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Consideration of Facial Growth and Oral Function with the Use of High Pull Headgear

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INTRODUCTION

A case using high pull headgear (HPHG) with the adjunct of pre-adjusted bracket system is presented. The patient was a boy of 11 years of age who requested for correction of upper incisor protrusion and deep bite. Clinicians found in patient that all permanent teeth except third molars were erupted, the skeletal maturation and growth was not yet to reach the spurt, the mandible remained in a retruded position and its active growth had not presented at initiation of treatment. The purpose of this report is to demonstrate possible influence of facial growth and alterations of oral function upon the treatment outcome. The concept of this treatment decision will be discussed on the aspects of guidance of mandible growth, biomechanics of light force and effects on the oral function.

Case Report

High pull headgear with face bow has been a popular treatment modality for upper first molars distalization and anchorage enhancement. It can effectively inhibit the eruption of upper molars, enhance condylar growth to contribute a forward movement of the mandible and further improve the bite and lip incompetence. The compliance from patients is particularly important for favorable treatment outcome.

The patient was an 11-year-old boy with features of Class II division 1 malocclusion. Patient’s growth spurt seemed to be continued in the recent year. Lip biting and thumb sucking habits were suspected as the causes of patient’s malocclusion. A combination of anterior bite turbo, which is a convenient alternative for a bite plate, pre-adjusted appliances and high pull headgear were applied. Lip training exercise was equally indispensable. Steady occlusion was achieved. Soft tissue profile improvement and oral function recovery were also satisfactory. (Taiwanese Journal of Orthodontics. 30(2): 114-127, 2018)

Keywords: growth spurt; oral function; pre-adjusted appliances; high pull headgear (HPHG); anterior bite turbo.
CASE REPORT

The patient had a convex facial profile with incompetent lip posture and retruded chin. He did not have gummy smile with correlated dental midline with his facial midline (Figure 1 and 2). The overbite was 5 mm and the overjet was 10 mm. The canine and molar relationships were Class II in both sides (Figure 2 and 3). Upper and lower dental arches were taper in shape with mild crowding. Upper central incisors were both procumbent and prone to get hurt from trauma with previous enamel fracture on patient’s right central incisor (Figure 3). The time of tooth injury could not be recalled and any history of treatment of both teeth was denied.

Figure 1. The patient had his first orthodontic records at age of 11 years and 2 months. Protrusive upper lip, retrusive lower lip, lip incompetence and no gummy smile were revealed. He had convex profile, with retruded chin and deep mentolabial sulcus. His facial appearance and malocclusions might attribute to lip biting and thumb sucking habits.

Figure 2. Deep impinging overbite about 5 mm and an excessive overjet up to 10 mm can be observed. The upper and lower dental midlines were correlated. V-shaped dental arches were noted.

Figure 3. The molar relation presented bilateral Class II relationship in the study models. The curve of Spee was measured as 5 mm in depth.
The presence of third molar tooth germs except #38 was found in patient’s initial panoramic radiograph. The root of patient’s lower left canine was long but the apex was open (Figure 4). Patient’s dental age obviously was ahead of his skeletal age. The cervical vertebrae maturation (CVM) stage which was judged from lateral cephalogram suggested that the patient still had some growth potential before his puberty. There were no pathological findings of temporomandibular joints after TMD evaluation. There was no facial asymmetry as indicated in PA cephalometric examination.

The measurements of lateral cephalometric analysis were listed in Table 1. Most of patients’ skeletal measurements were found within in normal range, including SNA, SNB, ANB. The abnormalities in dental and soft tissues consisted of proclined upper incisor and protrusive upper lip. These features should be recognized since their potential to impair the oral function.

**DIAGNOSIS**

The above data indicated that this patient had Angle’s Class II division 1 malocclusion and skeletal Class I relation. Other important features included lip incompetence, thumb sucking in young ages, lip biting, protrusive upper incisors, deep bite, retruded but good size mandible and excessive curve of Spee.

![Figure 4. The upper incisors were distinctly labial inclined in lateral cephalometric radiograph and no facial asymmetry was disclosed by the PA head film. The root apices of lower left canine (circled) were found open in the panoramic X-ray; this could be one of the useful indicators and references in assessing patient’s skeletal maturation.](image)
TREATMENT OBJECTIVE AND PLAN

The treatment objectives are: (1) to achieve stable occlusion with Class I canine and molar relationships; (2) to restore optimal overjet and overbite, correct lip habits, improve unbalanced perioral muscles and facial profile, and gain self-esteem.

