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Combining Circumvestibular Corticotomy with Maxillary Protraction as a Conservative Approach to Treatment in an Adolescent with Maxillary Deficiency: A Case Report with Long Term Follow-up

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A B S T R A C T

Maxillary protraction with a face mask is an effective treatment for class III children with maxillary hypoplasia. However, in late adolescence, orthopedic approaches are not very effective for treatment of maxillary deficiency. The aim of this study was to report a minimally invasive technique to orthopedically treat a 16-year-old female adolescent with mild to moderate maxillary deficiency, before the cessation of growth. A circumvestibular corticotomy technique was performed followed by a regimen of rapid maxillary expansion and application of heavy extra-oral forces. After termination of the orthopedic and orthodontic phases, the patient was monitored for ten years. The dental and skeletal results immediately after treatment were compared with the results ten years after termination of treatment. A noticeable anterior displacement of "A" point was observed after the orthopedic phase and this remained unchanged for ten years.

Keywords: Malocclusion, Angle Class III; Maxilla; Retrognathia; Orthopedic; Adolescent; Activator Appliances

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INTRODUCTION

The class III malocclusion is seen in 1 to 5 % of white Caucasian populations and at least one-quarter of them have maxillary deficiency[1]. Protraction with a face mask has been used as an effective approach for maxillary advancement in pre-school children [2]. To avoid interdigitation of circummaxillary sutures, the treatment of maxillary hypoplasia should be performed as early as possible[3]. Several attempts have been done to develop orthopedic treatments for adolescents with maxillary deficiency because interdigitation of circumaxillary sutures in the late childhood to early adolescence make maxillary advancement difficult[4-7]. It was suggested that rapid palatal expansion and constrcation might detach small connections between maxilla and other bones and reduce the skeletal resistance against anterior movement of A-point [8-12]. Some authors combined maxillary corticotomy (LeFort I design) with skeletal anchored class III elastics to protract the maxillae in some class III adolescents. They reported this method as an effective approach to overcome protraction resistance [10]. In another study, extra oral orthopedic forces were combined with maxillary

Fig. 1: Pretreatment intra- and extra-oral photographs

corticotomy to correct maxillary deficiency in a 15-years-old girl and 16-years-old boy. It was reported that this technique could effectively protract the maxillae in those non-growing patients [11]. find aHowever, more invasive approaches such as distraction osteogenesis or orthognathic surgery were considered for adolescents with more interdigitated sutures, which inevitably increase the cost and morbidity [12]. The goal of this case study is to present a novel alternative to overcome maxillary resistance and advance the maxillary base (A-Point) in a mature class III adolescent. For this purpose, we combined rapid maxillary expansion with a chair-side corticotomy procedure followed by heavy extra-oral forces.

CASE REPORT

A 16 year-old healthy female patient was referred by her general dental practitioner due to anterior cross bite. The patient's main concern was her flat face and irregularity of her front teeth. There was no history of class III malocclusion or mandibular prognathism in her family. Her parent reported that the facial profile was not deteriorating within past years.

Extra-oral examination revealed that the patient had a mild skeletal III profile with retrusion of upper lip and increased vertical proportions. There was normal upper incisor show at rest and on smiling. The flattening of her mid-face and increased scleral show was obvious in the profile and frontal views. Her chin projection was slightly increased but the mento-labial angle was normal (Fig.1). Clinical examination of the temporomandibular joint (TMJ) revealed a normal sound, with no pain or dysfunction. There was no evidence of temporomandibular disorder (masticatory muscle disorders, disc displacements, arthralgia, osteoarthritis or osteoarthrosis).

Intra-orally, the patient had class III canine and super class I molar relationship with a negative overjet of 3 mm. The vertical overlap of incisors was reduced but complete. The upper dental arch had a moderate to severe crowding and tooth size arch length discrepancy (TSALD). There was an anterior crossbite affecting the central and lateral incisors. She had no transverse discrepancy or posterior cross bite. The midline of upper front teeth was coincident with the facial midline while the upper dental midline was 1.5mm deviated to the left due to the

crowding. There was no evidence of wear on the the incisal tips of anterior teeth or mandibular shift on closure (Fig.1). The index of complexity outcome and need (ICON) which provides a summary score based on the severity of the malocclusion and the difficulty of the proposed treatment was sixty-four. A score of more than forty-three is taken to indicate a demonstrable need for treatment.

