

# Different Treatment Modalities of Maxillary Protraction in Cleft Lip and Palate Patients: A Literature Review

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**Abstract** Cleft lip and palate is the most common cranio-facial defect with patients displaying unfavorable growth pattern of the cranio-facial complex. When such a deficiency in growing subjects, is left untreated, can lead to severe functional, aesthetic, breathing and psychological problems. To treat patients with cleft lip and palate, early orthopedic correction is considered to be advantageous. This can be applied through a tooth-anchored protraction facemask, bone-anchored protraction facemask or even the application of direct force via intra-oral inter-maxillary elastics anchored in mini-plates between the maxilla and the mandible.

**Keywords:** maxillary protraction, cleft lip, cleft palate, class iii malocclusion, bone anchored, facemask

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## 1. Introduction

Cleft lip and palate is the most common cranio-facial defect with an estimated mean global prevalence of 1.25/1000 live births [1]. More than 200 genetic syndromes have been identified with cleft lip, with or without the palate, while the cleft palate has been linked to more than 400 disorders [2,3]. The etiology of cleft lip and palate is multifactorial, with both environmental and genetic factors involved [4,5,6]. Most patients with a complete cleft lip and palate have an unfavorable growth pattern of the cranio-facial complex [7]. Maxillary growth is often compromised due to the restrictive forces from early lip and palate repair [8], resulting in discrepancies in the anteroposterior and transverse relationships and a Class III skeletal pattern [9]. There is a varying degree of underdevelopment of the maxilla at the anteroposterior level which is evident in younger ages and progressively increases [10,11]. A study showed that the maxillary anteroposterior position decreases on average by 5.4 from 5 to 18 years of age [12]. When such a deficiency in growing subjects is left untreated, it can lead to severe functional, aesthetic, breathing, speech, and psychological problems [13]. A critical factor that should be taken into consideration is the severity and extent of cleft and Class III malocclusion, as both vary significantly amongst cleft lip and palate patients. This could potentially influence the outcome of the treatment [7]. The GOSLON index is a clinical tool that allows categorization of dental arch relationship in patients with unilateral cleft lip and palate, with scores from 1 to 5.4. Scores 1 and 2 represent, respectively, excellent and good dental arch relationships, requiring straight forward or no orthodontic treatment;

score 3 describes a fair dental relationship, requiring a more complex orthodontic treatment, such as maxillary expansion and protraction to compensate for the sagittal and transversal discrepancies; and scores 4 and 5 show poor dental arch relationships and often need orthognathic surgery correction [8]. To treat patients with cleft lip and palate, early orthopedic correction is considered to be advantageous. Hence, early maxillary protraction with extra-oral forces applied through a facemask has been performed to improve maxillary position [14,15]. Other methods include bone-anchored facemask or even the application of direct force via ankylosed primary canines and functional appliances [16]. Lastly, mini-plates and mini-implants have also been used recently in order to provide the necessary orthopedic correction [17].

## 2. Tooth Anchored Protraction Facemask

For years, the most common orthopedic treatment for a maxillary deficiency in patients with complete cleft lip and palate with a mild discrepancy was facemask treatment with or without rapid maxillary expansion [8]. In almost all the studies reviewed, despite the different ages of treated patients, type of expansion appliance, amount and direction of forces, duration of daily use, and treatment length, they show that the use of facemask for maxillary protraction in cleft lip and palate patients is very effective [7,18,19,20]. 7, with the anterior movement of the maxilla range from 1.0 to 4.0 mm, while the Sella-Nasion-A (SNA) angle increased by 1.0–2.0 degrees [21]. Other studies also showed an average of 2 mm of forward movement of the maxilla and downward and backward rotation of the mandible after 1 year of facemask treatment [22,23]. The facemask treatment is

most effective in a hypo-divergent growth pattern. Downward and forward movement of the maxilla, an increase in overjet, and a backward rotation of the mandible with increased anterior facial height have all been documented with facemask treatment [21]. Moreover, concerning force magnitude, direction, and duration for maxillary protraction facemask treatment, the evidence indicates the following parameters: 180–800 g force per side; force vector direction between 20 and 30 degrees below the occlusal plane or parallel to the occlusal plane; and duration from 10 to 24 hours of use per day [24]. Additionally, facemask wear heavily depends on patient compliance and is usually limited to 12–14 h/day due to the social barrier [25].

Early treatment with a facemask creates a better basis for conventional orthodontic treatment during the permanent dentition period, ideally eliminating or reducing severe skeletal discrepancies. As far as patients' age is concerned, the best treatment timing for facemask treatment is when the patient is in the deciduous or early mixed dentition period, more favorable outcomes might be expected than in late mixed dentition [7,21]. When considering chronological age, several studies stated that facemask treatment is more effective before the age of 10 [20,26]. On the contrary, when treatment is started late when the patient is 9 years or older, the Sella-Nasion-A angle, showed little or no change [21].

The addition of rapid maxillary expansion to disrupt the circum-maxillary sutural system enhanced the effect of the orthopedic facemask treatment and initiated downward and forward movement of the maxillary complex. Less dental compensations are demonstrated when a facemask is used in combination with a Hybrid Hyrax, a rapid palatal expansion appliance which is both tooth- and bone-borne [27]. The Alternate Rapid Maxillary Expansions and Constrictions protocol (Alt-RAMEC) that was proposed by Liou et al. [28,29,30] showed favorable results in maxillary advancement.