The treatment plan includes: (1) to restrain upper first molar from eruption by HPHG; (2) non-extraction therapy with arch form expansion by archwires; (3) use anterior bite turbo to facilitate an increase of posterior facial height via lower molar eruption; (4) exercise on lip training to improve the oral functional.

The working plan included:
1. Full mouth bonding with fixed pre-adjusted system of .022-inch x .028-inch OPA-K brackets.
2. HPHG that contains safety release modules was used to prevent accidental facial injury from extra force. The force level type of HPHG was approximately 300 grams. The force of the headgear was directed through the root trifurcation of the upper molars to prevent tipping movement. Two millimeter expansion of inner bow is required, patient was able to insert the inner bow into the buccal tube easily by gently squeezing the inner bow. The outer bow should be adjusted at least 2 to 3 mm away from the cheeks.
3. The anterior bite turbo was bonded on the lingual surface of each maxillary incisor.

TREATMENT PROGRESS

1. Leveling of teeth was started from the upper dentition (Figure 5). Anterior bite turbos on the upper central incisors were bonded and initiated the lip-training instruction. Anterior bite turbo can serve as a tiny guiding bite plane for lower incisors to come forward and rest on them. The mesial rotation of upper first molars was corrected by leveling.
2. Arch-wire expansion to correct upper arch form was performed. As shown in Figure 5, the space obtained from expansion and molar distalization allowed alignment of premolars and the retraction of upper anterior teeth.

Figure 5. Reshaping of arch form started with round arch wires at upper arch. First order bends (arrows) were added between lateral incisors and canines on the .016-inch stainless steel wires to prevent incisor flaring. The dental arch was expanded to oval shape and the teeth were also leveled. These procedures resulted in the decrease of incisor protrusion. The mesial-in rotated first molars were corrected at this stage and ready for face bow insertion of HPHG. Anterior bite turbo can serve as guide plane for lower incisors to come forward and seat on. The deep bite was instantly reduced to 2-3 mm.
3. Keep monitoring the body height and weight of the patient in every two months since patient’s first visit. The record indicated continuous increase in the first year and the increments gradually slowed down in the second year of treatment.

4. Leveled of the lower dentition except lower 2nd molars with a round archwire. The reduction the depth of curve of Spee and the dental space in the lower dentition was noted in Figure 6.

5. In the 4th month, banding the teeth 16 and 26 with triple-tube to incorporate with the facebow of HPHG were performed. This patient was instructed to wear HPHG 8-10 hours per day while at home or rest.

6. Applied the intermaxillary elastics in the premolar region to enhance the eruption of lower posterior teeth and level the curve of Spee.

7. Class I canine and molar relationships with optimal overjet and overbite were obtained after space closure. The continuation of HPHG at this time was served as a passive anchorage for sagittal and vertical control.

8. Consolidated the occlusion for few more months to monitor the change of facial growth (Figure 7). Apical orifice closure of lower left canine root was revealed in routine panoramic X-ray film (Figure 8). The increment of mandible growth slowed at the end of treatment while the ultimate mandibular size was adequate. Patient was encouraged to continue doing lip training exercise and wearing HPHG at night at later stage of treatment.

9. After debonding, the retention included upper Hawley retainer with a resin bite ramp from canine to canine on the palatal plate, and the lower conventional retainer. Full time wearing was requested in the first 3-6 months (Figure 9, 10).

10. The treatment results were regularly followed in 3-month interval for checking the oral function and occlusion of the patient.

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**Figure 6.** Using .016-inch NiTi round wire placed underneath the brackets of lower premolars and above the slot of incisors. Lower curve of Spee was leveled.

**Figure 7.** After more than 6 months of HPHG wear, canine and molar were both closer to Class I relationship. Short class II vertical elastics were used to encourage eruption of lower posterior teeth and to enhance the leveling of curve of Spee.
Figure 8. Panoramic X-rays were checked periodically to monitor the distal movement of upper posterior teeth while HPHG using. The traction force should be reduced if teeth 15 and 25 both shown distal tipping of their crowns (arrows). The bracket position of these teeth should also be readjusted in order to pursue a bodily distal movement. Note that lower left canine (circled) had a completely closed root apex suggesting the ending of the pubertal growth period.

Figure 9. Before bite turbo removal, patient was instructed to keep on his lip training exercise and wear HPHG at night for at least 6 more months. His facial profile change was remarkable which uplifted the corporation of our patient further.
Figure 10. Finish photos show noticeable nasal growth. The soft tissue profile has been markedly improved with increased lip thickness. The lip incompetence was no more observed. With optimal overjet and overbite, well aligned second molars, good dental occlusion, beautiful smile and functional efficacy were accomplished. Closed root apices were found in all teeth in the panoramic radiograph. Total treatment duration was 3 years 6 months.

