ORTHODONTICS FOR ORAL CLEFT CRANIOFACIAL DISORDERS

John L. Spolyar, DDS, MS

CHAPTER 26

PASSIVE PROSTHETICS (NEONATAL PERIOD)

1. What is a passive infant oral prosthesis?

An infant oral prosthesis is a passive device much like a denture without teeth that covers and follows the anatomic outline of the hard palate and its defect. To maintain position and to resist displacement, the margins of the prosthesis usually extend over the lateral alveolar segments and may extend into and over the lateral surfaces of the nasal cavity and vomer. The prosthesis is routinely made from polymerized methylmethacrylate (acrylic) (Fig. 26-1).

2. What does the prosthesis do?

A palatal prosthesis divides the oral and nasal cavities into functional spaces while providing a tactile reference for the tongue. Function is then segregated with the nose for airway and the oral cavity for feeding and proper tongue posturing. This segregation aids feeding and breathing and facilitates proper physiologic resting posture for the tongue with tip forward.

3. Does a prosthesis affect growth?

After surgical lip repair in cases of complete unilateral cleft lip/palate (UCLP) and bilateral cleft lip/palate (BCLP), medial displacement of the cleft segments is inevitable. A passive prosthesis, especially with proper nasal extension, prevents medial relocation of the cleft segments and provides normalized maxillary displacement growth in width achievement. Preventing medial collapse and promoting maxillary transverse growth have positive effects and serve to optimize oral volume, nasal respiration, dentoalveolar segment alignment, facial development, and overall anatomic balance. Perhaps the best potential growth and facial skeletal development are achieved by integrating passive prosthesis stabilization with rehabilitation protocols.

4. When is the prosthesis worn?

A prosthesis is best used as early as possible in the neonate's life—perhaps before the initial repair to facilitate feeding. If provided in coordination with the initial repair, a prosthesis is best left in place for 1 to 2 weeks before daily removal for cleaning. The appliance is best used on a full-time basis until a few weeks before palatoplasty, when it is used only during feeding. Appliance cleaning more frequent than daily may be indicated during upper respiratory tract infections that obstruct the nasal port because of mucus drainage.

5. How long does it take before a prosthesis is outgrown?

Facial growth occurs most in the vertical plane and least in the transverse plane. The prosthesis must be adjusted approximately every 6 weeks to reduce retentive undercuts and to broaden alveolar contacts. Generally, once the weight of the infant doubles, effective appliance retention is lost, and the appliance is no longer useful.

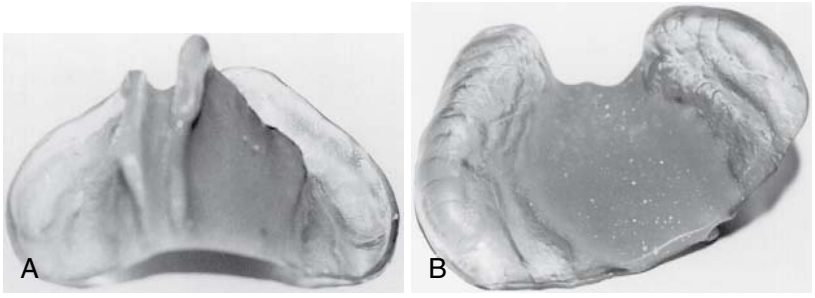

Figure 26-1. Passive infant oral prosthesis. **A,** Prosthesis on anatomic side shows nasal extension for retention. **B,** Oral side of prosthesis.

6. Does extension of the prosthesis over the alveolar structures restrict normal development of the lateral dental segments?

The "pressure" of alveolar remodeling growth easily exceeds the passive resistance of the appliance. With appliance adjustments over the alveolar extensions, normal development should proceed without restriction.

PRESURGICAL ORTHOPEDIC CORRECTION (NEONATAL PERIOD)

7. What is presurgical orthopedic correction?

Presurgical orthopedic correction (POC) is a procedure used to correct an anatomically abnormal bony relationship before any primary reconstructive surgery is performed.

8. How does POC apply to oral cleft patients?

In neonates with complete BCLP and UCLP, cleft maxillary components are distorted and abnormally positioned. The overlying soft tissue mirrors the skeletal deformity and gives the recognizable pattern of deformity in UCLP and BCLP. The objectives of POC are to reposition displaced basal segments and to realign soft tissue margins of like kind before corrective surgery is performed.

