Case report

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A modified headgear for maxillary advancement in cleft lip and palate patients: Case reports

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The article presents a modified headgear designed for maxillary protraction for cleft lip and palate patients. The headgear has a simple design at affordable cost. The detailed fabrication and clinical use of modified headgear are described. Combined with fixed orthodontic appliances, two patients with unilateral cleft lip and palate were treated by this modified headgear. The personalized headgear is delivered with the use of protraction force from the headgear to the upper archwire. Cephalometric analyses were measured at pre and post modified headgear therapy. Significant maxillary advancement was demonstrated with minimal skeletal vertical changes. However, labial tipping of maxillary incisors was observed. In summary, this modified headgear is proposed as treatment option for maxillary hypoplasia with similar treatment effects as conventional facemask.

Keywords: facemask protraction, maxillary advancement, maxillary protraction, modified headgear, Reverse headgear, unilateral cleft lip and palate

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Introduction

Prevalence of cleft lip and palate is as high as 2/1,000 births in Asian population [1] compared to the US and European countries which has been reported to be 1-1.2/1,000 birth [2]. Children with unilateral or bilateral cleft lip and palate are prone to develop midface deficiency related to maxillary hypoplasia or growth retardation from lip and palatal surgical intervention. Not only children are often at risk for poor facial growth, but also suffer from dental malocclusion especially anterior crossbite and insufficient space for permanent teeth eruption. In order to correct maxillary hypoplasia, advancement of maxilla has been a treatment of choices. It is a challenging to modify growth for cleft patients. The goal of this early intervention was to achieve maxillary advancement. This intervention may simplify surgical treatment in the future [3]. There are several designs for orthopedic maxillary protraction. A tooth regulating machine, headgear anchored, and occipitomental anchorage were proposed [4]. Nelson reported optimal anchorage in the treatment of Class III malocclusion using “anterior-pull appliance”. It consisted of a helmet with a projecting mouthguard [5]. Extra-oral appliance namely reverse headgear or protraction facemask has been invented with anchorage from the frontal bone and mental area such as Delaire, Petit, Turbinger, and Grummons types [6]. Petit type of protraction facemask has grown popularity over the past decade due to

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small design and ease of use. The principle of the use of reverse headgear aims to displace maxilla anteriorly with minimal unwanted side effects; however, mandibular and dental movements are still reported [7]. Rapid maxillary expansion is frequently delivered with facemask to disarticulate maxillary sutures and enhance the amount of maxillary movement. Numerous studies demonstrated both skeletal and dental changes contribute to negative overjet correction [8-13]. A wide range of contribution was differing which may be due to variation in treatment protocols including patient's age, appliance design, treatment duration, force vector direction and magnitude. Moreover, patient compliance is a crucial factor for the success of treatment. In this article, modified headgear is described as one of the extraoral appliances to facilitate maxillary advancement. This novel appliance aims to reduce the size of device in order to receive more patient compliance. Regarding to smaller components compared to RME/Facemask, simpler materials as well as inexpensive cost of the device, cleft patients could afford this treatment.

Fabrication and biomechanical aspect of modified headgear

Modified protraction headgear could be fabricated from preformed headgear. It was made from 0.125 inches and 0.15 inches stainless steel wire for inner bow and outer bow, respectively. The adjusted inner bow was coordinated to patient's arch form. Omega loops were bent bilaterally mesial to the headgear tube of maxillary molar bands. Anteriorly, the device should allow an anterior clearance of 4-5 mm from the labial surface of maxillary incisors. Two arms of outer bow were bent outward into hooks attached the elastic protraction. The junction of inner and outer bows was laid comfortably between the upper and lower lips. Intraorally, fixed orthodontic appliances were bonded with 0.022-inch orthodontic bracket slot then the maxillary arch was levelled and aligned with stainless-steel wire progressively up to 0.018 inches in diameter. Activated loops archwire comprising two U-loops were applied distally to maxillary lateral incisors for receiving elastics. In the posterior region, another two U-loops were placed in front of the maxillary first molars and tied back to the hooks to prevent the archwire from dislodgement. When modified headgear was delivered, elastic application was attached from outer bow hooks to U-loops at distal aspects of maxillary central or lateral incisors. The direction of the traction force was oriented to produce the desired displacement of the maxilla, approximately 20° downward from occlusal plane, 300-350 grams of force (3/16", 4.5 oz) on each side. The patient was instructed to wear elastics from the anterior U-loops to the modified hooks of outer bow at least 12 hours a day. Every 4-6 weeks was scheduled for orthodontic adjustment. The treatment time of headgear wear usually lasts 10-12 months. Figure 1 demonstrated a detailed modified headgear fabrication and biomechanical aspect as well as clinical application. In addition to pulling the maxilla forward, molar derotation and distalization could be performed by adjusting two U loops of the inner bow. Hence space could be created for aligning teeth especially for ectopic eruption of premolars. During elastic traction , tip back bend of the inner bow of the headgear was needed to counteract the force that tends to tip the molars in a counterclockwise direction. Moreover, lateral expansion of upper archwire could be adjusted to achieve normal buccal overjet, if posterior crossbite occurs.