Figure 11. Those records were taken two years after active orthodontic treatment. Patient got a stable occlusion at his early adulthood but discoloration of tooth 21 was found. Endodontic therapy was done after confirmation of pulp death. His body height had stopped at this time.
TREATMENT RESULTS

The growth of the maxilla was effectively controlled by the HPHG. Concomitantly, the mandible was no longer impeded, lower posterior tooth eruption caught up and accommodated well with the upper dentition. The coordination of patient’s growth spurt with the therapy was also satisfactory. Steady occlusion was maintained in the two-year follow up records (Figure 11). The profile change was remarkable as seen in Figure 12.

**Figure 12.** Patient’s profile change in serial photographs.

**Figure 13.** Cephalometric tracings of pre-treatment, after-treatment and follow up head films were superimposed.
Yang SC, Su MJ, Tsang YY, Tsai HM

Table 1. Summary of serial cephalometric measurements.

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Cephalometric tracings of before and after treatment were superimposed to indicate the changes of skeletal, dental components and soft tissue profile (Figure 13).

Treatment changes were mainly dental effect. Interincisal angle was reduced to normal, i.e. 122°. The change in L1-MP during treatment was limited. Most of the cephalometric measurements in the two-year follow up remained unchanged including the L1-MP (Table 1).

**DISCUSSION**

(I) **Timing of the treatment**

Early intervention of orthodontic treatment has some advantages of facial profile improvement, better self-esteem and avoidance of incisor trauma, while most reports pointed out that the management of retrusive mandible, excessive overjet and overbite could be deferred to late mixed dentition or during adolescence. The treatment could enhance sufficiently remaining growth of the mandible and minimize the need of premolar extractions and shorten the treatment duration (Jang et al, 2005; Koroluk et al, 2003).

This patient received treatment before 13 years of age with good attitude and compliance. By regularly monitor his physical growth, the patient had a remarkable physical growth in the first year of the therapy. This
patient’s compliance as well as the favorable growth pattern and amount contributed to the good outcome of treatment.

The observation of CVM and closure of root apices of permanent teeth were adapted as the references to assess the status of skeletal maturation and pubertal growth spurt (Demirjian et al, 1973; Issa et al, 2017).3, 4 His lower left canine was noted with open root apex at initiation, and closure of the same tooth was observed about one and half years later (Figure 4 and 8). The skeletal maturational stage of the patient was confirmed as CVM II at initiation and later to CVM III at finish of treatment.

(II) Choosing high pull headgear over other treatment modalities

The treatment modalities in growing patients with Class II division 1 malocclusion could be a good choice from various types of functional appliances, cervical pull or high-pull headgear, and Class II intermaxillary traction with or without premolars extraction. Those approaches were all effective in improving patients’ soft tissue profile and occlusion.5, 7 The functional appliances without the aid of pre-adjusted brackets may lead to unprecise inclination and torque control in finishing. Functional appliances were less preferable on permanent dentition. The intermaxillary Class II elastic tractions could increase lower incisor flaring and lower molar extrusion. Cervical headgear was reported by tipping in the upper molars and opening the bite; thus, compromise the stability of the corrected dentition.8

HPHG therapy worked mainly on the restriction of dentoalveolar growth of upper first molars while the lower teeth and the growth of the maxilla were not affected.8 In contrast, the effect on lower incisor proclination was often seen in the functional appliances.9, 10 The combined use of the HPHG with functional appliances such as Teuscher appliance, which was equipped with torque springs on the upper anteriors and capping on the lower incisors did show better control on the lower dentitions.11 In this case, pre-adjusted bracket system could ensure proper inclination and torque of the front teeth.

The main shortcoming of HPHG is its dependence on patient’s compliance. The improvement of soft tissue profile can give patient incentives to follow the instructions. Nowadays, TADs could provide similar effects as HPHG by intrusion of upper posterior teeth and distal movement of upper dentition. The patient preferred to actively participate the treatment by a traditional headgear.

The side effect dealing with the use of HPHG included the impaction of upper second and third molars or misalignment of these teeth,6 thus, heavy traction force should be avoided. Clinicians have to paid attention to the reports about injury to the face, eyes and mouth,12 and possibility of aggravating the tempomandibular joint dysfunction with HPHG.13

(III) Effect of light force and overbite correction

The requirement for the upper molar movement in this case was only to restrain the forward and downward development. The application of light force was adequate for this aim. The retraction of the proclined upper incisor and the angulation was mainly achieved by arch expansion and molar distalization.

