Orthopaedic Protraction of the Maxilla with Miniplates: Treatment of Midface Deficiency

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Abstract Class III malocclusion is a consequence of maxillary deficiency and/or mandibular prognathism, resulting in an anterior crossbite and a concave profile. Early class III malocclusion treatment with reverse pull headgear generally results in maxillary skeletal protraction but is frequently also accompanied by unfavourable dentoalveolar effects. Titanium miniplates used as temporary anchorage device might permit equivalent favourable skeletal changes without unwanted dentoalveolar effects. We report two cases having class III malocclusion with maxillary deficiency treated by using titanium miniplates. Cephalometric tracings were done pre and post treatment to determine the anatomic changes during the course of treatment.

Keywords Bone anchored miniplates · Mandibular prognathism · Maxillary hypoplasia · Reverse pull head gear

Introduction

Maxillary hypoplasia is characterized by deficiency of skeletal height, width, and anteroposterior relationships, which

requires multidirectional correction [1]. Class III malocclusion is a consequence of maxillary deficiency and/or mandibular prognathism, resulting in an anterior crossbite and a concave profile [2]. Treatment of young patients with maxillary deficiency is generally directed towards achieving positive overjet through a combination of dentoalveolar and skeletal effects. Protraction facemask therapy or reverse pull headgear (RPHG) is perhaps the most common approach for early treatment of these patients. This approach is limited, in that the forces are applied to the teeth, resulting in uncertain skeletal and often unwanted dentoalveolar effects [3]. Implants provide true stationary anchorage allowing treatment to proceed more rapidly with highly predictable results [4].

Various types of implants have been tested: Vitallium screws, Vitreous carbon, Bioglass coated aluminium oxide implants, Stainless steel plates and screws and Branemark implants [4]. These devices are relatively expensive, require a healing period before orthodontic loading, and often provide only indirect anchorage. More recently temporary skeletal anchorage device (TSAD), Miniplates and screws have been found to have advantage, including ease of manipulation, ability to withstand immediate force loading, minimal irritation of oral tissues and cost [1, 4, 5]. Anterior palate, buccal, or palatal interdental alveolar bone, and zygomaticomaxillary buttress are the anatomical regions in which the orthodontic implants are frequently placed [6]. However, miniplates should be placed by a surgeon because this is a technique sensitive surgery requiring flap elevation and strict asepsis. The advantage of absolute anchorage to aid in maxillary protraction was introduced in 1985 by Kokich et al. Later Smalley et al. experimented with osseointegrated Branemark style implants for maxillary protraction in monkeys [5]. The zygomaticomaxillary buttress is the prominent ridge at the zygomatic process of the maxilla and has a dense cortical

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Pre treatment (case1)

Post protraction (case1)

Fig. 1 Pre treatment and post treatment frontal, lateral profile and intra oral photograph of case 1

bone structure. Clinically it is between the maxillary second premolar and first molar in children and above the maxillary first molar in adults.

Case Report 1

A 13 year old boy came with a complaint of depression of middle part of face and forwardly placed lower jaw. There

was no h/o trauma and parafunctional habits and systemic illness. Clinical and radiological examination revealed maxillary retrognathism, mandibular prognathism, potentially competent lips, concave profile, class three molar relation, diminished mento labial sulcus, permanent dentition with retained 53 and clinically missing 13,18,28,38,48, normal palatal contour and distopalatal rotation of 12, mesiolabial rotation of 33, 34. Over jet of -3 mm, (anterior crossbite) (Figs. 1, 2) (Table 1).

Fig. 2 Photograph of superimposition (pre op—black line, post op—blue line)

Case Report 2

A 12 year old boy was concerned with depressed middle part of face, forwardly placed lower jaw and small teeth, with no history of trauma, parafunctional habits and systemic illness. Furthermore his father presented with maxillary hypoplasia. Clinical and radiological examination revealed maxillary hypoplasia, prominent mandible, reduced nasal tip projection, aged appearance, concave profile, competent lips, unesthetic smile, severe hypodontia, microdontia. Patient was in mixed dentition period with severe microdontia of existing teeth. Germs of 12, 13, 14, 15, 22, 23, 24, 25, 31, 32, 33, 34, 36, 41, 42, 43, 44, 45 could not be detected in panoramic radiograph (Figs. 3, 4), and there was an anterior crossbite (Table 2).