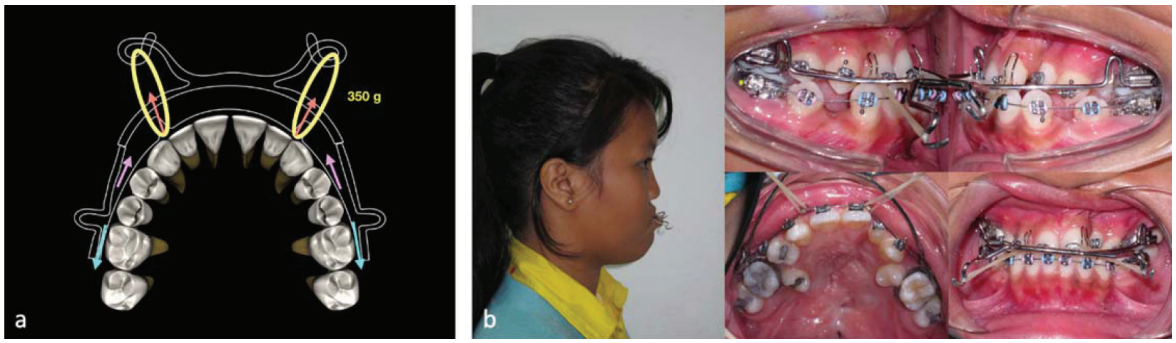


Figure 1 (a) Biomechanical aspect of modified headgear. (b) Clinical application

Clinical Outcomes

Two patients with repaired unilateral cleft lip and palate were diagnosed as mild to moderate maxillary deficiency. Patients and parents were discussed about treatment options either camouflage or surgical treatment. These patients opted to choose camouflage treatment due to risks and cost concerns of surgical treatment. The modified headgear was fabricated individually and delivered along with the full fixed appliances at the levelling stage of treatment. Table 1 demonstrated cephalometric analysis of these two patients in pre (T0) and post (T1) orthopedic treatment.

Case # 1

A 14 year 11-month-old adolescent female with repaired left unilateral cleft lip and palate presented with Class II malocclusion subdivision with anterior crossbite of 8 mm and congenital agenesis of maxillary right lateral incisor and maxillary left second premolar. Maxillary left lateral incisor was peg-shaped. Midface deficiency with concave profile and protruded lower lip were inspected. Pretreatment cephalometric analysis revealed a moderate skeletal type III with maxillary hypoplasia and hyperdivergent pattern. Maxillary incisors were proclined and mandibular incisal inclination were within normal limit. Full fixed appliances combined with modified headgear, extraction of mandibular right and left first premolars and build-up maxillary left lateral incisor were agreed to be performed for camouflage treatment. After eleven months of modified headgear wear, there was a significant forward movement of the point A (A to N perp = 5.5 mm), increased SNA (2°) with reduction of SNB angle (1°) and ANB angle (3°). Clockwise rotation of mandible was also observed. The maxillary and mandibular incisors were more proclined compared with pre orthopedic treatment values (Table 1). Class I canine and molar relationship, normal overjet and overbite were obtained. Maxillary left lateral incisor was built-up to normal tooth size achieving esthetic aspect. Soft tissue improvement was shown with lower lip profile reduction and nose revision after orthodontic treatment completion (Figure 2).

Case # 2

The patient was a 9-year 10-month premenarcheal girl with repaired left unilateral cleft lip and palate presented with midface deficiency. Skeletal type III was diagnosed as retrognathic maxilla and orthognathic mandible with normodivergent profile. Negative overjet of 4 mm, congenital agenesis maxillary left lateral incisor and ectopic eruption of maxillary left canine were noted. Non-extraction of orthodontic treatment with full fixed appliances combined with modified headgear was discussed with patient and parents.

Prosthesis of maxillary left lateral incisor was planned for dental implant when growth ceased. Cephalometric changes (Table 1) after modified headgear wear of 10 months was demonstrated. Maxillary advancement was shown. Skeletal discrepancy was reduced with ANB improvement (1.5°) and decreased Wits appraisal (3.5 mm). Class I canine and molar relationships were established with prepared space for maxillary left lateral incisor. Facial profile was significantly improved (Figure 3).

Table 1 Pre (T0) and post (T1) orthopedic cephalometric analysis of two patients.