9. What problems attend oral cleft treatment without POC?

- Lip closure alone does not reposition the maxilla and premaxilla in BCLP or pull the cleft maxillary segment forward in UCLP well enough for closure of the cleft.
- Lip repair alone does not reposition the maxilla forward in BCLP to provide a full midface or pull the cleft maxillary segment forward in UCLP to balance the malar and alar bases or reduce the stigmatizing "crooked face."
- A protruded premaxilla at the base of the columella makes columellar lengthening and nasal tip correction impossible until the patient reaches adolescence.
- Persistent fistulas and residual clefts in the alveolus require the difficult surgery of bone grafting when the patient is between 6 and 8 years old.

10. What are the benefits of POC?

- A better platform is produced for the lip and nose as well as for the alveolus.
- Primary surgical closure can be performed without tension.
- A more precise method controls the cleft components without dependence on simple closure of the lip over the deformity to mold the distorted parts.
- Dissection of mucoperiosteum at the edge of the cleft facilitates a two-layer closure without tension.
- Alveolar integrity is established to facilitate dental development.
- Closure of the hard and soft palate is facilitated.
- An intact primary palate is achieved at an early age.
- Gingivoperiosteoplasty can be done with or without primary bone grafting.
- A normal maxillary arch without fistulas is achieved with early secondary palate closure. Early "fork-flap" columellar surgery is possible in BCLP and may produce a good nose and lip.
- An intact oral cavity without fistulation is routinely established well within the first year of life with a clearly improved possibility for intelligible speech to follow.

11. What are the various techniques used in POC?

The techniques are best grouped by type of device retention as either passive or fixed (pinned).

12. What techniques use passive retention?

In the 1950s, McNeil and Burston used a passive oral prosthesis and external facial or head straps to effect segment repositioning and remodeling. Also, Nordin uses a T-shaped traction device applied to the nostril on the normal side in UCLP cases. The design tactic is to use extraoral transverse traction to correct the midfacial asymmetry and to minimize the posterior retraction forces on the developing maxilla.

Another technique reported by Figueroa for BCLP used a passive oropalatal prosthesis as an anchor, and a latex rubber retraction strip looped over the prolabium to reposition the maxilla and premaxilla.

13. How effective are passive techniques?

The results are variable in regard to achieving treatment objectives. All of these early techniques share the following disadvantages:

- Inconsistency and difficulty with patient compliance
- Incomplete control of directional mechanics best directed at the orthopedic deformity

- Unpredictable and partial achievement of treatment objectives
- Extended treatment time
- Labor intensive
- More expensive than non-POC treatment protocols

The techniques have the following advantages:

- Less invasive than pinning techniques, which require general anesthesia for placement
- Less expensive than pinning techniques

14. What techniques use pinned retention?

- In 1957, Hagerty first reported the use of pins to retain an expandable stainless steel bar in cleft palate treatment.
- In 1965, Hagerty et al. reported the use of an expandable acrylic palatal prosthesis with intraosseous pinning for anchorage.
- Contemporary techniques were reported during the 1970s and 1980s by Georgiade and Latham. BCLP was treated with a coaxial mechanism that expanded the maxillary base and repositioned the premaxilla at the same time. Latham et al. reported on the design and use of this extraorally activated expansion device that applied elastic traction to the premaxilla.
- In 1980, Latham reported the treatment of UCLP with a device for orthopedic advancement of the cleft maxillary segment. It was much like the maxillary base device used today.

15. How effective are pinned techniques?

Results are highly consistent in achieving treatment objectives with the attending benefits and advantages described above. The disadvantages include the following:

- Device placement requires a hospital operating room (OR).
- Pinned techniques are more expensive than passive retention POC.

16. How is POC used in UCLP and BCLP treatment?

- Soon after birth an impression is obtained, and the maxillary POC device is fabricated on a stone model.
- OR placement of the device is coordinated with myringotomy and pressure-equalizing tube procedures.
- The maxillary base device is retained by four channel-locking pins, two on each side, which pass through the acrylic base material into the palate for intraosseous fixation.
- For cases of BCLP, a staple is placed through the bony septal structure of the premaxilla to connect repositioning chains.

