IDEAS AND INNOVATION

MANAGEMENT OF VERTICAL EXCESS IN BIMAXILLARY HYPOPLASIA WITH CUSTOM MADE FRONTAL HIGH-PULL HEAD GEAR

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ABSTRACT

The purpose of this case report is to introduce a custom made frontal high pull head gear for the management of Vertical excess in cases with bimaxillary Hypoplasia. The need, technique and results of phase 1 treatment relating to orthpaedic effect of frontal high pull head gear is described.

Conventional means include the use of high pull head gear during growth spurt, orthognathic surgery (for vertical dysplasia of skeletal origin) intrusion of upper buccal segments with titanium mini screws or plates. Treating this condition during growth period is a problem with existing head gears. This article reports on two cases, treated with custom made frontal high pull head gear using force of 500g per side, for six months. Results showed a significant improvement in the vertical dimension. An added advantage was an acceptable advancement of the maxilla and mandible.

Key words: *Bimaxillary hypoplasia, frontal high pull headgear, vertical excess.*

INTRODUCTION

Successful treatment of patients with vertical excess demands prudent diagnosis and careful consideration of treatment mechanics. Management of vertical excess is increasingly gaining emphasis. Amongst the diagnosis, cephalometrics plays a vital role.

Attempts to limit vertical dimension in growing patients are by one or more of the following approaches: (1) high-pull headgear[1,2,3,4] with or without a splint, (2) extraction therapy, (3) bite-blocks (passive or active), (4) vertical-pull chincup, and (5) any combination[5] thereof.

In addition to above, means employed in adult cases include NiTi intrusion arches along with anterior elastics[6], orthognathic surgery[7], the increasingly common approach comprising intrusion of the upper molars by mini implants[8] and intrusion of upper buccal segments using titanium mini plates fixed to the zygomatic buttress[9].

Head Gears may be used for anchorage purpose to hold the molars, to provide guidance to the growing jaws and distalization of molars and so the buccal segments[2, 4, 10]. When used for anchorage, 300 grams[11] of force per side may be adequate, but for orthopaedic effect minimum of 500 grams[2,11,12] per side is the optimum force required. Some investigators have even used up to 800 grams per side[12, 13]. For the distal tooth movement a minimum of 500 grams each side may be considered as optimum force[14]. Head gears provide maximum orthopaedic effect when used during the pre adolescent stage, while the patient is under going growth spurt (female 10-14 years, Male 12-16 years)[2,3]. In case of Class III malocclusion, where hypoplastic maxilla is to be advanced, head gear use must be started before closure of the facial sutures i.e. 7-8 years[12,13]. Orthopaedic effect on the mandible however can be best achieved during spurt time.

Types of head gears commonly employed are Class II and Class III head gears. Class II Head gears include high pull, low pull and combination type. High pull head gear is used to restrain prognathic and hyperplasic maxilla which is vertically excess[2,3,4]. Low pull head gear or the neck strap, on the other hand is used in Class II malocclusion where maxilla is prognathic and vertically short[2,3,4,10,14], and mandible may be normal or hypoplastic (Class II composite). Combination and Interlandi head gear is indicated for prognathic maxilla with normal growth vector[4,15]. Class III Head Gears

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(Delaire or Petit) may be used to advance hypoplastic maxilla[4,12,13] the mandible being in normal sagittal position or may be prognathic. In mild to moderately hyperplastic mandible, chin cup with high pull or straight pull head cap may be used[13].

NEED FOR THE DESIGN OF FRONTAL HIGH PULL HEAD GEAR

The conventional class II high-pull head gear distalizes the maxilla along with intrusion where as Class I sagittal relation or bimaxillary hypoplasia does not demand any further retraction of maxilla. The Class III head gear (face mask or petit) advances hypoplastic maxilla and restrains the mandible. Moreover, this head gear has a tendency to increase the vertical dimension of the mid face further as it extrudes the buccal segments as an effect of head gear force.

APPLIANCE DESIGN: Keeping in view the above mentioned factors, this new head cap is designed to meet all these requirements. The frontal high pull head gear comprises of following three parts;

Head Cap

Safety Modules

Face bow

The head cap further consists of three parts namely; Circumferential part, Mid line strap with Adjustable buttons and bilateral loops placed in the anterior region of the head to receive safety modules above the centre of resistance of the maxilla.

