

# A Review of Orthodontic Considerations before and after Alveolar Bone Grafting in Patients with Cleft Lip and Palate

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## ABSTRACT

There are many factors to consider regarding the orthodontic treatment of an individual with cleft lip and palate in relation to the alveolar bone graft procedure. Some of these are: the sequence and timing of treatment, indications for pre-graft orthodontics, the appropriate appliances that should be used, and considerations in post-graft orthodontics. A review of some of the current concepts, management, and protocols are described.

*Keywords: cleft lip and palate, bone graft, orthodontics, pre-graft orthodontic treatment, post-graft orthodontic treatment*

## INTRODUCTION

The complete cleft lip and palate includes the alveolar ridge thus creating separate maxillary segments. An alveolar bone graft is required in order to establish continuity of the arch, provide bony support for the teeth adjacent to the cleft, close the oronasal fistula and improve nasal esthetics.<sup>1,2</sup> Numerous centers graft during the mixed dentition phase, following the Boyne and Sands protocol,<sup>3</sup> when the teeth are developing and erupting. Thus, there are many factors to consider regarding the proper timing of the graft and related dental procedures.

At the Noordhoff Craniofacial Foundation Philippines (NCFP), where this author is affiliated with, the ideal time to perform orthodontic treatment and alveolar bone graft is during the mixed dentition stage. The ideal protocol for individuals with clefts, from birth to adulthood recommended by NCFP, which operates and treats patients at the Our Lady of Peace Craniofacial Center and the Smile Train Craniofacial Center, is shown in Table 1. For brevity, other specialties involved in cleft treatment, such as pediatrics, psychology, otorhinolaryngology, etc., have not been included here.

Even though many centers advocate grafting during the mixed dentition phase, there is a heterogenous mix of patients in the mixed dentition or permanent dentition, in various stage of canine development, who present for alveolar bone graft. The decision whether to perform the bone graft before or after orthodontic treatment depends on various factors, some of which will be discussed here.

The objective of this paper is to explain the considerations in the mixed dentition and the permanent dentition related



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**Table 1.** Ideal Protocol for Individuals with Clefts Recommended by the Noordhoff Craniofacial Foundation Philippines

Age	Orthodontics/Orthopedics	Surgery	Speech Therapy	Dentistry
0 to 3 months	Nasoalveolar molding			
3 to 6 months		Lip repair		
6 to 12 months				Initial consultation as soon as first baby tooth erupts
12 to 18 months		Palate repair		Follow up every 6 months or as needed
2.5 to 3 years			Start of speech therapy then follow up as needed	
4 to 6 years	Initial orthodontic consultation	VPI surgery (if needed) and lip and nose revision (if needed)		
7 to 11 years	Phase I Orthodontic Treatment: Expansion, crossbite correction, 2 x 4 appliance, etc.	Lip and nose revision (if needed) and Alveolar bone grafting (if needed)		
12 to 16 years	Phase II Orthodontic Treatment: Comprehensive orthodontics			
17 years and above		Orthognathic surgery (if needed)		Prosthodontic management (if needed)

to orthodontic treatment before and after secondary alveolar bone grafting in patients with cleft lip and palate. This article includes an overview of alveolar bone grafting, the indications, considerations, and the orthodontic procedures that are done before and after grafting.

**ALVEOLAR BONE GRAFTING: AN OVERVIEW**

Alveolar bone grafting was first reported by Von Eiselsberg in 1901 by using the bone of the little finger and a pedicle graft. Autologous bone grafts using the iliac crest was introduced and grafting using iliac crest prior to eruption of the canine in cleft lip and palate was reported in the 1970s.<sup>4,5</sup> Other donor sites from the cranial bone, tibia, mandibular symphysis, and rib have also been reported. Use of bone substitutes such as bioceramics, bone morphogenetic protein-2 and more recently, cell therapy, are alternatives that may reduce morbidity<sup>6</sup> but these are not readily available and are quite expensive. Cancellous iliac crest bone remains the material of choice by many cleft teams<sup>7</sup> because of its accessibility, adequate amount of bone available, faster revascularization, and high potential for osteogenesis<sup>8,9</sup>.

There are many advantages in performing bone grafts. If done before the eruption of the canine, it provides bone support for the unerupted tooth<sup>5,10</sup> and the teeth adjacent to the cleft,<sup>5,11</sup> which in turn, reduces or minimizes the chance of canine substitution of the lateral incisor or prosthetic replacement of anterior teeth adjacent to the cleft<sup>12</sup>. Bone grafting allows for a continuous arch form and alveolar ridge, and closure of oronasal fistulae.<sup>11</sup> It improves facial esthetics by providing support and elevation of the alar base. In bilateral cleft lip and palate, it can provide stability to a mobile premaxilla.<sup>1,2,13</sup>

Alveolar bone grafting may be classified into two main types, according to the age of the patient: primary bone

grafting and secondary bone grafting. Primary bone grafting is performed before or during palatoplasty, usually before the age of two years.<sup>14-16</sup> The advantages of this technique are the stabilization of the maxillary arch and prevention of arch collapse. However, it reduces maxillary growth especially in the vertical direction, causes inadequate bone formation, and produces poor arch form.<sup>17,18</sup>

Secondary bone grafting, which is more widely accepted, is further subdivided into: *early*, which is completed between two and five years of age; *intermediate*, which is done during the mixed dentition, before the eruption of the permanent canine, and between the ages of six and 13 years; and *late*, which is performed during adolescence or adult stage, after the eruption of the canine.<sup>1,15,16,19</sup> Some authors describe late secondary bone grafting after the eruption of all permanent teeth as *tertiary bone grafting*.<sup>20</sup> Most cleft palate teams in Europe and North America prefer intermediate secondary bone grafting because there is an opportunity for more maxillary growth to occur prior to the surgical procedure and has a better prognosis.<sup>7,21</sup>

**FACTORS INFLUENCING IDEAL TIMING OF THE BONE GRAFT: WHEN IS IT BEST TO DO GRAFTING?**

Ideally, a child with a cleft should have a panoramic radiograph taken by the age of six or seven. A panoramic radiograph is necessary to assess the developmental age of the teeth. Since in most cleft children there is a delay in the eruption of the teeth compared to children without clefts,<sup>22</sup> dental age is a more reliable indicator of the proper timing of the alveolar bone graft and the dental procedures associated with it.

Prior to the bone graft, occlusal and periapical radiographs of the cleft site have traditionally been used to evaluate and

quantify the alveolar defect. In recent years, cone beam computed tomography (CBCT) scans have been shown to be a more precise method of assessing the cleft defect before and after bone grafting.<sup>23-27</sup>

Clinical and radiographic evaluation of the alveolar cleft defect, development of the canine or lateral incisor adjacent to the cleft, and the conditions and positions of the upper teeth on a regular basis is necessary to determine the best time to perform the surgery.