A lateral cephalogram highlighted a skeletal class III relationship (ANB=-2˚, Wits appraisal=-4mm), mostly due to maxillary deficiency (SNA=76˚, SNB=78˚) with slightly increased vertical proportions (Jarabak index=57.6, SN.MP=34˚). The sagittal inclination of upper incisors was slightly increased and lower incisors decreased (U1.FH=113˚, IMPA=86˚). There was no evidence of a mandibular asymmetry regards to the superposition of the lower border of the mandible. Based on the clinical and radiographic evaluation a sagittal skeletal discrepancy of the maxillary base was suspected.

The patient had the severe psychosocial impact of malocclusion based on Psychosocial Impact of Dental Aesthetics Questionnaire.

The primary aim was to improve midface appearance by a minimally invasive surgical approach and alleviate dental discrepancies in an adolescent. The secondary aim was to assess the long time results of this orthopedic approach.

Treatment plan:

The first strategy was to align the teeth and prepare them for orthognathic surgery (maxillary advancement).

The second plan was a non-surgical approach to overcome the resistance against maxillary advancement in combination with orthopedic forces. This resistance mainly originated from interdigitation of circummaxillary sutures. This method was planned based on the results of previous studies [8,10,11] and the theory that combination of the maxillary expansion with a conservative corticotomy (LeFort I cuts without downfrcture) might decrease the attachments of maxillary base in the adolescents. The patient and her parents chose to proceed with second option. They were informed that, there is a considerable risk of failure of maxillary base advancement in the second plan because of her age and growth stage.

Treatment mechanotherapy and progress:

Pre-treatment records including study models, 2D radiographs and extra and intra-oral photographs were collected to monitor the progression of treatment (T1). A banded Haas-type expander with two palatal extensions and two buccal hooks between canines and 1st premolars was fabricated based on the working cast and cemented to the 1st molar and premolars (Fig.2).

Fig. 2: The banded Haas-type expander with two palatal extensions

Local anesthesia was administered on the buccal and labial surfaces of the maxilla and a full thickness flap was raised in this area. A linear corticotomy was performed in the anterior and lateral walls based on the design of a LeFort I procedure. The corticotomy line was also horizontally and vertically extended to the pterygomaxillarcay sutures. In this procedure the cortical bone was cut for 3 mm of depth by means of a Piezotome (Piezotome Cube, Acteon, Merignac, France) and assessed by a periodontal probe. After spending 6 days for initial healing, the expander was activated twice (0.25 mm per turn) every other days by the patient's parents for 16 days. At the same time an orthopedic force of 600 g per side was applied to the maxilla by means of heavy extra-oral elastics (14 Oz, ½ inch, American Orthodontics, Sheboygan, Wisc, USA) connected to a rail-type facemask appliance (G&H Orthodontics, Franklin, IN, USA).

The elastics were attached to the buccal hooks of cemented appliance with a downward and forward pull of 30° to the occlusal plane. The patient was instructed to wear the facemask 12 hour a day and change the elastics every 24 hour. After 16 days, the expansion protocol was changed. The patient was instructed to expand the devise for 3 days and then constrict it for another 3 days to reactivate the bone and delay the maxillary bone healing during protraction. This instruction was continued for 4 months. The maxillary protraction procedure was discontinued after the overcorrection of the sagittal deficiency and post protraction orthodontic records including cast and radiographs were prepared (T2). The post treatment lateral cephalogram of the patient was traced and compared with the pretreatment lateral cephalogram. After that, a retention period of 6 months was undertaken for the patient while the Hass-type appliance was kept in its position. The patient was monitored for potential relapses within retention period. To correct dental irregularity and tooth size arch length discrepancy, a comprehensive fixed orthodontic treatment with four bicuspid extractions (maxillary first and mandibular second bicuspids) was performed for her. A fixed orthodontic treatment was started by applying 0.018 slot roth metal brackets (American Orthodontics, Sheboygan, Wisconsin, USA) to the maxillary and mandibular teeth. The extractions were performed at the beginning of fixed treatment. An initial upper, Niti arch wire of 0.014 was used followed by posterior traction of upper canines and lower first bicuspids. The leveling and aligning process was continued by the sequence of upper Niti arches of 0.016 and 0.016 * 0.022. Both jaws were passed to 0.016 × 0.022 stainless steel arches to perform anterior traction and finishing procedures. Class I canine and molar relationship was also achieved with class III elastics. After 23 months of fixed orthodontic treatment and achieving the intended goals, the fixed appliance was removed.

Fixed lingual retainers were bonded second bicuspid to second bicuspid on upper arch and the patient was instructed to use a vacuum formed retainer 24 hour for 6 months and night time for the next 12 months (T3). The fixed lingual retainer was removed after 18 months.

