An Anatomical Study of the Columella and the Protruding Premaxillae in a Bilateral Cleft Lip and Palate Infant

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An anatomical reconstruction of the protruded premaxillary segment of an infant with *bilateral cleft* of the *primary palate* was made from serial histological sections and described in comparison with the reconstructed *columella, alar cartilages, nasal septum,* and *premaxillae* of a neonatal control specimen. Most of the bilateral cleft abnormality was seen in the premaxillary bones which were advanced on the nasal septum and whose alveolar processes protruded anteriorly into the columellar area. The medial crura of the alar cartilages and the nasal septum in the cleft specimen showed an essentially normal structure. Underdevelopment of the columella was considered as primarily failure in the development of columellar skin caused by the invasive obstruction by the premaxillary bones.

Underdevelopment of the columella in the infant with bilateral clefts of the primary palate is a constant feature and one which we have tended to regard as secondary to the protruded condition of the premaxillae. The abnormal protrusion of the premaxillary bones has been demonstrated with dried skull preparations (Atherton, 1974, and Veau, 1926), in graphic reconstruction (King, 1954) and in histological sections (Latham, 1973). Some observations on the condition of the medial crura of the the alar cartilages and the nasal septum, which support the columella and the nasal tip, have been reported (Latham and Workman, 1974).

The structure of the medial crura of the alar cartilages and their relationships to the cartilaginous nasal septum and the protruded premaxillary bones in the bilateral cleft infant were studied histologically and by anatomical reconstruction. The same structures from a noncleft infant were similarly studied for comparison. A substantial protrusion and deformity of the premaxillary region was demonstrated in relationship to the apparently normally formed medial crura of the alar cartilages.

Materials and Methods

The naso-premaxillary region of a full-term fetus with bilateral cleft lip and palate (Figure 1) and that of a neonatal infant with normal facial development were removed for histological study. The blocks of tissue were decalcified in seven per cent formic acid, dehydrated, and embedded in low viscosity nitro-cellulose for sectioning in the horizontal plane on a Leitz sledge microtome. Sections were cut at a setting of 30 microns, and alternate sections were stained by the Masson trichrome method. Alternate sections were projected onto a drawing board at a magnification of 10 times using a photographic lens. The structural outlines of the cartilaginous and bony structures were drawn on sheets of blotting paper of a thickness of 0.5 millimeters; these

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were then dipped into molten paraffin wax. The outlines were cut out and assembled, and the resulting structures were mounted. The overlying soft tissues of the lip and nose were also reconstructed in the control specimen. Structures of bone and cartilage were coated with white and blue acrylic paint (water based) respectively.

As an aid to comparing the control and cleft reconstructions, the lateral and inferior views were drawn in the form of diagrammatic representations. The soft-tissue profile was drawn from an actual reconstruction in the case of the control and drawn in for the cleft specimen with reference to Figure 1. The following structures of the normal specimen were identified in their normal anteroposterior sequence by the letters A, B, C, and D: medial crus (A), nasal septum (B), anterior nasal spine (C), and alveolar process (D) (Figures 7A and 8A). Comparable structures in the cleft specimen were identified with the same letters (Figures 7B and 8B).

Findings

PREMAXILLARY BONES. In the normal specimen the premaxillary bones (both basal and alveolar parts) lay well posteriorly to the medial crura of the alar cartilages and also posteriorly to the antero-inferior corner of the nasal septum (Figures 2 and 4).

In the cleft specimen, the premaxillary bones occupied a grossly advanced position. The anterior nasal spine was adapted to the anterior border of the nasal septum in an extremely anterior position and was located in the posterior fork of the medial crura of the alar cartilages. The premaxillary basal bone, which would include the anterior nasal spine,

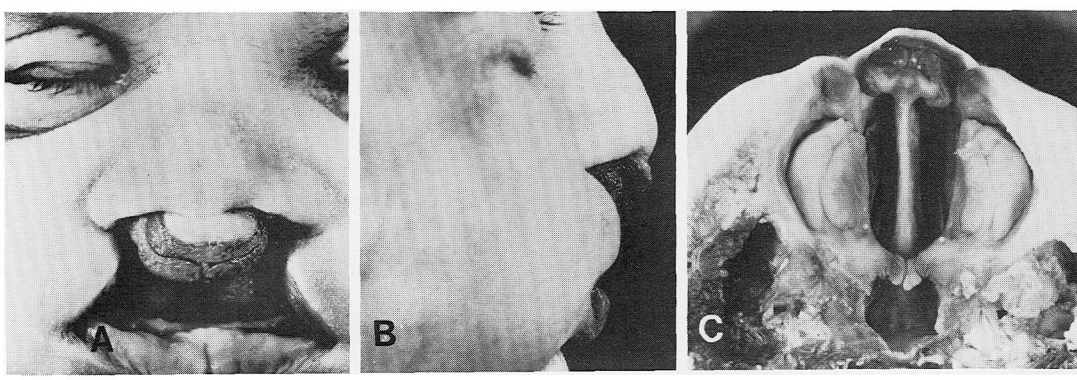
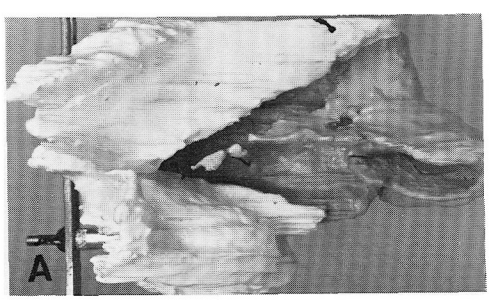


FIGURE 1A. Front face photograph of full-term fetus with bilateral cleft lip and palate. 1B. Profile view of same specimen. 1C. Palatal view.