### Development of the permanent canine

It is generally believed that the best time to do the bone graft is when the root of the canine erupting into the cleft area is one-half to two-thirds developed of its final length (Figure 1). Following the bone graft, as the canine erupts into the grafted site, it brings additional bone<sup>1</sup> and increases functional load on this area. These promote integration of the graft with the surrounding bone and enhances success of the surgical procedure.<sup>2</sup> It was also reported that alveolar bone height was better, dehiscence was minimized,<sup>28</sup> there was less root resorption, and less planned prosthetic replacement<sup>29</sup> when the bone graft was performed prior to the eruption of the canine.

### Development of the lateral incisor

In patients where the developing lateral incisor is located immediately posterior to the cleft, there would be inadequate bone as it erupts and drifts anteriorly. If this is not addressed in a timely manner with a graft, then the prognosis of this tooth is compromised.<sup>1</sup> Consequently, if the tooth germ of the lateral incisor is in the cleft area and will migrate and erupt into the bony bridge site, it is advantageous to perform the bone graft between the ages of 5 and 7 years, before the

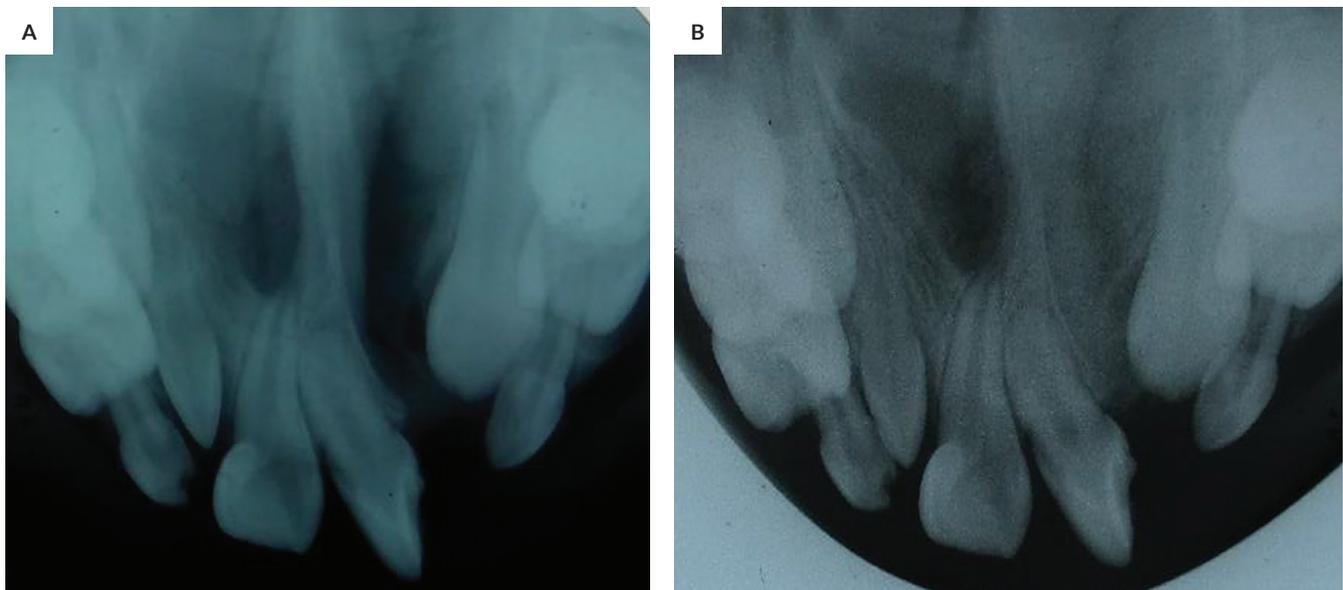
eruption of the canine.<sup>30</sup> This will enhance the bone fill in the cleft area and facilitate the eruption of the lateral incisor.

Studies comparing grafting during the early mixed dentition versus during the late mixed dentition have shown that bone grafting at a younger age can produce acceptable results,<sup>31</sup> with comparable facial growth outcomes.<sup>32</sup>

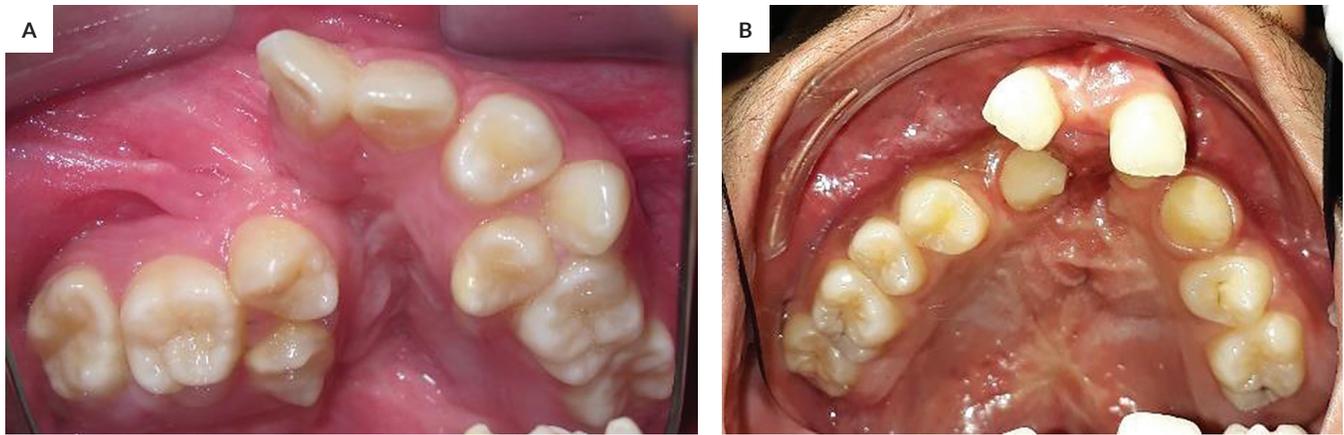
## INDICATIONS FOR PRE-GRAFT ORTHODONTICS

A number of cleft teams consider pre-graft orthodontics necessary to achieve a successful bone graft.<sup>33</sup> More bone formation, less residual alveolar bone defects, and less complications were associated with patients who had pre-graft orthodontics.<sup>34,35</sup> On the other hand, there are also reports that pre-treatment with orthodontics did not significantly produce better bone levels compared to those without.<sup>36,37</sup> The conflicting evidence regarding this may be due the wide variety of cases and different orthodontic procedures used in these reports. Since there are studies that are favorable or equivocal about orthodontic procedures prior to bone grafting, it is important for the clinician to remember that there is an extensive assortment of problems associated with these cases, and collaboration between the surgeon and the orthodontist is necessary to come up with the most favorable treatment plan for each case.