An Inner and outer type of face bow was used in this appliance. The inner bow of the face bow was designed to pass through the head gear tube that was placed in the premolar region of the appliance in the case 1 and through the molar head gear tube in case 2.

Outer Bow was bent at 45° to the occlusal plane (fig 2). After bending the outer bow, the inner bow was inserted in the head gear tube and a mark was then placed on the outer bow, just below the centre of resistance (premolar area). With the help of face bow pliers and laboratory pliers, distal part of the outer bow distal to the mark, was bent upward again at 45^0 to the horizontal to fabricate the terminal hook. This hook was bent laterally in inverted 'U' shape, away from the cheeks to avoid trauma.

For head gear application, the head cap of appropriate size was selected. Safety modules were then passed through the loops on both sides (fig 1). The fabricated face bow was inserted in the mouth and was so adjusted that when 500 gms of force was applied on each side, the anterior portion of the face bow lied passive within the commissure with relaxed lip posture. The patients were instructed a minimum of 12 to 15 hours per day head gear wear.

CASE 1

The patient was healthy 11 years old boy in the late mixed dentition stage. The parents were concerned about the crooked teeth and unsightly smile of their child (figs 6, 7). Interview with the parents revealed the child inherited skeletal pattern from father. Parafunctional habits were neither seen nor reported.

On extra oral examination the patient showed an increased height of the mid face with competent lips (fig 3). The face was otherwise symmetrical. On smile the gums showed both in anterior as well as buccal region (fig 6). Side view of the patient, however revealed a mildly convex profile and a high angle.

Intraorally the upper anterior segment was severely crowded with gross rotation maxillary central incisors making an anterior 'v' shaped notch. The lower anteriors were proclined and mildly crowded. Overjet was moderate because of compensation from the deficient mandible) and overbite was more or less normal. The interarch relationship of the buccal segments revealed a mild class II molar and canine relationship on both sides. The upper arch form was narrow and tapering where as the lower arch form showed a normal ovoid view.

The sagittal elements of the cephalometric analysis revealed bimaxillary hypoplasia. Both maxilla and mandible were found deficient (Table 1). The vertical analysis on the other hand determined a high angle case due to increased height of the mid face (Table 1). The patient was diagnosed as skeletal and dental class II malocclusion due to bimaxillary hypoplasia.

Treatment objectives in the upper arch were primarily expansion followed by bodily intrusion and advancement of the maxillary apical base. In the lower arch aim was space gainance, distal arch expansion and advancement of the mandibular apical base.

In the upper arch all premolars and left cuspid were in early stage of eruption. Therefore a rigid expander whether hyrax or modified expansion device could not provide stability to the appliance. Consequently, the first step expander was designed as quadhelix from 1.2mm stainless steel wire which was activated every 3 weeks. In the lower arch lip bumper was applied with acrylic shield in the labial segment.

When premolars and cuspids erupted enough to be engaged in the splinted fixed expander, modified expansion device was fabricated containing an ordinary midline screw of 7mm range (fig 8). The whole of upper dental arch was splinted with wire framework and the acrylic splint was split in the midline to facilitate expansion. This fabrication was provided with a head gear tube in the premolar region on both sides to receive inner bow of the face bow attached to the

Fig 1: Frontal hgh pull head gear assemgly (head safety modules and face bow)