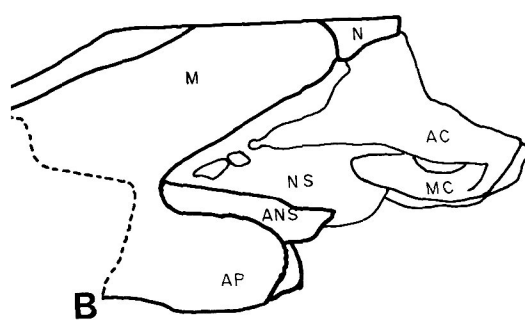


FIGURE 2A. Lateral view of reconstructed naso-premaxillary cartilage (grey in photograph) and bone (white) of normal full-term fetus.

FIGURE 2B. Outline tracing of photograph in Figure 2A. showing alar cartilage (AC), medial crus of alar cartilage (MC), nasal septum (NS), anterior nasal spine (ANS), labial plate of alveolar bone (AP), nasal bone (N), and maxilla (M).

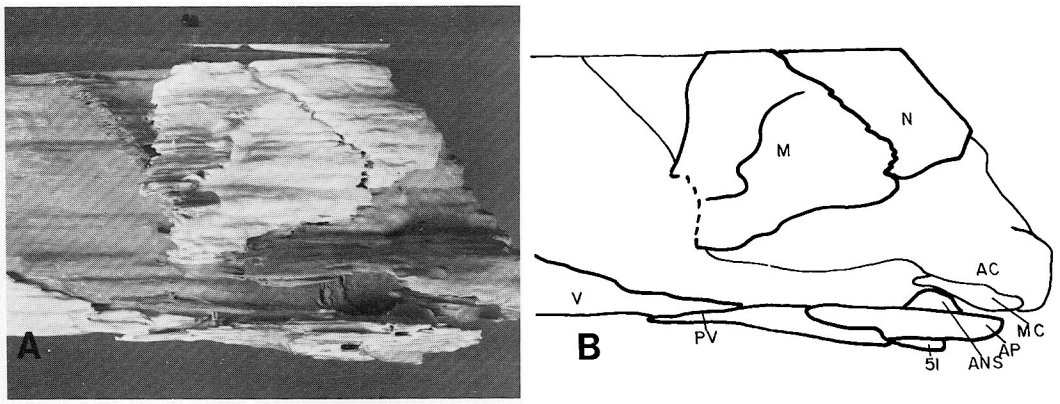


FIGURE 3A. Lateral view of reconstructed naso-premaxillary segment of bilateral cleft infant. The premaxillary bones are particularly small and appear flattened since soft tissue is not shown.

FIGURE 3B. Outline tracing of photograph in Figure 3A, showing alar cartilage (AC), medial crus of alar cartilage (MC), premaxillary alveolar bone (AP), premaxillo-vomeral suture (PV), vomer (V), nasal bone (N), frontonasal process of maxilla (M), and primary incisor tooth (51).

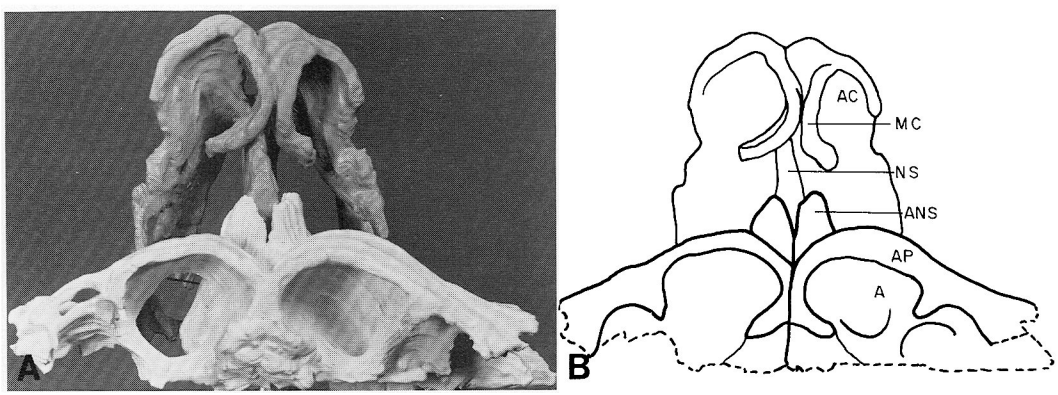


FIGURE 4A. Inferior view of reconstructed normal naso-premaxillary region. Medial crura of alar cartilages are well shown extending from and supported by nasal septum. Anterior nasal spine is a bifurcated structure with midpalatal suture showing in midline.

