials, or case-controlled investigations. The available literature consisted of twelve case reports, six review articles, and three finite element method (FEM) studies. It is important to acknowledge that case reports had a very limited sample size; only one study reported on three cases, while three studies included two cases each.

Table 1: Comparison of pre & post treatment cephalometric parameters

Cephalometric parameters	Case 1		Case 2	
	Pre	Post	Pre	Post
SNA	77º	81º	80º	82º
SNB	81º	81º	83º	83º
ANB	-4º	0º	-3º	-1º
UI-NA	21º(3mm)	26º(5mm)	25º(4mm)	29º(7mm)
LI-NB	28º(5mm)	29º(5mm)	23º(4mm)	24º(4mm)
GoGn-SN	28º	29º	30	31º
FMA	23º	24º	25º	26º
IMPA	99º	100º	80º	85º
Co-A	71mm	73mm	75mm	80mm
Co-Gn	93mm	94mm	105mm	106mm
Differential	22mm	21mm	30mm	26mm
Nasolabial angle	100º	98º	73º	76º

Table 2: Indian review of literature

S.N.	Name of Article	Authors	Publication	Age	Sample size	Follow up	Type of SAS
Case Reports							
1	Orthopaedic protraction of the maxilla with miniplates: treatment of midface deficiency.	Degala S, Bhanumathi M, Shivalinga BM.	J Maxillofac Oral Surg. 2013;14(1):111-8.	13 & 12yr	02	No	TSADs
2	Contemporary solutions for managing Class III malocclusion.	Krishnaswamy NR.	J Indian Orthod Soci. 2015;49: 19-26.	13, 22 & 20yr	03	No	TSADs
3	Miniplate Aided Maxillary Protraction for Correction of A Class III Malocclusion: A Case Report.	Behlim F, Bhalla A, Kuttappa MN, Shenavi L, Bhaskar V, Nayak K US, Shenavi L.	Heal Talk. 2015;8(1):39-40.	11yr	01	No	Miniplates
4	A comparative evaluation of skeletal, dental, and soft tissue changes with skeletal anchored and conventional facemask protraction therapy.	Tripathi T, Rai P, Singh N, Kalra S.	J Orthod Sci. 2016; 5 (3): 92-99.	10.1 & 9.9yr	02	No	Miniplates
5	Management of skeletal Class III malocclusion with face mask therapy and comprehensive orthodontic treatment.	Kirthika Muthukumar, N. M. Vijaykumar And M. C. Sainath	Contemp Clin Dent. 2016;7(1): 98–102.	9yr	01	No	Maxillary splint with RME
6	Fem Models of Cranium Along with Maxilla and Modified Implants to Analyse Stress and Displacement for the Purpose of Maxillary Protraction.	Vikram NR, Prabhakar R, Kumar SA, Karthikayan MK, Saravanan R, Nagachandran KS, Karthik S, Anbu V.	Biomed Pharmacol J 2017;10(3): 1181-5.	9yr	01	No	Mini implant
7	Management of skeletal Class III with facial asymmetry using skeletal anchorage: 4-year follow-up.	Tripathi T, Kalra S, Rai P.	Dental Press J Orthod. 2020; 25(2):24.e1-9.	13yr	01	4yrs	Miniplates
8	Rapid maxillary expansion facemask therapy in growing patients: A 2 case report and review of literature.	Palkit T, Aggarwal I, Bhullar MK, Goyal M, Singh N, Singh VK.	Indian J Oral Health Res. 2020;6:78-86.	10 & 11yr	02	No	Maxillary splint with RME
9	Bone Anchored Maxillary Protraction: A Case Report.	Krishna UR A. Pillai AR, Jayarajan J, Shaz F.	J Ind Dent Assoc Kochi. 2020;2(1):33-8.	15yr	01	No	Miniplates
10	Management of skeletal class iii malocclusion using rme and facemask followed by fixed orthodontic treatment-A Case Report.	Choudhury PP, Rakesh R, Karim MS, Chakrabarti AK.	J Adv Med Dent Sci Res. 2021;9(12):193-201.	12yr	01	No	Maxillary splint with RME