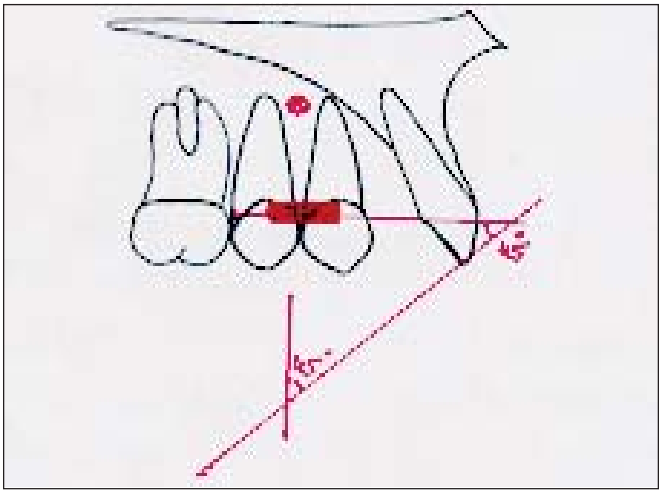

Fig 2: Face bow fabrication

Fig 3: Pretreatment front view

Fig 4: Pretreatment side view

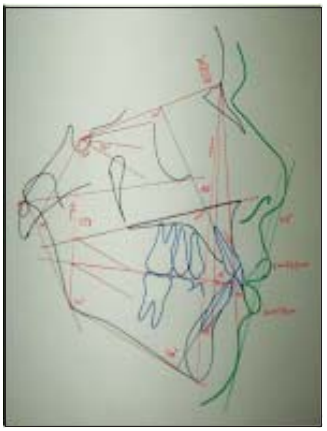

Fig 5: Pretreatment Ceph Tracing

Fig 6: Pre intra oral view

Fig 7: Pre upper occlusal view

Fig 8: Appliance in situ

Fig 9: Head gear application

Fig 10: Position of the head gear

Fig 11: Front view post phase 1

Fig 12: Post phase 1 front view

Fig 13: Post phase 1 side view

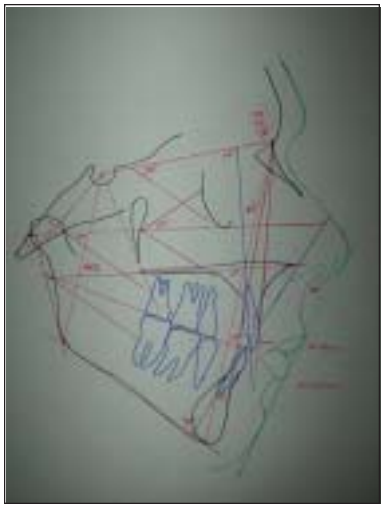

Fig 14: Post phase 1 ceph tracing

Fig 15: Pretreatment front view

Fig 16: Pretreatment side view

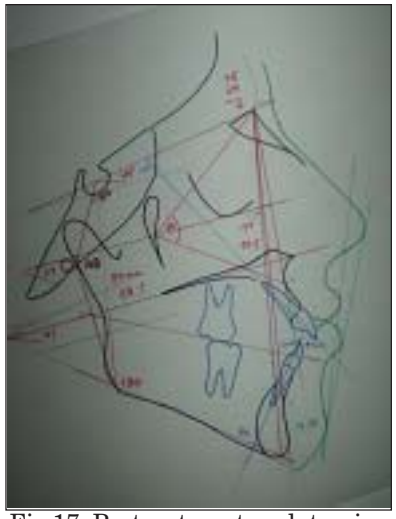

Fig 17: Pretreatment ceph tracing

Fig 18: Pretreatment right side view

Fig 19: Pretreatment front view

Fig 20: Pretreatment left side view

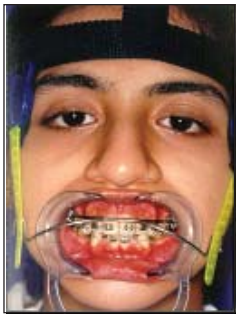

Fig 21: Head gear application

Fig 22: Position of head gear

Fig 23: Post phase 1 right side view

Fig 24: Post phase 1 front view

Fig 25: Post phase 1 left view

Fig 26: Post phase 1 front view

Fig 27: Post phase 1 side view

Fig 28: Post phase 1 ceph tracing

frontal high pull head gear. The expander was activated 4 turns (2 mornings, 2 evening) twice in a week for 3 weeks. On completion of expansion, the frontal high-pull head gear was applied (fig 9). Force applied per side was 500 gm and head gear wear was instructed a minimum of 12 – 15 hrs / day. The patient showed good compliance with the head gear wear. The duration of phase I treatment with frontal high pull head gear was six months. Side effect of the modified expansion device was observed as inflammation of the palatal mucosa.