17. How does the UCLP device produce orthopedic correction?

- Once the device is in place, a drive screw is activated a half turn (0.25-mm displacement), and activation is continued once or twice a day by the parent at home (Fig. 26-2).
- The patient is observed on a regular basis. Activation continues until, by design, no further turning of the screw is possible. The segments should be well aligned with 1 to 3 mm of space (defect) between the nearly abutting segments.

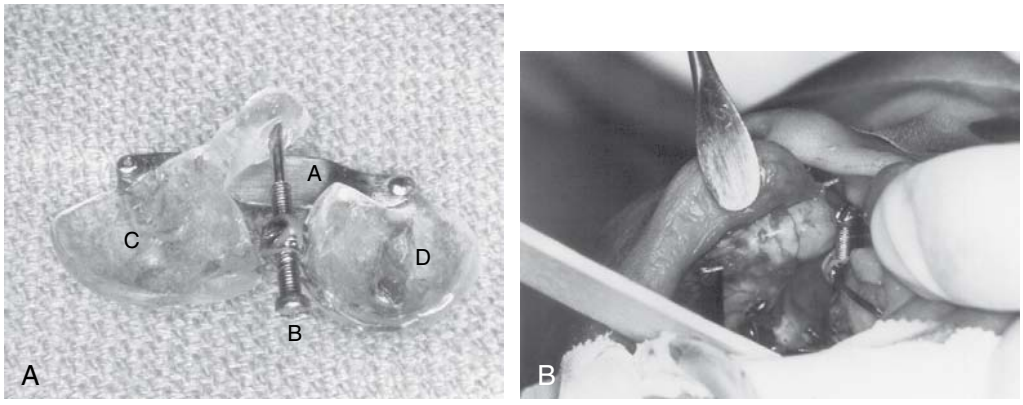

Figure 26-2. Unilateral cleft lip/palate presurgical orthopedic correction device. **A,** Viewed from its anatomic side. A coplanar double hinge *(A)* allows rotation and translation of the greater segment (GS) and lesser segment (LS) to one another. Turning screw *(B)* against GS *(C)* pulls LS *(D)* forward. The principal action is LS advancement with outward rotation and GS advancement with inward rotation. **B,** With device in place, the drive screw lies adjacent to the cleft segment and is easily accessed at the front of the cleft defect.

18. How long does it take before a patient with UCLP is ready for reconstructive surgery?

- Screw activation takes from 3 to 6 weeks to complete, depending on the size of the cleft, rate of activation, and amount of correction designed into the device (up to 14 mm).
- A resting period of 2 to 3 weeks allows dissipation of any residual load (strain) that builds up after applying the active force (stress).
- If the device is applied by age 4 weeks, the first reconstructive surgery can be done at age 3 months.

19. How does the BCLP device produce orthopedic correction?

- Once the device is in place, as the case demands, an expansion screw can be activated one-quarter turn (0.25-mm expansion at the anterior cleft segment) at a time. As instructed, activation once or twice a day by the parent at home or, perhaps better, one full revolution by the physician during weekly follow-up well achieves proper lateral segment placement (Fig. 26-3).
- The elastic chain tension is checked for possible adjustment on a weekly basis. The pressure should not exceed 2 ounces per side. Excessive force causes undue septal staple translation without orthopedic effect and possible failure.
- The patient is observed on a regular basis until the case is fully corrected with proper maxilla–premaxilla segment alignment and 0 to 2 mm of space at each cleft defect.

20. How long does it take before a patient with BCLP is ready for reconstructive surgery?

- Elastic chain repositioning takes from 4 to 7 weeks to complete, depending on amount of premaxillary protrusion, size of premaxilla, age of patient, and rate of activation.
- A resting period of 2 to 3 weeks allows dissipation of any residual load to reduce rebound.
- If the device is applied by age 4 weeks, the first reconstructive surgery can be done at age 3 to 4 months.

21. What are the significant treatment effects in BCLP?

The single most important response is forward maxillary repositioning to achieve premaxillary–maxillary alignment. The premaxilla shows less orthopedic adjustment and the vomer the least. This response is apparently age dependent.

22. What is the incidence of postalveolar cleft palate fistulation in patients treated with and without POC?

Cleft palate fistulation (CPF) is reported in 20% to 25% of patients treated without POC. The incidence may be as high as 50% in one-stage neonatal protocols. CPF was reported to be less than 8% in UCLP and BCLP treated with POC.

23. Do pinned POC devices stimulate maxillary growth?

Yes, in BCLP treatment. Maxillary forward translation in BCLP is about twice normal during the active phase of treatment.