Following this the patient was diagnosed to have skeletal class III malocclusion (case 1) with vertical growth pattern, skeletal class III malocclusion with hypodontia and microdontia (case 2).

Both the patients underwent routine haematological, biochemical, microbiological investigations. Under antibiotic coverage patients underwent surgery under GA. Patients were discharged uneventfully after a day with periodic follow-up.

Technique

Two designs were used; one was bollard device (Fig. 5) made of titanium for first patient, other was modified

Table 1 Pre and post treatment cephalometric measurements (case 1)

	Normal values	Pre treatment values	Post treatment values
SNA	$82^{\circ} \pm 3$	80°	84°
SNB	$80^{\circ} \pm 3$	82°	82°
ANB	$3^{\circ} \pm 1$	-2°	2°
MPA	32°	32°	33°
U1-SN	$102^{\circ} \pm 2$	103°	103°
L1-MP	$92^{\circ} \pm 5$	81°	81°
Y-axis	66°	67°	68°
Wits appraisal	0 mm	BO ahead AO 11 mm.	AO ahead BO 5 mm.
Eff. Mandi. Length	114 ± 4.3	116 mm	116 mm
Eff. Max. Length	92.1 ± 4.1	84 mm	87 mm
Facial axis	0°	-5°	-6°
Interincisal angle	$133^{\circ} \pm 10$	152°	154°
Lower anterior face height	64.3 ± 3.6 mm	63 mm	64 mm
Angle of inclination	85°	84°	85°
Overjet	2–4 mm	–3 mm	2 mm
Overbite	2–4 mm	3 mm	2 mm

traditional miniplates made of stainless steel (Fig. 6) for second patient.

- Surgical placement of the TSADs in the maxilla and mandible was carried out under GA.
- After LA infiltration upper buccal vestibular incision was placed bilaterally over the zygomatic buttress region. In mandible near lateral incisor and canine region lower labial vestibular incision was placed bilaterally.
- Mucoperiosteal flaps were elevated for bone exposure.
- The plate was bent to fit the bony surface.
- Two miniplates were placed along the contour of zygomatic buttress in maxilla, two between canine and lateral incisor in mandible.
- Bollard device were placed with the attachment units facing anteriorly in maxilla and mandible (case 1, Fig. 5).
- Modified traditional stainless miniplates were placed with hooks facing posteriorly in maxilla and anteriorly in mandible (case 2, Fig. 6).
- The hole for screw sized 2.0 mm diameter and 8 mm length, located closest to the attachment unit was drilled first.
- The first screw was not completely seated to allow some rotation and adjustment of the plate to an ideal position.

Fig. 3 Pre-op cephalometric tracing (*left*) and post op OPG (*right*) of case 2

- All screws were subsequently tightened with a hand driver.
- After irrigating with saline, closure was obtained in 1 plane with restorable sutures.
- Patients were instructed to brush at least twice a day, chlorohexidine mouth rinse was recommended.
- Non resorbed sutures were removed 20 days after operation.
- Intermittently reexposure of attachment unit under LA was done due to overgrowth of tissue on it (case 1).
- Two months later bonded Hyrax for upper arch was placed, alternate expansion and constriction of maxilla was done for 7 weeks (case 1) along with opening of bite (Fig. 5).
- Temporary skeletal anchorage devices were loaded approximately 3 weeks after surgery. Eight oz class III extraoral elastics were used which have to be changed at least once in 24 h to be worn for 24 h (case 1, 2) (Fig. 7).
- After 10 months Hyrax was removed (case 1).
- The plates were well tolerated by the patient with no post op infection.

Discussion

Orthodontists have tried to modify facial growth by applying orthopaedic forces to the teeth to be further transmitted to the skeletal base of the maxilla and mandible. However, dentoalveolar compensations rather than alterations of the facial growth were mostly responsible for the improvement seen in the dental arch relationships [2]. To eliminate the dental side effects, titanium miniplates shown to be well tolerated by patients can now be used to apply orthopaedic forces [7]. Titanium TSADs offer direct structural and functional anchorage according to Bränemark's definitions [8, 9]. The role of TSAD is to provide

reliable stability when loaded with forces, without damaging adjacent structures and minimal discomfort to patient. A comparison of two protocols for maxillary protraction highlighted some clinical aspects: the face mask protocol requires the appliance to be worn for fewer hours per day but the face mask is more bulky and less easily tolerated than intraoral class III elastics [10]. It is generally recommended that facemask therapy be started before the age of 8 years [2].