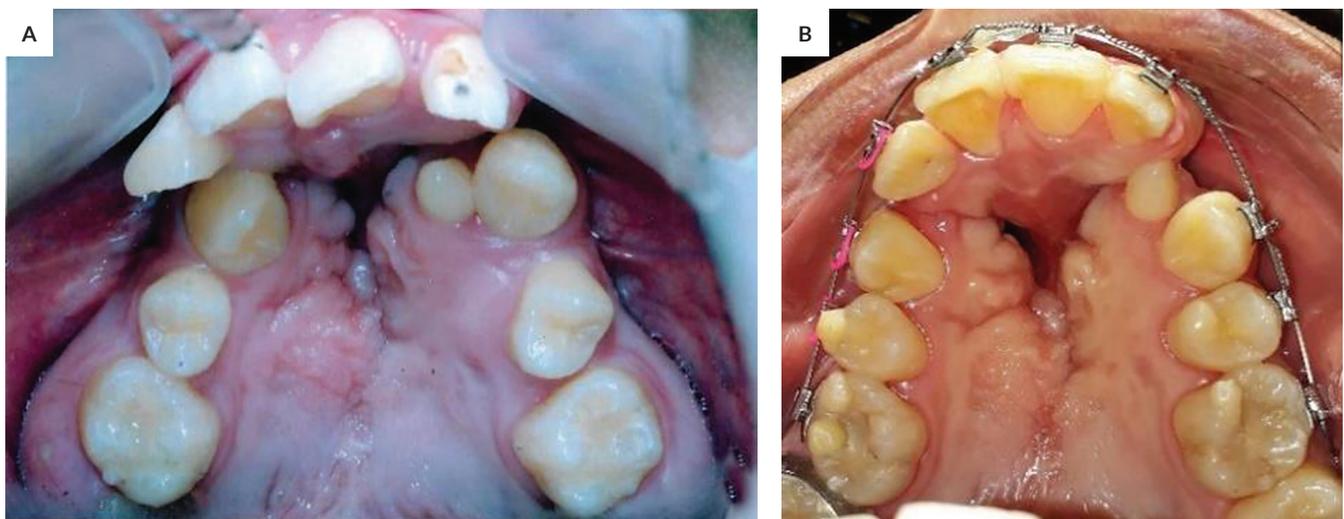
Pre-graft orthodontics should be started several months prior to grafting to allow adequate time for the desired tooth movement to be achieved. During this period, other dental procedures, such as extraction of teeth in the cleft site a few months prior to grafting, can be done to improve mucosal volume and quality in order to facilitate surgical closure.



**Figure 1.** Occlusal radiographs of a left unilateral cleft lip and palate: (A) before alveolar bone graft and (B) after alveolar bone graft.



**Figure 2.** Pre-treatment occlusal photographs: (A) T-shaped arch form of a complete unilateral cleft lip and palate, and (B) V-shaped arch form in a bilateral cleft lip and palate.



**Figure 3.** Occlusal photographs of a complete bilateral cleft lip and palate (A) before orthodontic treatment, and (B) after expansion using fixed appliances.

### **Collapsed upper posterior segments and maxillary expansion**

Individuals with complete cleft lip and palate have hypoplasia of the maxilla in both the sagittal and transverse directions, leading to anterior and posterior crossbites. The dental arch is typically constricted towards the cleft defect. In a complete unilateral cleft, the arch morphology may be T-shaped (Figure 2A), while in a complete bilateral cleft, the arch form is typically V-shaped (Figure 2B).

Many authors in different centers in the U.S., Taiwan, China, Brazil, and Canada have advocated the expansion of the maxillary arch during the mixed dentition, prior to bone grafting.<sup>15,34,38-41</sup> This method corrects arch morphology, increases the arch perimeter, and improves access to the graft site and nasal floor mucosa.<sup>15,39</sup> Since the arch perimeter is increased during expansion, this may reduce crowding in the permanent dentition. Correction of the arch morphology

by expansion during the mixed dentition will allow the permanent teeth to erupt into a symmetrical arch<sup>42</sup> and mitigate the possibility of bone dehiscence and buccal plate defects, which are associated with expansion at a later age<sup>43</sup>.

The amount and location of the constriction determine the type of maxillary expanders that can be used. If the constriction is located in both the premolar and molar areas, an expansion screw with a symmetrical opening such as a Haas or Hyrax can be used. Other appliances which can produce symmetrical expansion are the Niti expander and the W-arch. If the constriction is in the canine or premolar areas and there is no constriction in the molar areas, an expansion screw with differential opening such as a fan-type expander, reverse quad helix or a maxillary expander with differential opening may be used. A quad-helix may also be used for differential or symmetrical expansion, depending on the activation of the springs.<sup>33,39,40,42</sup>

Expansion of a constricted arch in the permanent dentition prior to bone grafting may also be necessary. This can be achieved with the use of brackets bonded on all the teeth (Figure 3B), an expander or a combination of both.

The goal of expansion is to normalize the maxillary arch form and make the arch into an ovoid shape, approximate the cleft segments, and thus improve surgical access. Correction of the transverse crossbites may also be achieved but is not the primary goal of expansion.<sup>33</sup> Excessive expansion can make an existing oronasal fistula very large, increase the risk of post-surgical scar tissue contraction, heighten the possibility of dehiscence, and may negatively affect bone graft prognosis.<sup>44,45</sup> It is important to coordinate with the surgeon during active expansion of the maxillary arch to determine the optimal maximum amount of expansion, without compromising the surgical results.

Once the desired expansion has taken place and if a maxillary expander has been used, the expansion appliance is removed, two impressions are taken, and two appliances are fabricated, according to Santiago.<sup>15</sup> One is a Hawley retainer, which the patient should wear full time to retain the expansion until the surgery. The other is a surgical splint, which is cemented in the operating room, right after the bone graft. Alternately, a removable Essix-type retainer may be used in lieu of a surgical splint.<sup>46</sup> The surgical splint or Essix-type retainer is worn for 8 to 12 weeks to preserve the expansion while the bone is healing.