Cephalometric parameter	Norms*	Case #1			Case #2		
		T0	T1	T1-T0	T0	T1	T1-T0
A-P skeletal relationship							
SNA (°)	84±3.6	77	79	2	75	77	2
SNB (°)	81±3.6	82	81	-1	78.5	77	-1.5
ANB (°)	3±3	-5	-2	3	-3.5	-2	1.5
Wits appraisal (mm)	-2±3.5	-7	-3	4	-7	-4.5	3.5
A to N perp (mm)	0.4±2.3	-4.5	1	5.5	-5	-3	2
Pog to N perp (mm)	-1.8±4.5	4.5	6	1.5	-1	-1.5	-0.5
Vertical skeletal relationship							
SN-MP (°)	30±5.6	36	38	2	33	33	0
FMA (°)	24±5.1	27	28	1	24	24	0
Gonial angle (°)	118±6.1	129	130	1	130	130	0
Dentoalovelar relationship							
U1 to SN (°)	108±6.1	111	122	11	100	118	18
U1 to NA (°)	22±5.9	35	42	7	26	37	11
L1 to NB (°)	30±5.6	29	32	3	11	16	5
IMPA (°)	97±6.0	90	93	3	79	85	6
U1/L1 (°)	125±8	121	105	-16	145	128	-17
Overjet (mm)	3	-8	-1	7	0	3.5	3.5
Overbite (mm)	2±1	-5	-1	4	0	0	0
Soft tissue relationship							
LL to E line (mm)	2±2	10	9	-1	7.5	4	-3.5
Nasolabial angle (°)	91±8	47	40	-7	103	110	7

T0 – Pre modified headgear

T1 – Post modified headgear

*Thai cephalometric Norm. [14, 15]

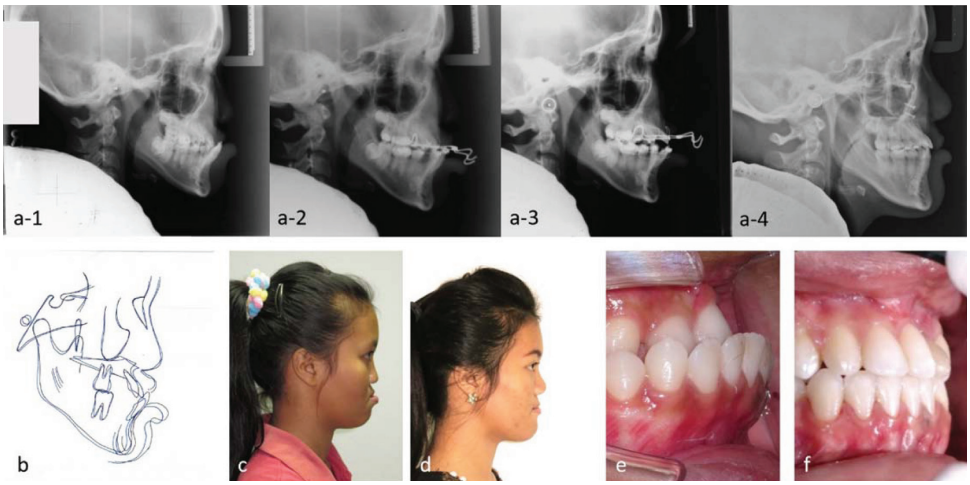


Figure 2 Case #1 (a-1) pretreatment (a-2) pre modified headgear (a-3) post modified headgear (a-4) posttreatment lateral cephalograms (b) superimposition (black: pre modified headgear; blue: post modified headgear) (c) pretreatment extraoral photograph (d) posttreatment extraoral photograph (e) pretreatment intraoral photograph (f) posttreatment intraoral photograph