Currently 2 types of TSADs are used: screw implants and bone plates [9]. The zygoma anchorage system introduced by De Clerck et al. was used for distalization of the teeth [6]. Different designs of miniplates are Bollard device that has either 2 (mandibular) or 3 (maxillary) fixation holes, a round connecting bar that perforates the mucosa, and an orthodontic attachment unit with a locking screw. The C-tube is a 2 hole titanium miniplate with a flat connection bar and a tube to allow attachment to the orthodontic appliance. Modified traditional miniplate with a 2 (mandibular) or 3(maxillary) fixation holes, 2/3 holes modified by cutting edges according to direction and magnitude of force to be applied. Multipurpose miniplate was designed by Erverdi.

Miniplate placement surgery in young patients is complicated by the reduced height of the maxillary alveolar bone, cannot be placed before mandibular canine eruption, orthopaedic traction on miniplates usually cannot be started before the age of 10 years [2, 10]. The location of miniplates, point of exposure to the oral cavity is absolutely critical [2, 6]. A higher exposure point may lead to mucosal irritation, inflammation and hypertrophy. Nevertheless, it should be inserted to the highest position on the zygomatic buttress to maintain a thicker bone. Manufacturing the zygoma plates in variable lengths may help to overcome these problems [6] or using modified miniplates as in our second case. In the first case the connecting bar emerged at mucogingival junction, was a key factor for good soft

Fig. 4 Pre and post treatment frontal and lateral profile photograph (case 2)

Table 2 Pre treatment cephalometric measurements (case2)

	Normal values	Pre treatment values	Post treatment values
SNA	$82^{\circ} \pm 3$	77°	82°
SNB	$80^{\circ} \pm 3$	83°	82°
ANB	$3^{\circ} \pm 1$	-6°	0°
MPA	32°	15°	18°
U1-SN	$102^{\circ} \pm 2$	103°	104°
L1-MP	$92^{\circ} \pm 5$	94°	95°
Y-AXIS	66°	52°	54°
Wits appraisal	0 mm	-9 mm	3 mm
Eff. mandi. length	114 ± 4.3 mm	115 mm	116 mm
Eff. max. length	92.1 ± 4.1 mm	80	85
Facial axis	0°	4°	6°
Interincisal angle	$133^{\circ} \pm 10$	145°	142°
Lower anterior face height	64.3 ± 3.6 mm	45 mm	47 mm
Angle of inclination	85°	85°	85°
Overjet	2–4 mm	-5 mm	2 mm
Overbite	2–4 mm	+3 mm	3 mm

extremely important, avoid overtightening of the screws. In addition, excellent passive adaptation of the plate to the zygomaticomaxillary buttress is necessary to avoid excessive force on the bone. Regarding patient discomfort, although miniplate placement required a mucoperiosteal flap, the surgery appears to be associated with minimal postoperative pain and inconvenience but swelling was a problem that was encountered. To reduce cheek irritation the attachment units of device should always be bent parallel to dental arch.

Our patient was treated early, before the pubertal growth spurt to take advantage of the patent circumaxillary sutures. In the process of distraction, the maxilla is distracted from the complete lefort I osteotomy line and the pterygomaxillary disjunction [1, 11]. The alternative rapid maxillary expansion and constrictions (Alt-RAMEC) was developed to open the circumaxillary sutures without the disadvantages of overexpansion of the maxilla [12]. As sutures unite bones and play a role as growth sites in the growing skull, it could be assumed that a normal growing child has his or her natural osteotomy sites for distracting bones away from each

Fig. 5 Intra operative photograph (case 1) where Bollard device was placed **Fig. 6** Intra operative photograph (case 2) where modified miniplates were placed

tissue management. Primary stability of the TSAD is other by applying orthopaedic force [1]. The

Fig. 7 Intra oral photograph showing miniplates with elastics (*left*) and Hyrax appliance (*right*) of case 1

Table 3 Circummaxillary sutures

	Sutures
Sutures 1	Intermaxillary suture Nasomaxillary suture
Sutures 2	Frontomaxillary suture a,b,c Zygomaticomaxillary suture
Sutures 3	Internasal suture Zygomaticotemporal suture
Sutures 4	Nasofrontal suture

circumaxillary sutures were classified into four groups (Table 3) [13].