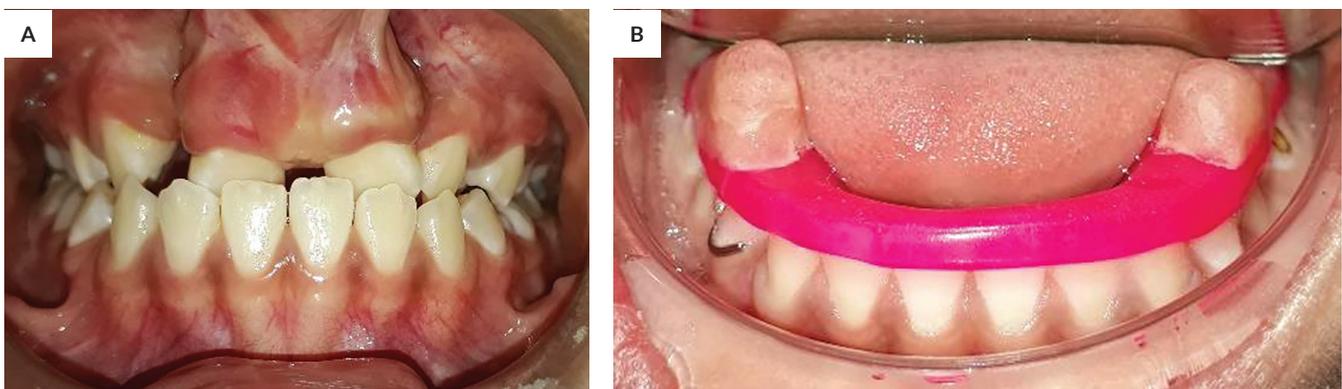
If fixed appliances were used for expansion and if there are any other planned orthodontic tooth movements needed to be done after the bone grafting, the brackets may be retained but the arch wire should be segmented shortly prior to the bone graft. Orthodontic tooth movement in the upper arch may begin as early as 8 weeks after the surgery or until there is radiographic evidence of adequate bone in the grafted area.<sup>39</sup>

### Trauma from occlusion of the teeth on or near the cleft

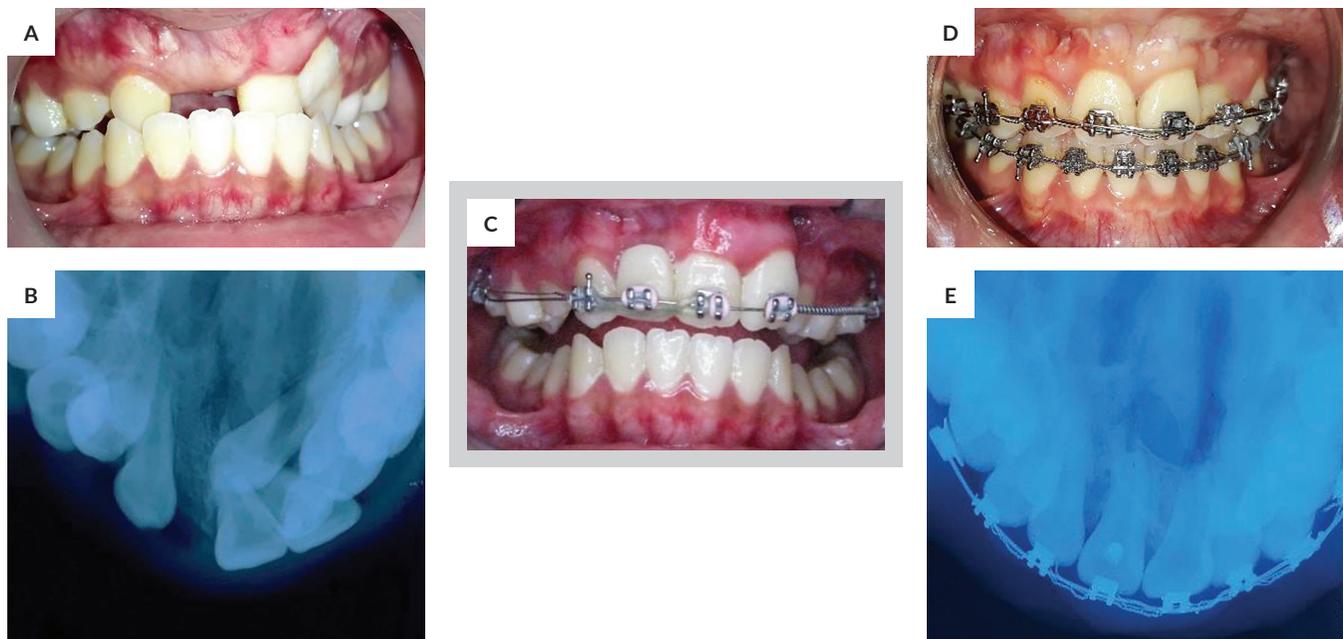
Traumatic forces on the teeth near the cleft after grafting will increase the risk failure of the graft. The occlusion should be checked to determine if premature contacts and heavy forces will be placed at or near the bone graft site after the surgery. If these are present, then the teeth need to be aligned first with fixed appliances. But care should be taken during alignment of these teeth so as not to resorb the thin shell of bone covering their roots and not induce resorption of these roots.<sup>33</sup> In some bilateral cases where the upper central incisors are present, the premaxilla is mobile and there is traumatic occlusion with the lower incisors, pre-graft orthodontic treatment may not be needed, and a posterior bite plate is all that is necessary. The bite plate provides a vertical stop and prevents occlusal forces near the grafted area<sup>39</sup> (Figure 4).

### Insufficient access for the graft

Interferences with mucoperiosteal dissection in cases where the incisors are severely inclined or displaced toward the cleft defect should be corrected with fixed appliances prior to the bone graft (Figure 5). This improves surgical access by allowing mucosal flaps of adequate shape and size to be reflected, placed, and sutured over the grafted site.<sup>42</sup> If only a thin plate of cortical bone is covering the root of the teeth adjacent to the cleft, care must be taken so as not to move the tooth roots into the cleft defect. According to Wirthlin<sup>33</sup> if anterior brackets are used, atypical bracket placement may be required in teeth adjacent to the cleft. Brackets may have to be placed on these incisors which would preserve the existing angulation of the teeth, and not following their long axis. This would prevent compressive forces from being placed on the thin shell of alveolar bone covering the root and impede bone resorption of this thin shell of bone, as well as prevent root resorption. Preservation of the presurgical amount of bone supporting the teeth near the cleft is an important factor in successful bone grafting.<sup>47</sup>



**Figure 4.** A complete bilateral cleft lip and palate with traumatic occlusion on the incisors: (A) pre-treatment photograph and (B) A lower bite plate was fabricated prior to the bone graft. The lower incisors were also covered with acrylic to prevent their supra-eruption.



**Figure 5.** A bilateral cleft lip and palate case showing: the (A) and (B) pretreatment photograph and occlusal radiograph prior to bone grafting of the right side; (C) progress photograph showing the upper teeth with fixed orthodontic appliances and a pontic to replace the missing lateral incisor (for esthetics), and (D) and (E) post-graft photograph and occlusal radiograph.

Correction of crowded, inclined, or displaced anterior teeth may also decrease the risk for plaque formation, gingivitis, and dental caries. Consequently, this may improve dental hygiene and decrease the risk of infection after the surgery.