With the use of expander, the maxillary arch changed from tapering to ovoid form. Molar and Canine relationship, however was the same as before that is Class II. On completion of first phase of treatment, there was a significant improvement in the facial proportions of this patient in all three dimensions. The transverse change resulted from expansion (figs 11, 12), whereas improvement in vertical and sagittal dimensions was the result of frontal high pull head gear (fig 13).

In order to attain results of phase I treatment, pre and post treatment cephalograms were analyzed (figs 5, 14 and table 1). A total of 25 angular and linear measurements were used in the cephalometric analysis. Cephalometric analysis determined a significant intrusion of the upper dentition. As per vertical analysis SN mandibular plane angle showed a reduction of 6° and sum of posterior angles interpreted a marked decrease of 8°. Similarly, ratio of posterior face height to total anterior face height showed an improvement of 3% and maxillary height angle recorded a reduction of 3° with the use of this head gear (Table 1). Reduction in maxillary height angle (MHA) is indicative of decrease in the height of maxilla and consequently improvement in vertical dimension of the mid face.

Sagittal analysis also showed an amazing change in horizontal relationship and position of both maxilla and mandible. Point A showed an advancement of 3° and the same was forward movement of point B (3°). Anterior movement of the chin was also confirmed from facial angle that showed a difference of 2° (Table 1).

Dental analysis showed an improvement of 5° in the axial inclination of maxillary central incisor (Table 1). The lower incisors inclination however determined a mild improvement, measuring a decrease of 2°. Improvement in the lower incisors inclination was also seen from Holdaway Ratio (Pre 8:0, Post 7:2) that shows slight up righting of the mandibular incisors and advancement of the chin. From the soft tissue analysis nasolabial angle showed a significant change of 9°.

TABLE 1: PRE AND POST TREATMENT (PHASE 1) CEPHALOMETRIC ANALYSIS

1. SKELETAL ANALYSIS

Sagittal Analysis

Variables		Pre	Post	Diff
<SNA	**Case 1**	76°	79°	3°
	Case 2	75°	78°	3°
<SNB	**Case 1**	70°	73°	3°
	Case 2	69°	74°	5°
<ANB	**Case 1**	6°	6°	0°
	Case 2	6°	4°	2°
AO-BO	**Case 1**	-3mm	0mm	+3mm
Distance	**Case 2**	6mm	4mm	2mm
FA (Facial	**Case 1**	75°	77°	2°
angle)	**Case 2**	83°	85°	2°

Vertical Analysis

<SN-MP	**Case 1**	45°	39°	-6°
	Case 2	49°	46°	-3°
Sum of	**Case 1**	405°	397°	-8°
Posterior	**Case 2**	408°	403°	-5°
Angles				
PFH:TAFH	**Case 1**	57%	60%	3%
	Case 2	58%	59.25%	1.25%
LAFH:TAFH	**Case 1**	61%	63%	2%
	Case 2	59%	57.77%	-1.23%
MHA	**Case 1**	58°	55°	-3°
	Case 2	69°	68°	-1°
FMA	**Case 1**	45°	34°	-11°
	Case 2	37°	28°	-9°

2. Dental Analysis

UI – SN	**Case 1**	100°	105°	5°
	Case 2	110°	111°	1°
UI – PP	**Case 1**	107°	108°	1°
	Case 2	115°	116°	1°
IMPA	**Case 1**	100°	98°	-2°
	Case 2	92°	95°	3°
IIA	**Case 1**	115°	119°	4°
	Case 2	110°	109°	-1°
UI – NA	**Case 1**	4mm	4mm	0mm
Distance	**Case 2**	8mm	8mm	0mm
UI – NA	**Case 1**	23°	25°	2°
Angle	**Case 2**	32°	33°	1°
LI – NB	**Case 1**	8mm	7mm	-1mm
Distance	**Case 2**	8mm	9.5mm	1.5mm
LI – NB	**Case 1**	35°	31°	-4°
Angle	**Case 2**	32°	35°	3°
Holdaway	**Case 1**	8:0	7:2	-1 : 2
Ratio	**Case 2**	8:0	9.5:0	1.5:0