Improvement in facial esthetics before puberty has a positive impact on the psychosocial development of young children. Furthermore surgical maxillary advancement often results in an unpleasing widening of the alar base. Benefits to early treatment may include potential for a greater orthopaedic change in a shorter period of time, earlier esthetic improvements in the smile and facial profile, prevention of periodontal recession and dental wear, earlier functional improvement eliminating an anterior functional shift of the mandible, and avoiding or decreasing the chances of later orthognathic surgery. The benefits of palatal expansion may include expansion of a narrow maxilla and correction of posterior crossbite, increase in arch length, bite opening, loosening or activation of circum-maxillary sutures, and initiating downward and forward movement of the maxillary complex. The miniplates used were locally available and cost effective.

In conclusion, the TSADs is a reliable technique to obtain skeletal anchorage and may eliminate the need for extraoral force. The surgical insertion technique and position of the plates and oral hygiene status of the patients certainly influence the success of the system and clinician may face some minor problems. In our patients we observed minimal inflammation, no hypertrophy, good anchorage, no infection,

no mobility of the device, with noticeable skeletal and soft tissue changes providing better esthetical result. Future studies are required to evaluate its limitations, ideal age group, force level and differential indications.

Conflict of interest None.

References

1. Kircelli BH, Pektas Z, Kircelli C (2006) Maxillary molar distalization with a bone-anchored pendulum appliance. *Angle Orthod* 76(4):650–659
2. De Clerck HJ, Cornelis MA, Cevidanes LH, Heymann GC, Tulloch CJ (2009) Orthopedic traction of the maxilla with miniplates: a new perspective for treatment of midface deficiency. *J Oral Maxillofac Surg* 67:2123–2129
3. Heymann GC, Cevidanes L, Cornelis M, De Clerck HJ, De Camilla Tulloch JF (2010) Three-dimensional analysis of maxillary protraction with intermaxillary elastics to miniplates. *Am J Orthod Dentofacial Orthop* 137:274–284
4. Chung KR, Kim YS, linton JL, lee YJ (2002) The miniplate with tube for skeletal anchorage. *J Clin Orthod* 36(7):407–412
5. Cornelis MA, Scheffler NR, Mahy P, Siciliano S, De Clerck HJ, Tulloch JF (2008) Modified miniplates for temporary skeletal anchorage in orthodontics: placement and removal surgeries. *J Oral Maxillofac Surg* 66(7):1439–1445
6. Eroglu T, Cetinsahin A, Uckan S (2010) Success of zygomatic plate screw anchorage system. *J Oral Maxillofac Surg* 68: 602–605
7. De Clerck H, Geerinckx V, Siciliano S (2002) The zygoma anchorage system. *J Clin Orthod* 36(8):455
8. Chaurand lara J, Facio Umana JA (2012) Modified miniplates for orthopaedic skeletal anchorage. *Int J Oral Maxillofac Surg* 41:566–568
9. Cornelis MA, Scheffler NR, De Clerck HJ, Tulloch JF, Behets CN (2007) Systematic review of the experimental use of temporary skeletal anchorage devices in orthodontics. *Am J Orthod Dentofacial Orthop* 131(4):S52–S58
10. Cevidanes L, Baccetti T, Franchi L, McNamara JA, De Clerck H (2010) Comparison of two protocols for maxillary protraction: bone anchors versus face mask with rapid maxillary expansion. *Angle Orthod* 80(5):799–806
11. De Clerck H, Cevidanes L, Baccetti T (2010) Dentofacial effects of bone-anchored maxillary protraction: a controlled study of

- consecutively treated class III patients. *Am J Orthod Dentofacial Orthop* 138(5):577–581
12. Turley PK (2007) Treatment of the class III malocclusion with maxillary expansion and protraction. *Semin Orthod* 13:143–157
 13. Wang YC, Chang PM, Liou EJW (2009) Opening of circumaxillary sutures by alternate rapid maxillary expansions and constrictions. *Angle Orthod* 79(2):230–234