### Considerations in bilateral clefts

In bilateral cleft lip and palate, the premaxilla is attached only to the vomer and is mobile from birth. This consequently leads to the downward displacement of the premaxilla (with resulting deep bite), a lateral displacement of the premaxilla, or both. In some cases, there is a wide cleft gap between the premaxilla and the posterior lateral segments. Correction of these problems with an osteotomy at the same time as the alveolar bone graft may be done, but it is preferable to exhaust all orthodontic means necessary before an osteotomy is indicated.<sup>48</sup>

Several authors have reported different appliances to correct the vertical excess of the premaxilla, excessive overbite, and anterior traumatic occlusion prior to the alveolar bone graft: orthopedic intrusion of the premaxilla using an intraoral tooth-borne distractor<sup>49</sup> and modified by Meazzini and others;<sup>50</sup> an acrylic splint cemented to the primary incisors on the premaxilla, which is attached to cantilever springs on the first molars,<sup>51</sup> and brackets attached to an acrylic cap cemented to the primary incisors on the premaxilla, with the acrylic cap connected to a bonded expander on the posterior segments.<sup>52</sup>

Appliances that can be used for a laterally displaced premaxilla or large alveolar clefts are a tooth borne distraction

device;<sup>53</sup> orthodontic protraction with an expansion screw,<sup>54</sup> or a double hinged expander using the Alternate Rapid Maxillary Expansion and Constriction (ALT-RAMEC) technique.<sup>53,54</sup> The same technique in these two articles can also be used in closing large cleft gaps in unilateral cleft lip and palate. These devices have been shown to be effective in moving a displaced premaxilla to the center and in closing large alveolar gaps. However, these appliances require patient cooperation, and the tooth borne distraction device and the ALT-RAMEC appliances are difficult to fabricate.

### Can the bone graft be done after canine eruption and during adulthood?

When it is not possible to perform secondary alveolar bone grafting at the ideal time, acceptable outcomes can still be expected for late bone grafting.<sup>55</sup> Although it was shown that there is better bony cohesion and stabilization of the alveolar segments in patients who underwent bone grafting before the eruption of the canines, some benefits may still be achieved in grafting after canine eruption, such as improved soft tissue symmetry of the lip and nose, facial esthetics, provision of a platform for future implant placement,<sup>19</sup> and continuity of the maxilla in preparation for orthognathic surgery cases<sup>15</sup> (Figure 6).

### OTHER DENTAL PROCEDURES THAT NEED TO BE DONE BEFORE GRAFTING

Decayed teeth adjacent to the cleft should be restored before the grafting procedure. Healthy ectopic teeth next

to the cleft may also be preserved to maintain the alveolus. However, teeth near the cleft that have a poor prognosis as well as healthy ectopic or supernumerary teeth that have erupted in the line of the cleft, should be extracted at least two months before the alveolar bone graft to allow adequate time for the soft tissues to heal prior to the surgery.<sup>1</sup>

## CONSIDERATIONS IN POST-GRAFT ORTHODONTICS

Even though pre-graft orthodontic treatment is performed in many craniofacial centers in developed countries worldwide,<sup>34</sup> there are many factors which influence the timely access to orthodontic care, such as availability of insurance,<sup>56</sup> financial constraints, awareness of the parents regarding timely treatment, accessibility of a qualified orthodontist, unavailability of surgeons, lack of access to required presurgical dental procedures, or a combination of these factors. Because of these, a number of cleft individuals in developing countries have their bone graft surgery during their adolescence or adulthood, after the eruption of the canine and without the benefit of orthodontics.

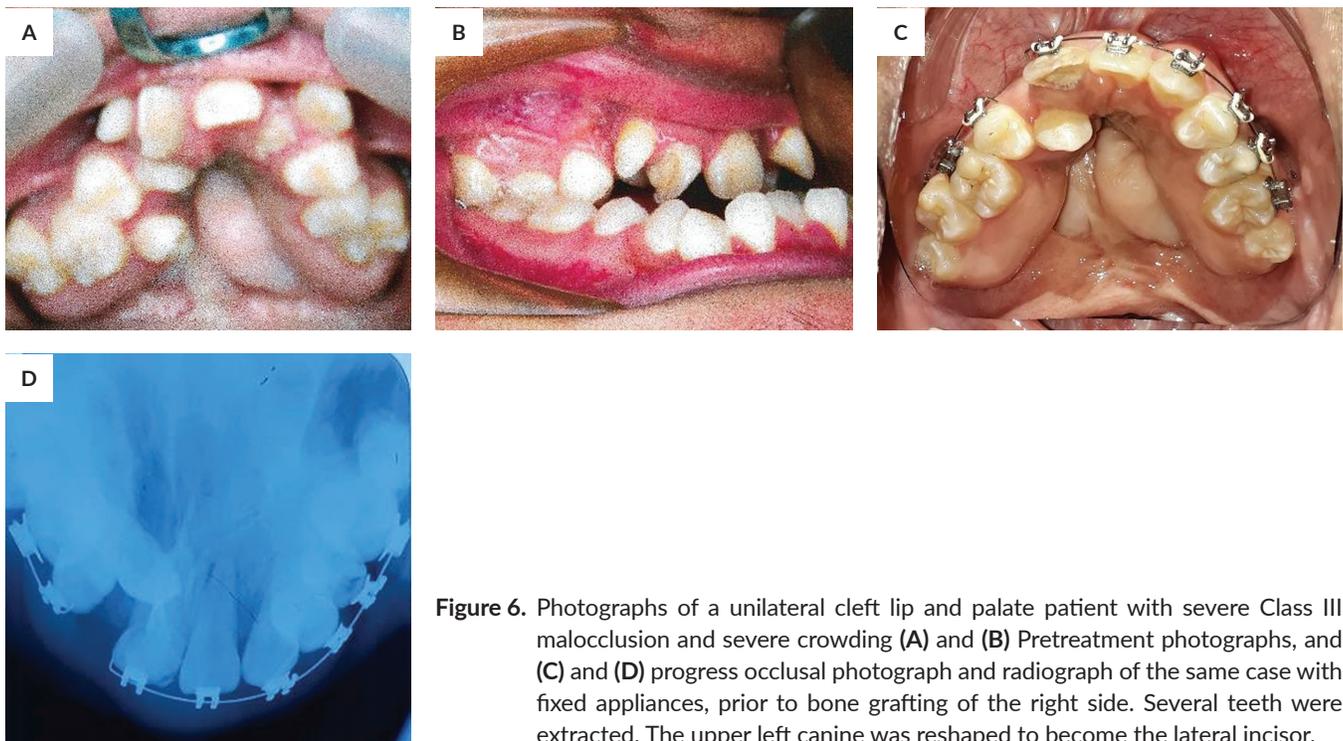
There are other limitations to the timing of orthodontic treatment in relation to the bone graft. According to Padwa, there are patient, dental, and surgical considerations associated with orthodontic treatment after the bone graft. Patient factors include poor cooperation and poor oral hygiene. Dental factors such as, no arch collapse, no anchorage available for orthodontic appliances, no tooth erupting into the cleft defect, and early canine development

can preclude orthodontic treatment prior to grafting. A large bony defect, insufficient soft tissues, and late bone graft are surgical factors that may delay orthodontic treatment until after bone grafting.<sup>57</sup>