After 10 years, the patient was examined again and follow-up records including study models, 2D radiographs and extra and intra-oral photographs were collected (T4) and compared with pretreatment and post protraction records.

Treatment results:

In general, treatment results showed that the goals were satisfactorily met (Table 1; Figs. 3-5).

T1-T2

The maxillary base was successfully advance with reasonable dento-alveolar side effects and remained unchanged for ten years (Table 1; Figs. 3-5).

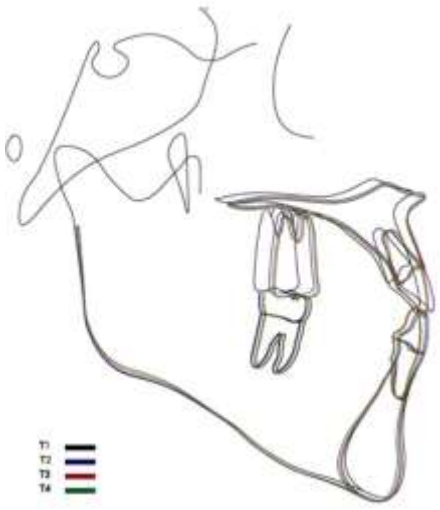

Fig. 3: Cephalometric superimposition at the cranial base (centered on sella). T1: Pretreatment; T2: Post protraction; T3: After fixed treatment; T4: Follow up

The skeletal discrepancy between the maxillae and mandible was mostly corrected due to protraction of maxillary base (ANB from -2 to +3, Wits from -4 mm to 0 mm). Some dento-alveolar side effects including the slight increase in the inclination of upper

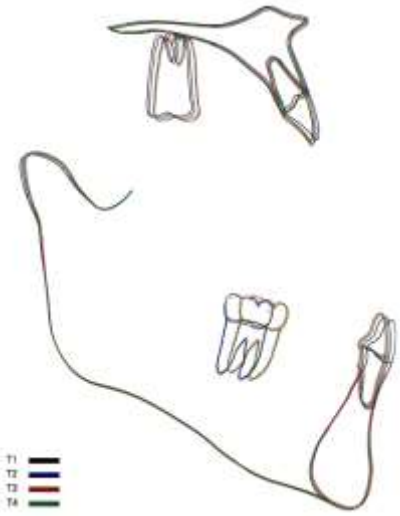

Fig. 4: Maxillary superimposition (palatal plane centered on ANS) and Mandibular superimposition (mandibular plane centered on menton). T1: Pretreatment; T2: Post protraction; T3: After fixed treatment; T4: Follow up

incisors (U1-FH) and the mild decrease in the inclination of lower incisors were seen after superimposition of lateral cephalometries (Table 1).

The ICON index was significantly decreased from T1 (64) to T2 (37). No significant periodontal side effects such as gingival recession, fenestration, dehiscence or periodontal pocket were noted after orthopedic or orthodontic treatment.

T2-T3

The vertical and sagittal skeletal parameters did not change within fixed orthodontic therapy (Table 1) but a significant decrease was noted in the inclination of upper and lower anterior teeth within the treatment (U1. FH from 117 to 133 and IMPA from 85 to 82). The index of complexity outcome and need was significantly decreased within this period. The ICON index was calculated thirty-seven in T2 and seven in T3. The buccal surface of lower first molars showed evidences of initial carries after orthodontic treatment.

T3-T4

The skeletal achievements especially in the maxillary base were stable and remained unchanged for ten years. No significant dento-alveolar side effect and no change in the ICON index (7) were seen within this period.