3. Soft Tissue Analysis

UL to	**Case 1**	+2mm	+2mm	0mm
E Line	**Case 2**	- 4mm	-5mm	-1mm
LL to	**Case 1**	+3mm	+3mm	0mm
E Line	**Case 2**	-1mm	-1mm	0mm
UL to	**Case 1**	+4.5mm	+5mm	+0.5mm
S Line	**Case 2**	+1mm	0mm	-1mm
LL – to	**Case 1**	+5mm	+4.5mm	-0.5mm
S Line	**Case 2**	+2.5mm	+2.5mm	0mm
Nasolabial	**Case 1**	113°	104°	-9°
Angle	**Case 2**	93°	97°	4°

Aesthetic (E) line and Steiner's (S) line measurement remained more or less the same.

CASE 2

Zahra 15 years old female presented with mutilated malocclusion. Her chief complaint was an unsightly elongated face and inability of teeth to meet. As per report she had been treated with removable plates for the last about 2 to 3 years. Interview with the parents revealed her mother had a tendency towards high angle. The patient reportedly suffered from naso-respiratory disease since 7 years of age through pre adolescent stage.

Extra oral examination showed a long face with competent lips and flat mentalis. The front view showed excessive mid face height and otherwise symmetrical face (fig 15). Her profile showed a grossly high angle case (fig 16).

Intra orally she presented with complete open bite extending back to the molar region (fig 19). In the buccal segments, minor cross bite was seen in the canine and premolar region on both sides. The upper dental arch was mildly crowded with proclined incisors. The mandibular incisors showed a moderate crowding. On closure, the only teeth in occlusion were lower second molars contacting the maxillary first molar on both sides (figs 18, 20). Molar relation on both sides was class III. Same was with the canine relation on both sides. In the anterior region, open bite was -2.5 mm and over jet was 7 mm. The cephalometric analysis of this patient determined a skeletal class II relationship because of bimaxillary hypoplasia and vertical excess of the mid face (Table 1).

Treatment goals for the existing problems were to intrude upper buccal segments, de-crowd upper and lower arches and establish normal occlusal relationships.

TREATMENT PROGRESSION

In order to attain these objectives, therapeutic extractions of all first premolars were under taken and maxillary and mandibular dental arches were banded and bonded. The frontal high pull head gear was applied to intrude buccal segments, so as to correct open bite

(figs 21, 22). Force applied on each side was 500gm and the Inner bow passed through molar tubes. Strategy behind this design was to intrude upper buccal segments and consequently to improve the vertical dimension of the face. As the buccal segments, intruded, open bite was corrected to normal over bite relationship (figs 23, 24, 25). In about six month's duration, vertical dimension of the face showed a significant improvement. SN mandibular plane angle showed a decrease of 3°, the sum of post angles determined an improvement of 5°, ratio of post face height was improved to normal value where as ratio of anterior face height came to near normal value. The maxillary height angle measured a decrease of 1° (Table 1).

The sagittal analysis determined an advancement of 3° of the maxillary apical base (point A) and 5° for the mandibular apical base (point B). Before treatment both maxilla and mandible were hypoplastic (SNA 75°, SNB 69°). Six months after the use of this headgear, SNA was improved to 78° and SNB to 74° respectively. Overbite was improved from the pretreatment negative value of -2.5mm to 1.5mm. The facial angle showed an advancement of 2° where as the ANB angle improved from 6° to 4°.

DISCUSSION

Treating vertical dysplasia on deficient maxilla and mandible (bimaxillary hypoplasia) was a problem with existing head gears. Class II high pull head gear when used, inhibits forward growth of maxilla besides intrusion,[1,2,3,4] further aggravating the existing discrepancy. The use of this custom made high pull head gear not only intruded the maxilla, but also improved sagittal relationship of both maxilla and mandible by advancing their apical bases anteriorly.