24. Does pinned POC treatment adversely affect maxillary growth?

No.

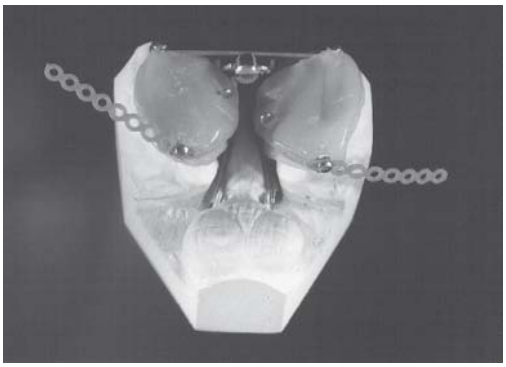

Figure 26-3. Bilateral cleft lip/palate pinned presurgical orthopedic correction base device can be expanded, enabling lateral segment placement to fit the premaxilla. The expansion screw at the drive box is activated from the front of the mouth. The device also acts as a base appliance for maxillary protraction in response to the coupling force for premaxillary retraction. Bilateral elastic chains attached to the premaxilla pass around a roller (not shown) under the drive box and then proceed forward and laterally to hook onto buttons for tensioning at the head of each segment.

ORTHODONTIC MANAGEMENT

Primary Dentition (Age 3 to 6 Years)

25. What is the primary dentition?

The first teeth to erupt, also known as *milk teeth* and *baby teeth*. Because the primary dentition is completely replaced by the adult dentition, *deciduous dentition* is a proper designation. Most children complete their primary dentition by the age of 2.5 to 3.0 years.

26. Why is orthodontic treatment important at this age?

Treatment positively influences postural and vegetative functions, occlusal function, facial growth, speech, eustachian tube and middle ear effusion, and reconstructive efforts.

27. What is achieved with orthodontic treatment?

Early treatment offers an opportunity for greater ease and efficacy of orthopedic procedures to increase space and optimize conditions for eruption and root formation; to attain proper occlusion; to increase oronasal volume; and to change the maxillary facial platform.

28. What physical signs are most important?

- Severe dental crossbites, both bilateral and anterior occlusal
- Very narrow maxillary dental arch
- Anterior (incisal) openbite
- Shallow or narrow palate
- Shifting of the bite, usually to one side, causing functional or postural mandibular asymmetry (functional shifts)
- Other important related problems are encumbered speech, oral respiration with noisy sleeping pattern, bad oral habits (thumb [digit] sucking, tongue thrusting, bruxism, severe attrition), and recurrent otitis media.

29. What procedures are undertaken at this age?

Principally, orthopedic with transverse maxillary distraction (expansion) and anterior respositioning (protraction).

30. What kinds of devices are used for maxillary expansion?

Expansion devices are either removable or fixed. *Removable* devices use a slow continuous expansion rate of 2 mm/month until completed. *Fixed* devices, either attached by stainless steel bands or directly bonded to posterior segment teeth, may use rapid continuous expansion at a rate of 0.5 mm/day or less to completion of expansion (Fig. 26-4).

31. How long of a rest period is needed after expansion?

A bonded fixed device is used with expansion over a 2-week period in a regimen of 4 to 5 mm segments followed by a 4- to 6-week period of rest. This sequence is repeated until expansion is completed. Accumulation of residual load during rapid expansion is dissipated during the rest periods. Research has shown that residual load accumulating during rapid palatal expansion completely dissipates in 5 to 7 weeks, depending on patient age. Many orthodontists prefer a 3-month rest period after rapid palatal expansion. Such long periods of rest are unnecessary after slow expansion.

32. How much expansion is necessary?

The amount of appliance expansion varies from as little as 7 mm to as much as 20 mm with use of two devices. In certain cases expansion beyond that necessary for occlusal balance may be desirable to increase nasal airway volume.

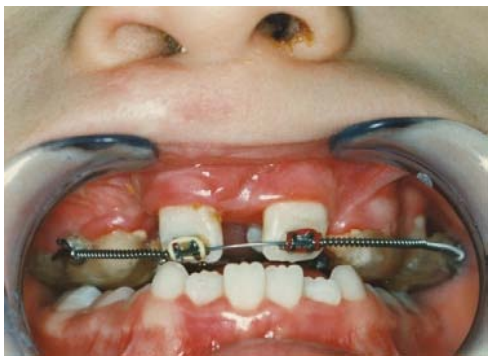

Figure 26-4. Intraoral view of rapid palatal expansion device directly bonded to the dentition with simultaneous orthodontic treatment for incisor alignment and decompensation for anterior crossbite correction. Note the separation of central incisors, a rare event in complete oral cleft patients, well after alveolar bone graft.