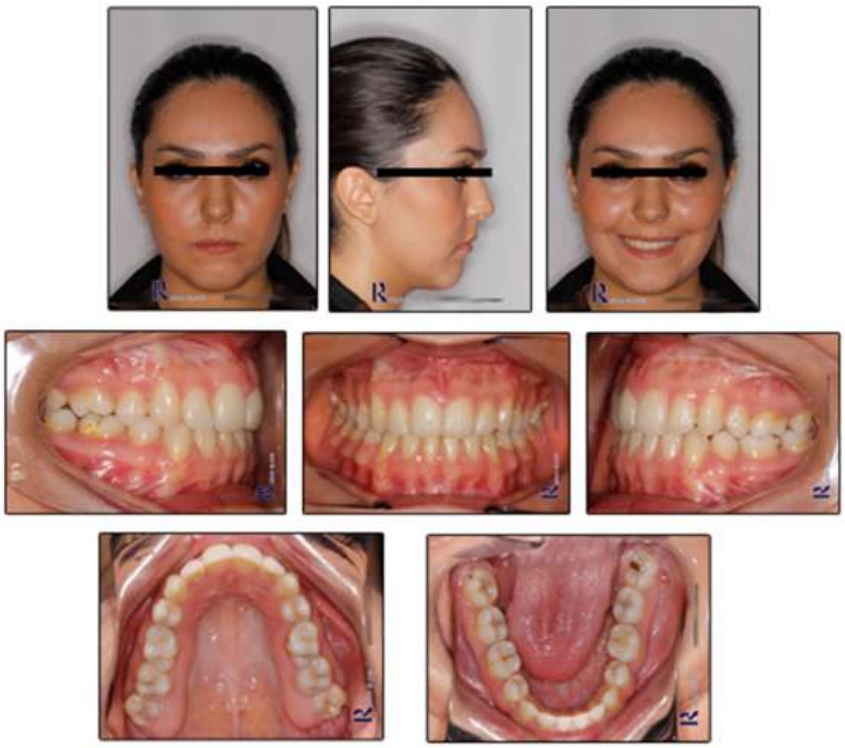

Fig. 5: Follow-up intra and extra oral photographs

Table 1: Conventional cephalometric analysis

	Variable	Normal	T1	T2	T3	T4
Maxilla	SNA(˚)	82	76	80	80	80
	Co.A (mm)	87	79	82	82	81
Mandible	SNB(˚)	80	78	77	77	78
	Co.Gn (mm)	110	115	117	118	120
Maxillo-mandibular relationship	ANB(˚)	2	-2	+3	+3	+2
	Wits appraisal(mm)	0	-4	0	-1	-1
Vertical	FMA (MP.FH) (˚)	27	28	29	29	30
	Jarabak index	62	57.6	56.4	56.3	56
	SN.MP	32	34	36	35	36
Dentoalveolar	U1.NA (˚)	22	24	26	22	22
	U1.NA (distance) (mm)	4	4	6	4	4
	U1.FH(˚)	112	113	117	113	113
	L1.NB(˚)	25	24.5	22	15	14
	L1.NB (mm)	4	6	7	4	4
	IMPA(˚)	90	87 ˚	85˚	82 ˚	82 ˚
Soft tissue	UL to E-Plane(mm)	0	-6	-1	-1	-1
	Nasolabial angle(˚)	110	115	112	113	114

T1: Pretreatment; T2: Post protraction; T3: after fixed treatment; T4, Follow up

DISCUSSION

Maxillary protraction with a face mask is an effective treatment for class III children with maxillary hypoplasia. However, in late adolescence, orthopedic approaches are not effective for treatment of maxillary deficiency. These methods of treatment were not effective for our patient because previous investigations reported that, orthopedic forces could increase relapse rate, morbidity and dentofacial complications in the mature adolescents with maxillary retrognathism [13].

The alternative treatment options were dental camouflage and orthognathic surgery, which the patient and her family deferred upon. As previous investigations highlighted, application of camouflage treatment in class III patients causes lower facial esthetic results in comparison to the combination of orthognathic surgery and orthodontics [14,15]. Therefore, we decided to apply a novel approach in which a modified corticotomy technique was applied according to Lefort I design. The corticotomy line was shallow and extended vertical and horizontally. This in-office procedure was followed by a maxillary expansion and constriction regime to break the tight connections between maxilla and its adjacent bones and activate circummaxillary sutures to decrease the advancement resistance[8]. The abovementioned approach was less invasive than conventional osteotomy techniques that require general anesthesia. The application of orthopedic forces in combination with abovementioned technique resulted in an improvement in the fullness of the infraorbital region and profile. The skeletal discrepancy between the maxillary and mandibular base was corrected due to protraction of maxillary base.

Although the advancement of maxillary base

was successful in this patient, some dento-alveolar side effects including a slight increase in the inclination of upper incisors (U1-FH) and a mild decrease in the inclination of lower incisors (IMPA) were also evident (Table I) The comprehensive orthodontic treatment was done for her in order to level and align the teeth, correct the inclination of the teeth and create an ideal overjet, over bite and occlusion. No evidence of relapse was seen in the midface fullness after 23 months of fixed orthodontic treatment (Fig. 3 and 4).