In cleft lip and palate patients with Goslon rating of 4 and 5, greater amounts of maxillary protrusion are required, but since the facemask appliance is anchored in the teeth, orthopedic force is not transferred directly to the circum-maxillary sutures but directly or partially on the dentition, this leads to multiple side effects including dental compensations with proclination of the maxillary incisors and retroclination of the mandibular incisors. It also causes an increase in facial vertical dimension due to extrusion of the maxillary molars, counter-clockwise rotation of the palatal plane, and eventual clockwise rotation of the mandible with downward and backward movement of the chin. The reaction forces delivered by the chincup of the facemask also contribute to this effect [31,32]. To minimize the effect of a counter-clockwise rotation of the maxilla with the facemask treatment, the force was applied from the canine area rather than the molar area and at an angle of 30 degrees downward from the occlusal plane [21].

### 3. Bone Anchored Protraction Facemask

Over the past decade, new treatment protocols have been proposed to substitute conventional dental

anchorage for maxillary protraction with a facemask in patients with clefts by using bone anchorage via mini-plates [8].

Some of the investigators claimed that the infra-zygomatic area could transfer the orthopedic force more effectively to the sutures than the lateral nasal wall and cause a slight tendency for counter-clockwise rotation of the naso-maxillary complex. In contrast, some of them suggest that the lateral nasal wall might be favorable to minimize the counter-clockwise rotation of the maxilla and the lateral nasal wall of the maxilla might be a proper site for mini-plate placement because it is anterior to the center of resistance of the naso-maxillary complex, allowing the force vector to be near the center of resistance. Therefore, changing the force application point to a more forward position and the force vector to a more downward direction might be recommended to minimize the unwanted counter-clockwise rotation tendency of the naso-maxillary complex [21].

A study compared bone-anchored and tooth-anchored facemask, they found that in all cases, there was significant forward displacement of the point A. Side effects such as proclination of the upper incisors, extrusion of the upper molars and clockwise rotations of the mandibular plane, were considered minimal in bone anchored facemask relative to that usually observed with conventional protraction facemask with tooth-borne anchorage [33].

### 4. Bone Anchored Maxillary Protraction

Bone-anchored maxillary protraction (BAMP) has been described by De Clerck et al. It is an alternative treatment modality that applies bone-borne orthopedic forces through intra-oral inter-maxillary elastics anchored in mini-plates between the maxilla and the mandible, thereby minimizing dentoalveolar compensations. This treatment stimulates more forward growth of the maxilla by opening the palato-maxillary suture and zygomatico-maxillary suture [17].

It can be started in the late mixed or early permanent dentition [34]. 11 to 12 years is the optimum age to start the treatment, which is considered an advantage as the time of active growth is decreased after treatment and continuous orthodontic treatment is ensured when the treatment has started by then [13,32]. The treatment duration ranges from 7.9 to 18 months [13].

Several studies have shown marked skeletal changes after BAMP treatment in Class III patients without oral clefts, with an average of 4 mm of maxillary protraction and an increase in the SNA angle of 4.5° to 7°, they also reported a slight decreases in the mandibular plane angle and the gonial angle. In addition, a slight posterior displacement of posterior ramus, condyles, and chin was observed associated with the posterior remodeling of the glenoid fossae [17,34,35]. Even though BAMP treatment showed impressive results in patients without clefts, the success of this treatment on patients with clefts was debatable, since their maxillary growth is under negative influences from the fibrous scar tissues [8].

Recent studies have reported favorable outcomes on bone-anchored maxillary protraction treatment in growing

cleft lip and palate patients with Class III malocclusion. Improvement was observed in facial aesthetics and convexity. Orthopedic changes were most significant at the zygomatic regions in a forward and outward direction, and at the maxillary complex in a forward direction. Sagittally, forward displacement of A point and limited forward displacement of B point contributed to the less concave profile and improvement of the Class III malocclusion [8,25,31,32]. Large variations were found regarding the effect of the treatment on individual subjects. For instance, the displacement of A-point has been observed to range from 0.8 mm to 6.5 mm. This could be due to zygomatic suture maturation, with more favorable outcomes reported for patients at an early stage of maturation [13,36]. In the vertical dimension, anterior rotation of the mandibular plane angle was observed. These changes can be explained by the significant gonial angle closure. Additionally, other vertical angular measurements, such as maxillary/mandibular plane angle and occlusal plane angle, showed a tendency for a greater decrease. The backward and upward force vector of Class III elastics applied to the anterior region of the mandibular body can explain the gonial angle closure. This light compression force applied by the elastics results in remodeling of the condylar head and fossa, which reduces the gonial angle producing an effect of the mandible moving “backward” and “counter-clockwise” [13,31,32]. The gonial angle closure is not a clinical concern in patients with UCLP considering their predominant vertical growth pattern [32].

The difference in long-term results and stability of facemask and BAMP treatment modalities remain debatable in cleft lip and palate patients [25]. Strain from scar tissues in the lip and palate is not eliminated by the orthopedic treatment, hindering the sagittal maxillary growth until the end of growth [32]. Some studies reported the potential to avoid orthognathic surgery. In others, maxillary protraction effect might have decreased the amount of surgical maxillary advancement that will be needed after growth [25]. The long-term stability of both treatments should be studied in the future.

## 5. Conclusion

It can be concluded that even though all modalities induced maxillary sagittal growth, BAMP might have a promising effect as an alternative for face mask therapy in maxillary protraction of cleft lip and palate patients, with minimized dentoalveolar compensations and backward rotation of the mandible.

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