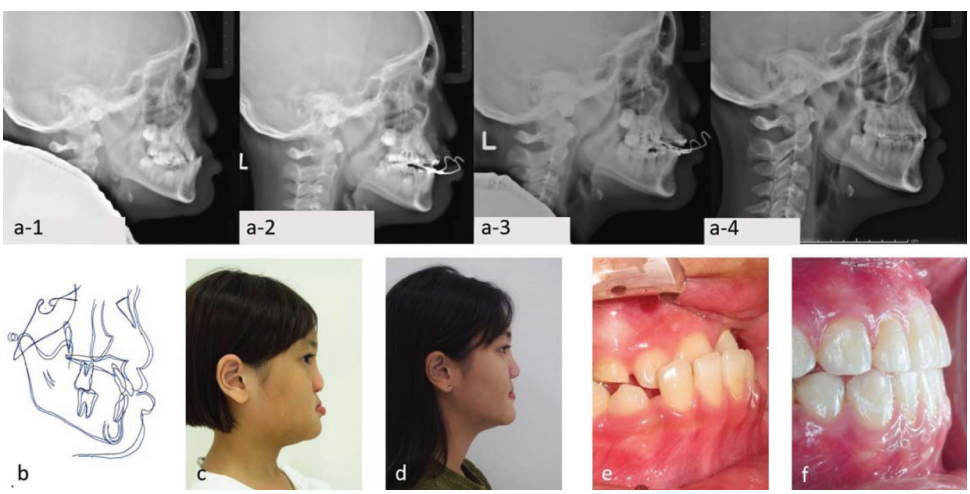


Figure 3 Case #2 (a-1) pretreatment (a-2) pre modified headgear (a-3) post modified headgear (a-4) posttreatment lateral cephalograms (b) superimposition (black: pre modified headgear; blue: post modified headgear) (c) pretreatment extraoral photograph (d) posttreatment extraoral photograph (e) pretreatment intraoral photograph (f) posttreatment intraoral photograph

Discussion

The results after use of modified headgear demonstrated desirable response to maxillary advancement. The amount of increased SNA and A to N-perp in both cases were found similar to comparative data of preadolescents with unilateral cleft lip and palate treated with conventional protraction facemask. Buschang et.al., summarized that maxilla was protracted approximately 2-3 mm or 0.6°-2° after facemask treatment [16]. Likewise, SNA was increased 1.50°±1.32°as reported by Jia, Li and Lin [17]. As the potential for normal anterior displacement is limited in cleft lip and palate patients, it may imply that forward displacement of maxilla from

protraction force tends to overcome maxillary retrusion. The clockwise rotation of mandible often found as an unwanted side effect of facemask treatment especially in hyperdivergent pattern due to force applied to chin cup [18, 19]. However, mandibular rotation may contribute to reduce skeletal discrepancy in hypodivergent type. Some claimed that the effect of reverse headgear was mainly backward rotation of the mandible rather than maxillary advancement [20, 21]. Up to 61% contribution of mandibular rotation was reported in treatment of unilateral cleft lip and palate patients with reverse headgear [17]; therefore, protraction facemask should be used with caution in vertically growing patients. Unlike protraction facemask, there is no chin pad component in this modified headgear, vertical dimension is then separately controlled by fixed appliance mechanics. Increase in SNA, reduction of Wits appraisal and ANB with minimal changes in vertical dimension (SN-MP, FMA, Gonial angle) were shown in cases using modified headgear.

Regarding to movement of dentition, proclination of maxillary incisors were demonstrated. Kim et al. [22] reported in noncleft Class III subjects that maxillary incisor angulation was shown greater proclination in the nonexpansion compared to the palatal expansion group (2.81°). Similarly, the amount of proclination in these reported cases using modified headgear was more than cases with conventional facemask adjunct to Hyrax expansion [17]. The use of light wires may affect incisal inclination due to large play in the bracket slot. Hence, the incisal inclination should be effectively controlled for ideal inclination during full fixed appliance treatment.

A meta-analysis of the effectiveness of protraction facemask therapy in noncleft patients revealed the mean magnitude of protraction was less in the nonexpansion group using longer treatment duration [22]. Recently, optimal force for maxillary protraction facemask was reported in a systematic review. Yepes, et al. [23] summarized that 300-400 g of force produced similar effects compared to those produced by greater forces (500 g and higher). Therefore, light to medium force for protraction was used in this modified headgear with increase in treatment duration.

Although mean value changes of cephalometric measurements in younger group (aged 4-10 years old) were greater than the older group (aged 10-15 years old) but difference is insignificant [22]. Previous studies disagreed with more skeletal movement than dental movement in older age group [10-12]. This connoted that age may not affect the treatment efficacy.

Moreover, improvement of occlusal relationship and facial esthetics of post protraction is beneficial to patients in gaining psychosocial acceptance. Social-emotional well-being are reported to decrease their oral health-related quality of life [24]. Young children with orofacial clefts have less negative social-emotion than in older group (aged 15-18 years old) [25]. If improvement of facial appearance can be performed at early stage of life, positive societal perception will increase self-confidence in cleft patients. According to the result of modified protraction headgear treatment, this appliance could be one of treatment options for patients with cost-effectiveness. However, more cases and long-term outcomes should be conducted to objectively substantiate effects of the modified headgear and compare this technique to other alternative treatments.

Conclusion

1. The modified protraction headgear produces effective treatment outcome of skeletal and dentoalveolar changes especially significant maxillary anterior movement with minimal vertical changes.

2. As simple design and construction of the modified headgear, it could be a viable treatment

modality for cleft lip and palate patients with mild to moderate maxillary retrusion.

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