33. When was maxillary expansion first used?

No one knows, but it was first reported in the literature in 1859 for the correction of constricted maxillary dental arches over a period of 2 weeks.

34. What other use do expansion devices have?

A fixed expansion device or retained removable device is a handle to the maxilla. This handle of opportunity is realized in maxillary protraction for correction of maxillary midfacial deficiency and anterior dental crossbite (Fig. 26-5).

35. During primary dentition, when is the best time for maxillary protraction?

The best time is determined by the eruption of the permanent central incisors, which secure the repositioned maxilla with a proper bite. This translates to a dental age of at least 5 years to begin protraction treatment, which continues for 12 months. In general, the best time is before age 7 years.

Mixed Dentition (Age 7 to 11 Years)

36. What is mixed dentition?

The period when both primary and permanent teeth are present in the mouth. It is referred to as the "ugly duckling stage" and represents a period of marvelous complexity in dental arrangements and numbers. At inception (before incisors erupt) there is a total of 48 teeth; this number is reduced to 28 over a period of approximately 5 years.

37. What are the succedaneous or successional teeth?

The incisors, cuspids, and bicuspids occupy a place in the arch once held by a primary tooth.

38. What are the accessional teeth?

All teeth that erupt posterior to the primary teeth (e.g., first, second, third molars).

39. What is achieved by orthodontic treatment of mixed dentition?

During this period there is, perhaps, one last opportunity for segment alignment of the maxillary components, dental alignment, and space definition at sites of agenic teeth (almost always lateral incisors). In a nutshell, it is a most important opportunity to define maxillary dental arch perimeter.

40. What treatment procedures are used?

- Maxillary expansion and protraction
- Preparatory extractions
- Orthodontic treatment
- Tooth straightening

Preparatory extractions often include supernumerary teeth (teeth not present in a normal dentition and, in oral cleft patients, associated with cleft margins by the alveolar defect). Supernumerary teeth are commonly ectopic. If multiple, the additional supernumerary teeth usually are unerupted (impacted) and elevated within the anterior maxillary cleft segment. Orthodontic treatment is used to remove incisor irregularities, to create space for the agenic lateral incisor(s) and prospective graft sites, and to define buccal segment dental arch length. The decision to extract permanent teeth to reduce excessive dental crowding is often made during this period.

41. Why is this period critical for the alveolar bone graft?

With the canine root 25% to 50% formed, success rates for grafting are high during this age range.

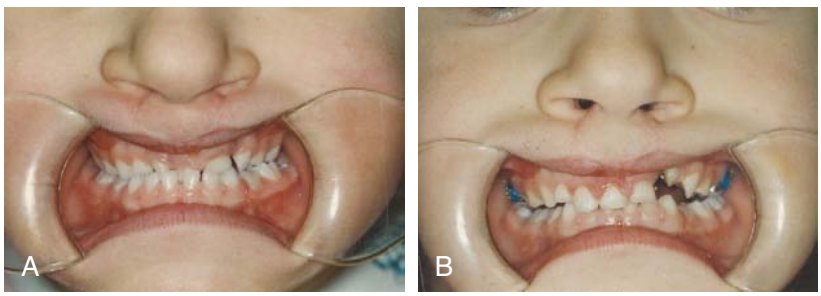

Figure 26-5. **A,** Intraoral view before maxillary protraction. **B,** Same view after maxillary protraction.

42. Why is it important to graft the alveolar defect when the canine root is less than 50% formed?

Canine teeth may erupt and migrate through the bone graft. With root formation beyond 50%, teeth begin eruptive bodily relocation in excess of root lengthening, and the cuspid may penetrate from its intraosseous crypt into the void of the alveolar defect.

Adolescent and Adult Dentition (Age 12 to 17 Years and Beyond)

43. What is adolescent dentition?

The first 6 years after onset of full eruption of succedaneous teeth during the period of accelerated adolescent growth in stature and facial development.