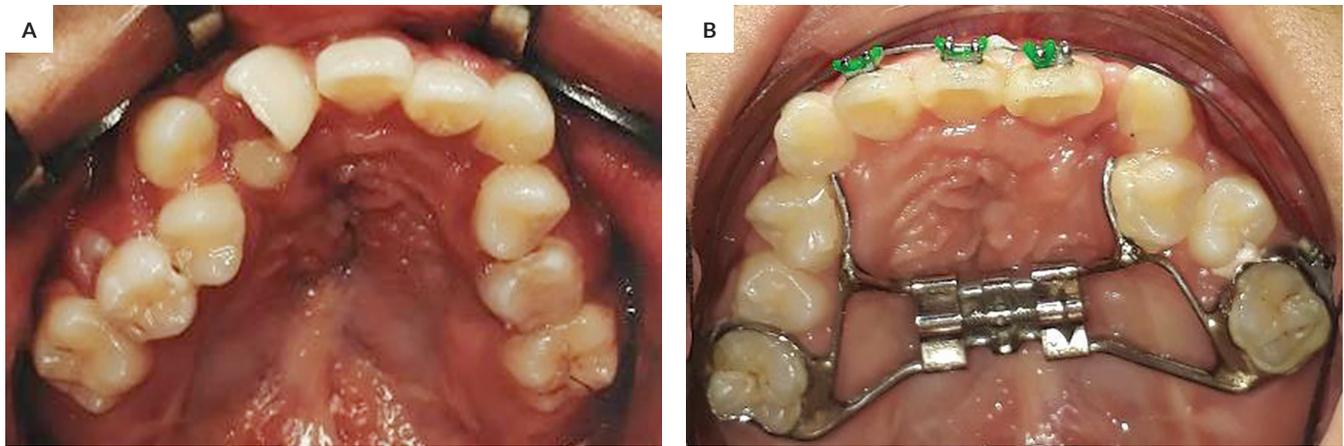
Regardless of the type of orthodontic tooth movement that will be done after the grafting, sufficient time should elapse after the surgery to allow for the soft tissues to heal and for bony integration to occur. Orthodontic treatment can be started as early as eight weeks after surgery, when there is indication of successful consolidation of the graft.<sup>1,58</sup> Other authors recommend that orthodontics should commence four to six months after bone grafting, when there is radiographic evidence of good bone quality.<sup>39,59</sup>

### Maxillary expansion after alveolar bone graft

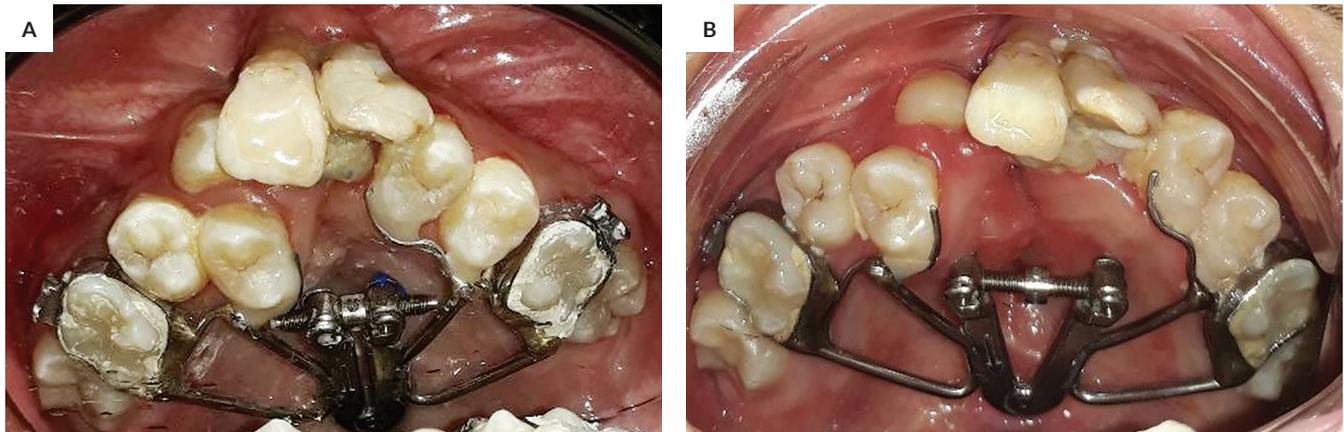
In most growing patients who did not undergo pre-graft orthodontic expansion, the transverse deficiency will persist and may become even worse as they become older, the permanent teeth will erupt into an arch which is deformed and constricted, thereby producing crowding. Maxillary expansion after the bone graft is beneficial in cleft patients with deficient arch width and crowding (Figures 7 and 8). Rapid maxillary expansion with the use of a Haas or Hyrax expander can open the mid-palatal suture after the alveolar bone graft procedure without compromising the integrity of the graft.<sup>60</sup> There is also no significant difference in graft volume and bone density in patients who had slow maxillary expansion before the alveolar bone graft procedure and those who had maxillary expansion after the bone graft.<sup>58</sup> However, results may be unpredictable, and in some patients, buccal



**Figure 6.** Photographs of a unilateral cleft lip and palate patient with severe Class III malocclusion and severe crowding (A) and (B) Pretreatment photographs, and (C) and (D) progress occlusal photograph and radiograph of the same case with fixed appliances, prior to bone grafting of the right side. Several teeth were extracted. The upper left canine was reshaped to become the lateral incisor.



**Figure 7.** Post-graft occlusal photographs of a right unilateral cleft lip and palate with hypodontia of the right lateral incisor: (A) before orthodontic treatment, and (B) progress photograph where a Hyrax was used to alleviate the crowding. Brackets were bonded to the incisors to improve esthetics. The upper right lateral incisor was extracted, and the right canine will be reshaped to take its place.



**Figure 8.** Occlusal photographs of a complete bilateral cleft lip and palate after bone graft: (A) at the start of orthodontic treatment using a banded fan-type expander, and (B) after expansion.