11	Modified Implant and FEM Model Creation for Maxillary Protraction	Vikram NR, Karthikeyan MK, Saravanan R, Kumar SA, Nagachandran KS, Karthik S.	Current Pra Med Sci. 2022;10:60-8.		01		
12	Non-surgical correction of Class III adolescent patient with tads and Damon system: A case report.	Shaikh AA, Kumar GA, Ramesh GC, Chinthan G, Indra S.	APOS Trends Orthod. 2022;12:139-48.	16yr	01	No	Maxillary splint with lower TADs
Review articles							
1	Maxillary Protraction Therapy	Sivakumar A, Valiathan A.	J Indian Orthod Soc: 2009;43(1):40-47.				
2	Bone anchored maxillary protraction	Mathur A, Toshniwal NG, Kharbanda OP, Thakur A.	Am J Orthod Dentofacial Orthop. 2012; 141(5): 530-1				
3	Skeletal Anchorage System [Miniplates] - An Orthodontic Perspective - A Review	Bhardwaj A, Sharma AK, Mishra K, Jeswani R.	Acta Scientific Dental Sciences. 2020;4.10: 03-10				
4	Bone-anchored maxillary protraction – A Literature review	Nizar A, Jibinjoy, Shetty NK, Kumar A.	Int J Dent Med Sci Res. 2021;3(6):419-22.				
5	Bone Anchored Maxillary Expansion and Bone Anchored Maxillary Protraction – A Review	Laddha S.	SVOA Dentistry. 2021;2(6): 308-11.				
6	Bone-anchored maxillary protraction (BAMP): A review	Kamath A, Sudhakar SS, Kannan G, Rai K, Sb A.	J Orthod Sci. 2022; 11:8.				
FEM Studies							
1	Effects of different force directions of intra-oral skeletally anchored maxillary protraction on craniomaxillofacial complex, in Class III malocclusion: a 3D finite element analysis	Garg D, Rai P, Tripathi T, Kanase A.	Dental Press J Orthod. 2023; 27(5):e2220377.				
2	Biomechanical effects of Skeletally anchored Class III elastics on the maxillofacial complex: a 3D finite element analysis	Rai P, Garg D, Tripathi T, Kanase A, Ganesh G.	Prog Orthod. 2021;22(1):36.				
3	Effect of micro implant assisted rapid palatal expansion on bone-anchored maxillary protraction: A finite element analysis	Suresh S, Sundareswaran S, Sathyanadhan S.	Am J Orthod Dentofacial Orthop. 2021 ;160(4):523-32.				

5. Discussion

Patients with Class III malocclusion exhibit a complex three-dimensional disproportion in maxillary and mandibular development. This condition involves varying degrees of compensations within the soft tissue and dentoalveolar components. Class III malocclusion may be associated with maxillary growth deficiency (and/or maxillary retrognathia), mandibular growth excess (and/or mandibular prognathism), or a combination of both, often accompanied by vertical and transverse anomalies.

The case reports detail the management of preadolescent patients with maxillary hypoplasia using face mask therapy in conjunction with SAS. The treatment involves positioning mini plates positioning in the infra-zygomatic crest and applying protraction forces to the maxilla via the facemask. The efficacy of these mini plates is closely linked to the surgical precision and the thickness & quality of the bone. Notably, the bone quality in the maxilla tends to improve significantly after the patient reaches at least 11 years of age. Consequently, the use of SAS is particularly recommended for older patients compared to tooth-borne appliances.

The intended objective of orthopedic protraction is to achieve significant skeletal advancement of the maxilla while minimizing dental alterations. A systematic review has indicated that SAS is particularly well-suited for achieving these desired outcomes.[7] The treatment outcome may vary involve a reduction in the counter clockwise rotation of the maxilla, consequently leading to a decrease in clockwise rotation of the mandible. An additional advantage of SAS is its applicability to patients who may not be within the ideal age range for traditional face mask therapy but still exhibit ongoing midfacial growth.

The utilization of SAS does present certain inherent drawbacks. These include the necessity for an invasive surgical procedure during both placement and subsequently removal of the hardware. Such procedure may potentially induce psychological trauma in young patients. Additionally, a common issue reported with SAS is the loosening of components.[8]

The utilization of SAS for orthopedic protraction has a history of implementation. However, certain challenges are inherent in this approach. These challenges include the potential for trauma to developing permanent teeth and the surrounding follicles, as well as the occurrence of asymmetric placements. To address these issues, customized guides designed using CAD-CAM (computer-aided design and computer-aided manufacturing) technology have been employed. These guides facilitate the precise translation of surgical plan thereby overcoming the aforementioned challenges.[9-10]

6. Conclusion

The management of Class III malocclusion resulting from maxillary hypoplasia, and addressed through facemask therapy, aims to correct the condition by leveraging a synergistic interplay of skeletal and dentoalveolar effects. Skeletal anchorage facilitates substantial maxillary protraction while minimizing unfavourable dental consequences. Although SAS appliances hold promise for inducing further skeletal modifications, their routine application necessitates additional empirical evidence.

7. Source of Funding

None.

8. Conflict of Interest

None.

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Cite this article: Chauhan D, Datana S, Sharma M, Waingankar AM, Thakur VK. Orthopaedic protraction of midface with skeletal anchorage system: Report of two cases and Indian literature review. *J Contemp Orthod*.2025;9(2):269–274.