44. What orthodontic appliances are used during this period?

Occasionally, maxillary expansion may be indicated for a second time or, less often, primarily. Rigidly bonded or banded jackscrew appliances are most effective, but often spring wire-type expansion devices attached to two molars may be used successfully for buccal segment dental expansion. However, the principal procedures are carried out with comprehensive orthodontic appliances and complete bracing of all clinically erupted permanent teeth. This technique gives virtual control over the six possible bodily movements in space for each tooth.

CONTROVERSY

45. Is alveolar bone grafting a definitive procedure?

Bone grafting is not a definitive procedure even when it is entirely successful. The first graft may not compensate for vagaries of cleft type and individual variation, and results may be impossible to predict. A fuller alveolus for an osseointegrated implant or multiunit fixed prosthesis or elevation at the ala base is often a legitimate indication for a second graft during adolescence and adulthood.

FACIAL GROWTH IN ORAL CLEFT PATIENTS

46. Is craniofacial morphology of parents related to susceptibility for oral cleft in offspring?

Yes. Good evidence from cephalometric studies in parents of children with cleft lip (CL) and/or cleft palate (CP) supports this hypothesis. In the *lateral view*, all such parents have significantly shorter upper facial height compared with lower facial height. A larger cranial base saddle angle was found in parents of children with CLP and CP. In the *frontal view*, all parents had a significantly narrower head (skull) width (HW) and smaller cephalic index. There were also greater ratios of HW to interorbital, interzygomaticofrontal suture, nasal, bizygomatic, and alar width. Parents of children with CLP also showed asymmetries in the nasal alveolar shelf. In summary, shorter height and greater width in the upper face characterize all parent types.

47. How is the craniofacial status of adult patients with isolated unilateral cleft lip/alveolus surgically treated in childhood different from that of normal samples?

Facial height is greater than in controls, and the maxilla–mandibular relationship demonstrates a flat facial angle. Patients with unilateral cleft lip/alveolus (UCLA) have a balanced retrognathic–apertognathic profile. With the least severe deformity, UCLA craniofacial status is closer to the normal population than to the remaining oral cleft population.

48. How is the craniofacial status of adult patients with isolated UCLP surgically treated in childhood different from that of normal samples?

Facial height tends to be larger than in controls. The facial angle demonstrates a retrusive configuration with midfacial deficiency. The maxillofacial abnormality is explained by the severity of the deformity of patients with UCLP, manifest as a long-face, backward-divergent, and midfacial-deficient profile. Mandibular deformity is independent of severity of UCLP deformity.

49. How is the craniofacial status of adult patients with isolated BCLP surgically treated in childhood different from that of normal samples?

A similar deformity pattern to UCLP is found in BCLP with bimaxillary dentofacial retrusion, clockwise facial rotation, lower facial height enlargement, and retrocheilia (reduced upper lip thickness).

50. How is the craniofacial status of infants with isolated CP different from that of the CLA sample?

The structures that are shorter in infants with CP compared with CLA (an acceptable normal standard) are maxillary length, posterior maxillary height, mandibular length in both corpus and ramus, nasopharyngeal depth and height, and anterior cranial base length. Larger structures are mandibular angle (gonial), palatal plane angle, and open facial rotation. In summary, infants with CP represent a different population from infants with isolated clefts of primary palate.

51. How is the craniofacial status of adult patients with isolated CP treated and untreated in childhood different from that of normal samples?

Whether or not surgically treated in childhood, the craniofacial status is about the same in adults with CP. The maxilla is shorter in length and retruded in position. The mandible is more posterior and retrognathic and smaller, with an increased plane angle; it is like the mandible found in patients with complete oral cleft and primary cleft palate. The facial angle, however, is not unlike that of controls. Differences are also found among the different types of CP. Patients with clefts of only the soft palate have the least affected maxilla but the most retrognathic profile. Patients with soft and partial hard palate cleft have the most retruded maxilla. Cases with soft and complete hard palate cleft have the best overall facial balance, nearly normal mandibular form, and profiles that are not retrognathic.

52. How does a pharyngeal flap affect facial development?

Done rather early in life, a pharyngeal flap contributes mechanical, functional, and tissue factors affecting facial growth. The flap causes a greater reduction in forward maxillary growth than what ordinarily occurs. The maxillary vertical dimension is unaffected. A greater facial opening rotation maintains facial balance. In general, restraint, scar, and increased nasal impedance to airflow disturb maxillary growth.

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