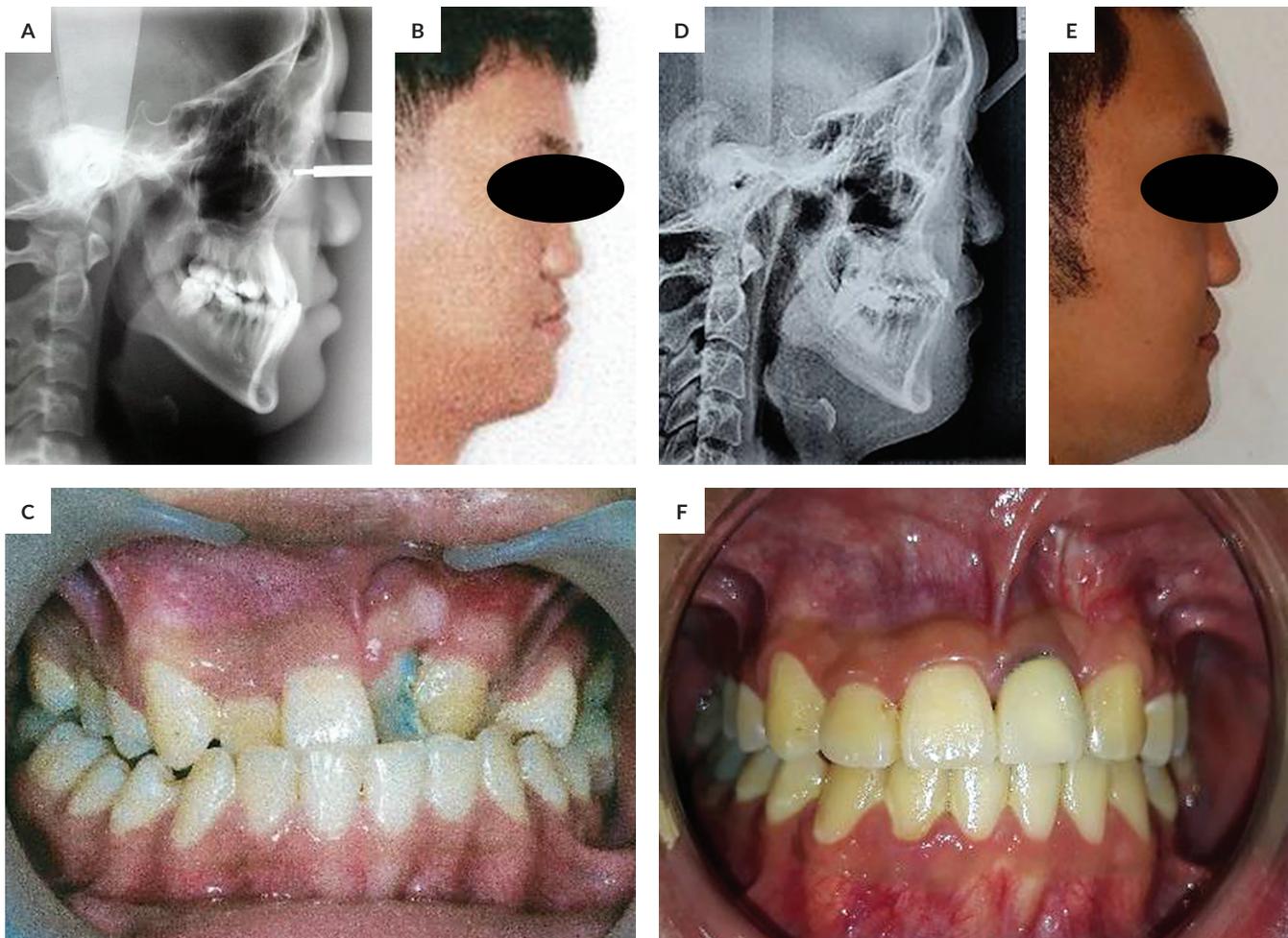
tipping of the posterior teeth, rather than skeletal expansion can be observed.<sup>60</sup> This effect may be acceptable for some cases but not in patients where severe transverse discrepancy exists. Limited buccal tipping of the posterior teeth may alleviate crowding in those with minor space deficiencies (Figure 7). Permanent retention may be necessary in these cases to maintain the expansion.

### Treatment options for maxillary deficiency

Patients with mild maxillary deficiency during middle to late adolescence may be treated with orthodontic camouflage, but this choice must be deferred until after growth has ceased and after careful evaluation of cephalometric radiographs and a clinical exam. The maxillary anterior teeth are proclined and the lower anterior teeth are tipped lingually to camouflage the skeletal Class III malocclusion (Figure 9). This may be achieved with class III elastics, temporary anchorage devices

or multiloop edgewise arch wires. In some of these cases where severe lower anterior crowding is present, extraction of the lower premolars is possible.

In cases with mild maxillary discrepancy during the early mixed dentition, or moderate maxillary hypoplasia during the late mixed dentition, the choice between maxillary protraction during early childhood or early adolescence, or orthognathic surgery during adulthood, is a difficult one because there is no standard predictive variable for those who would need orthognathic surgery. There are studies that investigated the cephalometric variables which may predict the need for future orthognathic surgery in unilateral clefts and most have indicated that the ANB angle is the most relevant value. A low or negative ANB angle at 5 to 6 years old<sup>61,62</sup> or an ANB angle  $\leq -0.45$  degrees (in combination with an overjet of  $\leq 2$  mm and a maxillary length  $\leq 57.25$  mm) at 11 years old,<sup>63</sup> can successfully predict the need for orthognathic



**Figure 9.** (A), (B) and (C) Lateral cephalometric radiograph and photographs of a complete left unilateral cleft lip and palate showing mild maxillary skeletal deficiency, negative overjet, and severe caries of the upper left central incisor. (D), (E) and (F) Post-orthodontic treatment records of the same case. Root canal treatment was performed on the upper left central incisor and the upper left canine was reshaped to substitute for the missing upper left lateral incisor.

surgery. These may offer some insight into making treatment plan decisions and preparing the patient and his or her family regarding future treatment options.

For those children with severe maxillary discrepancy and for whom orthognathic surgery is planned, dental compensation must be avoided during Phase I treatment. Comprehensive orthodontics can be started during adolescence and when most of the skeletal growth has been completed.