Schudy and White indicated that the vertical development of the molars was correlated the horizontal position of the chin.14 HPHG appears to provide good vertical control in growing individuals. Retardation of the eruption in upper molar will permit more lower molar eruption and increase in the posterior facial height and ramus length; thus, the counterclockwise mandibular rotation would help to maintain the anterior facial height.

After using HPHG for more than 6 months, the forward chin position caused the ANB angle reduction and improving the soft tissue profile. Mesial movement of the mandibular molars in small amount was also found. This observation was compatible with normal growth of the mandible in untreated samples.15
Schudy indicated that when the upper incisors angulation was corrected with a normal interincisal angle, the lower incisors usually had acceptable angulations related to the occlusal plane and to NB. This case had these measurements within normal range.

(IV) Soft tissue growth and change of oral function

Ghafari et al found the effect of HG that both intercanine and intermolar dimensions increased and suggested that the inner bow of headgear might have a shielding effect on the lip and cheek, thus, it could decrease the influence of buccal musculature on tooth position. To some extent, patient’s lip training exercise was also expected to improve patient’s oral muscle function (Figure 14). The patient appreciated the anterior bite turbo in patient’s lip training exercise. This device is not bulky to bother the tongue or speech while disarticulate the bite. Relative intrusion rather than true incisor intrusion was expected.

(V) Growth and functional considerations for arch dimensional changes

Dental arch preparation at initial stage was suggested in different reports for various purposes. Kondo (2008) carried out upper arch expansion before tongue lift training with a removable expansion plate but not for headgear wearing, whereas Nielsen (2017) started the arch preparation prior to the functional appliance which blended with an outer bow of headgear. Reshaping of narrowed arch form was required in this case for two concerns: First, was to secure the space for upper incisor retraction in order to have complete correction of the overjet; Second, was to adapt with the rapid growth of the condylar cartilage with the surrounding soft tissues including the nose, lips, and muscles that involved in oral function operation.

Studies on growth of the nose, lip length and thickness, arch width and intercanine and intermolar width by Sharma et al had suggested that most of these measurements increased between ages 8 to 13 and decreased afterward. Growth of these structures largely attributed from the burst demand of oral and nasal functions.

The change in shape of arch form could also provide room for free tongue movement and open airway for proper nasal breathing. The patient had 5 mm increase in
intermolar width of maxillary arch after treatment (Figure 15). However, it is difficult to differentiate whether the changes came from natural growth or the orthodontic force.

It was speculated that the increase of intermolar width in this patient was partially from the growth and partially from the therapy. Bishara et al studied arch width changes related to age and reported an increase of 2.2 mm in average between 8 to 13 years of age in boys. Similar results were also appeared in nasal, lip length and thickness and other facial structures. It seems that age around 13 years old could be a turning point, orthodontic intervention during this period could usually achieve favorable results due to extensive local growth.

To summarize this case report, small amount of distalization of upper dentition can be achieved by using high pull headgear. Arch wire expansion to reshape the V shaped arch form also helped in the correction of upper incisor proclination.

Only in growing patient, high pull headgear is effective to induce the forward movement of the mandible without flaring the lower dentition, thus further helped in overbite and overjet improvement.

Figure 15. Comparison of measurement on study models before and after treatment. It demonstrated that upper intercanine width increased 3 mm, while upper intermolar width was 5 mm more. The arch perimeter in the upper arch gained 3 mm whereas arch depth had 4 mm reduced. On the lower arch, intercanine width and intermolar width increased by 1 mm and 3.5 mm respectively. The arch perimeter and arch depth in the lower arch were maintained.
Bite turbo is a good choice to replace the traditional usage of bite plate, this adjunction of pre-adjusted appliance worked out well with oral muscle training exercise.

With controllable light force, simple technique, easy to follow mechanics and no impediment to second and third molar eruption, the HPHG was the choice in this case and has offered satisfactory result.

CONCLUSION

Creating a proper alignment of teeth is merely part of the challenge; fail to acknowledge the growth and soft tissue functional balance would achieve ineffective treatment results and endanger the occlusal stability.

REFERENCE

7. Maetevorakul S and Vitep S. Factors influencing soft tissue profile changes following orthodontic treatment in patients with Class II Division I malocclusion. Prog Orthod 2016; 17: 13-20
14. Schudy FF and White LW. JCO interviews: Fred F. Schudy, DDS, on the Vertical Dimension. JCO online 1992, August