Furquim et al. applied a different surgical technique with maxillary protraction. They combined surgically assisted rapid maxillary expansion (SARME) with orthopedic protraction by Sky Hook. Even though they applied osteotomy cut instead of corticotomy lines, the orthopedic movement of maxillary base was lower compared with the current findings [16]. This difference could be attributed to the osteotomy technique, in which a major advancement resistance was not removed. To be less invasive, they did not fracture the pterygomaxillary suture, so the osteotomy lines did not include the posterior connections of maxilla. Furthermore, the 32-year-old woman in that case-report was much more mature and probably had different bone metabolism compared with a 16-year-old female. Pelo et al.[11] reported a greater maxillary advancement than previous study which could attributed to the osteotomy technique in which the pterygomaxillary suture was fractured.

In contrast to the current results, Furquim et al. [16] reported palatal tipping of maxillary incisors and labial tipping of the mandibular incisors. This result is not in line with the common dentoalveolar effects of facemask therapy which is proclination of upper incisors and retroclination of lower ones.In another attempt, some clinicians applied a Lefort I osteotomy without down fracturing, followed by extra-oral forces to protract the maxilla in the fourteen young adolescents with bilateral alveolar cleft. They reported a mean movement of 7.2 mm after twelve weeks of maxillary protraction[17]. This noticeable and fast movement could be attributed to the more invasive surgical procedure (osteotomy) and the soft and hard tissue structures of cleft patients originated from multiple surgical procedures such as, lip and palate closure as well as bone grafting. Although this technique was reported effective in this population, the findings need to be considered with caution due to lack of data about long term stability of results. Yilmazet et al.[10] analyzed the effect of maxillary protraction with skeletal anchorage in combination with maxillary osteotomy. They reported a noticeable maxillary advancement (3.59 ± 1.32 mm) within four months of protraction period. The application of skeletally anchored class III elastics and Lefort osteotomy resulted in a great A point advancement and low dentoalveolar side effects. Although osteotomy cuts did not involve ptrygoid plates, the application of skeletal anchorage seems to decrease dentoalveolar side effects.

Masucci et al.[18] evaluated the long term stability of treatment with face mask in combination with rapid maxillary expansion (RME) without any surgical intervention.This treatment is reported effective in young adolescents and noticeably stable after 8 years (long term success rate of 73%). They reported that skeletal changes were mainly due to sagittal repositioning of the. Furthermore; the mean amount of maxillary advancement in this study was lower than the current study. This could be attributed to the fact that the combination of RME with extra-oral forces is less invasive and may not completely loose interdigitation of circummaxillary sutures.

Ten years after the termination of orthopedic phase, we noticed a slight change in the ANB and Wits parameters, but no change in the SNA value of our patient (Table I). This might be attributed to the late mandibular growth of that patient. No apparent change in the extra oral (midface fullness) and intra oral (sagittal molar and canine relationship, overjet and overbite) parameters was seen. In contrast to our results, in the follow up phase, a retrospective study, reported a higher relapse rate for the class III patients treated by a combination of an incomplete osteotomy and

orthopedic traction with facemask [19]. This difference between our case report and the study may be attributed to the different surgical approach used, such as osteotomy versus corticotomy. We used the corticotomy technique, which is a more physiological and minimally invasive procedure. They also reported that the treatment results in the patients underwent surgically assisted maxillary protraction was significantly less stable than patients who treated without this approach. This difference could be attributed to the limitation of soft tissue (envelope of movement) and the rate of movement. It is assumable that as the rate and amount of movement increases the ability of soft tissue to accommodate with the new situation decreases and the relapse rate probably increases.

The index of complexity outcome and need was significantly decreased from T1 to T3 (64, 37 and 7 respectively) which shows the effectiveness of treatment following the primary needs but remained unchanged for ten years (T4). ICON incorporates features of the Index of Peer Assessment Rating index and Orthodontic Treatment Need [20]. As mentioned by its developers, a score of more than forty-three indicates a definite need for treatment (T1 and T2). Furthermore, a score less than thirty-one shows that the outcome is acceptable and no furture treatment is required (T3 and T4).

CONCLUSION

This case report presented a minimally invasive technique to treat adolescents diagnosed with mild to moderate maxillary deficiency. Using the proposed method, for a selected adolescent with class III malocclusion and maxillary deficiency had the following advantages: i) overcome age limitations, ii) orthopedic movement of maxillary base, iii) minimal invasive surgery under local anesthesia, iv: minimum dentoalveolar side effect, v: great long term stability. Although the results were impressive, further case series and prospective studies are recommended to reveal more accurate information about this treatment approach.

CONFLICT OF INTEREST STATEMENT

None declared.

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