In case I, Rapid palatal expansion was done using bonded modified expansion device[16] in order to expand V shaped constricted and crowded upper arch. Besides opening mid palatal suture, Rapid palatal expansion releases the surrounding sutures and contributes to protraction by moving the maxilla forwards[17,18,19]. Bonded type expander with a full coverage acrylic cap splint was used with two purposes, expansion followed by intrusion of the whole of upper dental arch, where it acted as a rigid anchorage device to with stand heavy extra oral forces. Some workers found that increasing the number of teeth in the anchorage unit would enhance the skeletal effect[13,19]. In this patient, full coverage splint was given to increase rigidity of the appliance, so as to prevent the occlusal interferences and to maximize the effect of frontal high pull head gear.

In this bonded expander the head gear tube was provided in the premolar region (fig 2). In the literature, various studies are available regarding location of the centre of resistance of the maxilla. According to Tanne[20] and Hirato[21], the centre of resistance of the maxillary dentoalveolar complex is located between the root tips of maxillary first and second premolars. Staggers[22] found that centre of resistance of the maxillary bone is located at the level of the zygomatic buttress. Hata[23], on the other hand described that the centre of resistance of the maxilla is located 5mm above the nasal floor. Keles A[12] suggested that maxilla and the maxillary dentition are two separate units and their centres of rotation are not at the same location. Since the maxillary bone is connected to the facial bones with sutures and the maxillary dentition is connected to maxillary bone with periodontal attachments, they cannot be considered as one unit and they may behave differently towards orthopaedic forces.

The point of force application in this head gear was placed below the centre of resistance of the maxillary dentoalveolar complex[20,21], at an angle of 45° degree to the occlusal plane in order to increase the momentum of force (fig 11). Extra oral force used was 500 grams preside. Siatkowski[2] quoted that if line of action of the head gear force passes close to or through the centre of resistance, 400-500g force per side can be used. Haas[17] investigated that in order to obtain orthopaedic effect, the amount of force had to exceed one pound (454gm).

The line of force passed through the centre of resistance to get bodily intrusion of the whole of upper dentition (fig 2). Attachment of the extra oral force to the head cap was above the centre of resistance, in the anterior region of the head (fig 9). This high and anterior location of the extra oral force resulted in intrusion as well as advancement of the maxilla corresponding to anteriorly directed forces. The protraction of the maxilla may partly be the effect of R. M. E. Where as the anterior movement of the mandible occurred consequent to intrusion of the maxillary dentition. As the wedging action of maxilla was removed, the mandible rotated anteriorly and moved up and forward. Profile of the patient was improved by the forward movement of the chin.

The dental changes related to case 1 showed an improvement in the axial inclination of maxillary central incisors which could be the effect of expansion appliance. The lower incisors inclination however determined a mild improvement. This may be the effect of Lip bumper that causes expansion in the premolar region, accommodating and up righting the lower incisors.

In case 2, with open bite (fig 19), where buccal segments were extruded excessively, the inner bow of the face bow was passed through the molar tube (fig 21). The outer bow however was designed in the same manner (fig 22).

In about six months' time vertical dimension of the face showed significant improvement. This decrease in the vertical dimension was mostly because of frontal high pull head gear, but extraction strategy also contributed by closing the bite due to mesial movement of buccal segments.

Moreover, banding lower second molars might also be an added factor in reducing the angle. The mandible consequently rotated anteriorly and showed a significant 5° forward movement of point B, resulting in an orthognathic profile. Correction of open bite too, may be the effect of head gear and resulted in marked improvement of over bite relationship that showed a difference from the pretreatment negative value of -2.5mm to 1.5mm.

CONCLUSION

On the basis of results attained from the use of this custom made frontal high pull head gear, following conclusions may be drawn;

It caused bodily intrusion of the upper dentition when inner bow passed through the head gear tube in the premolar region, fabricated in the rigid bonded device.

It intruded upper buccal segment when inner bow was applied in the molar region.

It advanced the maxilla, to acceptable forward position.

It advanced and rotated the mandible anteriorly in counter clockwise direction.

Further use of head gear, a minimum of 8-10 hrs/day is suggested to prevent the relapse of the result attained during phase I as well as the next phase of treatment. An active retention on completion of comprehensive treatment may also be recommended to see the long term effect of this head gear. Moreover, use of splinted hyrax is suggested instead of modified expansion device to avoid inflammation of palatal mucosa.

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