#### Late maxillary protraction after alveolar bone graft

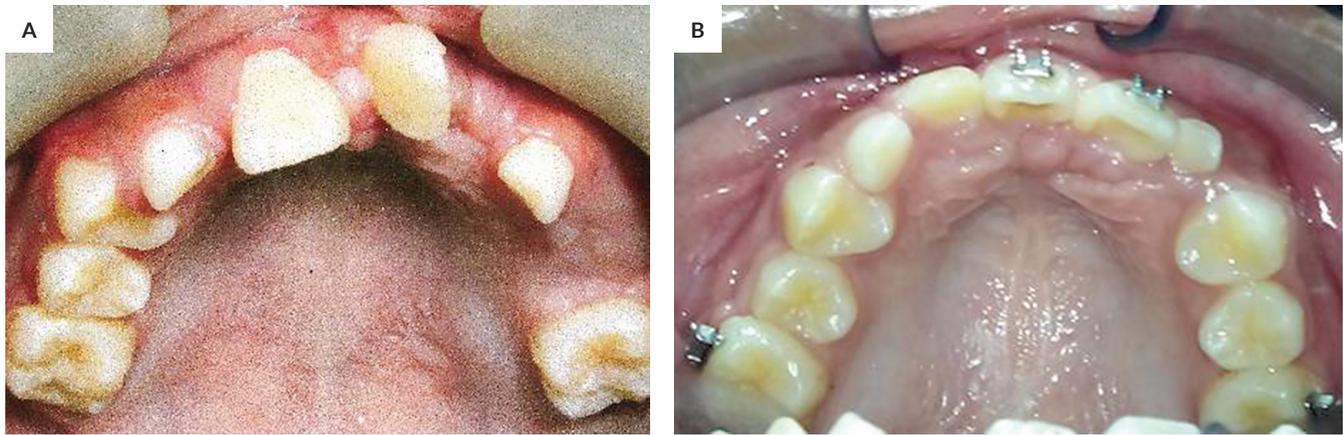
Orthopedic traction of the maxilla during the primary or early mixed dentition was previously reported as part of the protocol in the continuum of comprehensive cleft care in the treatment of unilateral cleft lip and palate patients. However, there are reports that early facemask therapy prior to the age of 10 produced variable results and may not be stable over the long-term.<sup>64-66</sup>

Late maxillary protraction after the bone graft is a viable option for adolescents between the ages of 9 and 14 years with mild skeletal discrepancy or those with moderate skeletal discrepancy and refuses or may not have orthognathic surgery at a later age. Advancement of the maxilla after bone graft “provides positive extra stimulus that can benefit the graft.”<sup>67</sup>

In this article, only two types of maxillary protraction will be described: the alternate maxillary expansion and constriction technique, and bone anchored maxillary protraction.

#### Alternate maxillary expansion and constriction (Alt-RAMEC) technique

Maxillary protraction during the late mixed or early permanent dentition has become possible with the introduction of Liou’s Alternate Rapid Maxillary Expansion and Constriction (Alt-RAMEC).<sup>68,69</sup> In this protocol, unilateral cleft lip and palate patients at the age of 9 to 12 years use



**Figure 10.** Occlusal photographs of a left incomplete unilateral cleft lip and palate: (A) pre-treatment photograph and (B) progress photograph after placement of fixed orthodontic appliances.

two-hinged expanders which are activated and constricted in weekly cycles for nine weeks, followed by protraction using intraoral protraction springs. The use of two-hinged expanders allows more effective opening of the circumaxillary sutures compared to a conventional rapid maxillary expansion device.<sup>70</sup>

Since there are reports that the two-hinged expanders and intraoral protraction springs can break during mid-treatment<sup>71,72</sup> and may not be accessible to some orthodontists, modifications to these devices using bonded or banded maxillary expansion appliances together with protraction facemask have been described<sup>73-75</sup>. Use of the Alt-RAMEC protocol in combination with facemask or reverse-pull headgear, and Class III elastics has been shown to have favorable results as well.<sup>76</sup> A long-term follow-up study using the Alt-RAMEC technique with a double hinged-expander, and protraction springs or Class III elastics have been shown to produce maxillary advancement of 5.43 mm after five to eight months of active protraction in unilateral cleft lip and palate patients.<sup>77</sup> Maxillary protraction using the Alt-RAMEC technique in UCLP may considerably decrease the need for orthognathic surgery, particularly in female patients.<sup>78</sup>

#### *Bone anchored maxillary protraction (BAMP)*

Protraction of the maxillary complex of 10- to 11-year-old Class III noncleft adolescents using titanium miniplates on the zygomatic crest and the mandibular symphysis was reported in 2009.<sup>79</sup> In this technique, Class III elastics are applied to hooks attached to the miniplates on the maxilla and mandible with a force of 100 to 200 grams per side. The use of miniplates on the maxilla with elastics attached to a protraction facemask in unilateral cleft lip and palate patients was described in 2010.<sup>80</sup>

At present, there are two major types of BAMP therapy: Type I, where miniplates are placed on the infra-zygomatic crest and a facemask is used for protraction, and Type II,

where miniplates are installed at the infra-zygomatic crest and mandibular symphysis, and Class III elastics are used for protraction.<sup>81,82</sup>

Studies have shown favorable results after type I BAMP therapy<sup>83,84</sup> and after type II BAMP therapy<sup>85-88</sup> in unilateral cleft lip and palate. If BAMP therapy is preceded by maxillary expansion with a fan-type expander, there was a higher but insignificant amount of maxillary forward movement.<sup>89</sup>

#### **Limited orthodontic treatment for better oral health, for treatment of impacted teeth, or improve esthetics**

After the alveolar bone graft, interim orthodontic treatment may be performed prior to phase II orthodontic treatment in cases when there are impacted teeth, self-esteem may be affected by anterior esthetics, or when there are crowded and rotated teeth in which oral hygiene and periodontal status will be affected (Figure 10). In these cases, the patient and his or her parents must be advised that another stage of treatment with orthodontic appliances will be done in the future.<sup>40</sup>

#### **SUMMARY AND RECOMMENDATIONS**

Orthodontic treatment is an important component in the interdisciplinary management of an individual with cleft lip and palate. Ideally, patients should be assessed at the start of the mixed dentition to determine the proper timing and sequence of bone grafting and related orthodontic and dental procedures. Clinical and radiographic evaluation on a regular basis is necessary to determine the best time to perform the bone graft. Some of the indications for pre-graft orthodontics are collapsed upper posterior segments, trauma from occlusion of the teeth at or near the cleft, insufficient access for the graft and in bilateral clefts, and downward and/or lateral displacement of the premaxilla. Many cleft teams

do the bone graft when the root of the canine adjacent to the cleft site is one-half to two-thirds developed. Some centers perform the graft at a younger age when the lateral incisor is adjacent to the cleft. Maxillary expansion may be performed after bone grafting in patients who have not received pre-graft orthodontics. Late maxillary protraction during the late mixed or early permanent dentition stage and limited orthodontic treatment for impacted teeth, esthetics, and improved oral health after the bone graft surgery, may also be accomplished in some patients. Each cleft individual is unique and collaboration between members of the cleft team is important to determine the best treatment plan tailored to the patient's needs.

### Patient Images

The images contained in this article were from patients who were treated at the Our Lady of Peace Craniofacial Center and/or the Smile Train Craniofacial Center which were both operated by the Noordhoff Craniofacial Foundation Philippines. Written and signed consent forms were obtained from the patients or their parents.

### Ethics Approval

A Certification of Approval was issued by the University of the Philippines Manila Research Ethics Board for this study protocol and its related documents (UPMREB 2023-0341-01).

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The author certified fulfillment of ICMJE authorship criteria.

### Author Disclosure

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