FIGURE 4B. Outline tracing of photograph in Figure 4A. Labelling as for Figure 2B. Alveoli of primary incisors (A).

was obviously abnormally forward in relationship to the cartilaginous nasal septum (Figures 3 and 5). In addition, the premaxillary alveolar bone protruded relative to its basal bone. The total protrusion carried the alveolar process so far anteriorly as to position it directly inferior to the columellar cartilages, obscuring them from view. The premaxillary bones bore little resemblance to the normal structures.

The incisor teeth appeared to have a vertical orientation. The paired premaxillary bones were joined in the midline by the interpremaxillary suture. They overlapped the vomer posteriorly and formed with it a tongue and groove type joint. The single vomer (the tongue) extended anteriorly between the premaxillary bones (Figures 3, 5, 7B and 8B).

ALAR CARTILAGES. The medial crura of the alar cartilages in the cleft specimen were comparable in form to those in the noncleft specimen (Figures 4 and 6). Their antero-posterior relationship to the anterior border of the nasal septum was also comparable (Figures 2, 3, 4, and 6). Inferiorly, the medial crura of the cleft specimen were almost completely obscured by the protruding alveolar process of the premaxillae (Figures 3, 5, 7B and 8B), while, in

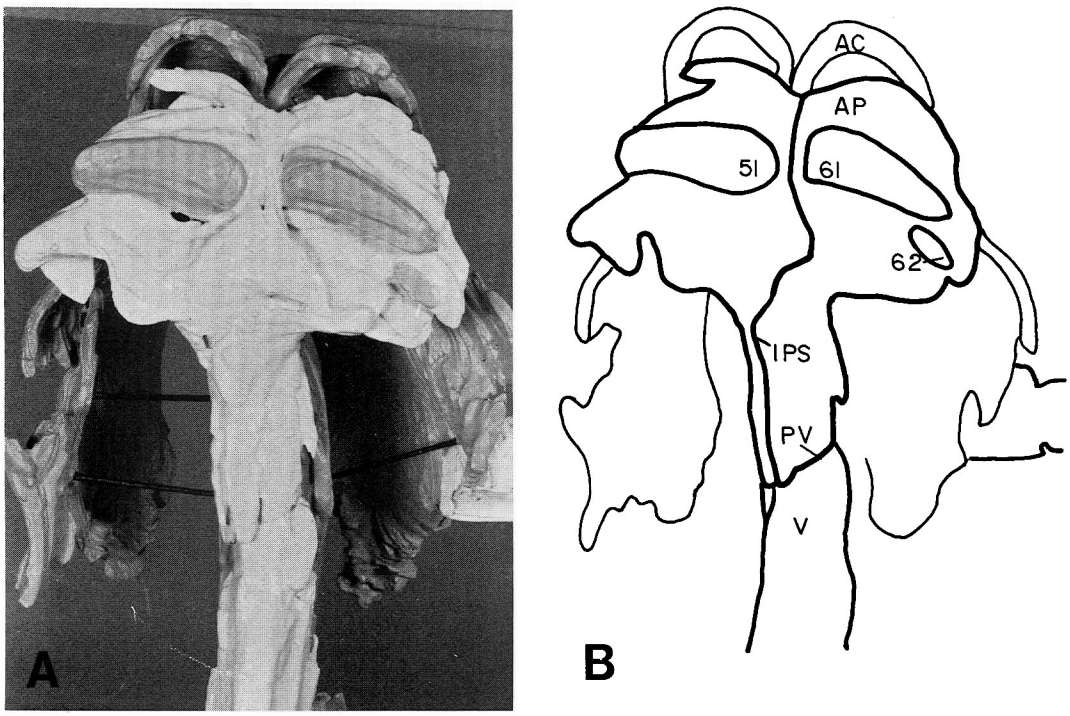


FIGURE 5A. Inferior view of reconstructed naso-premaxillary segment of bilateral cleft infant showing superimposition of premaxillary alveolar process on columellar cartilages. Shows well the skeletal midline structures.

FIGURE 5B. Outline tracing of photograph in Figure 5A. Primary incisor teeth 51, 61, 62. Interpremaxillary suture, IPS.

the normal specimen, these structures were widely separated (Figures 2, 4, 7A, and 8A).

NASAL SEPTUM. The normal naso-premaxillary region showed a free border of the cartilaginous nasal septum anterior to the premaxillary bone (Figures 2 and 4). The medial crura of the alar cartilages, for the most part, were positioned anterior to the nasal septum, but their posterior ends overlapped it for a short distance. In the cleft specimen no differences in the structure of the nasal septum and alar cartilages were noted (Figures 3 and 6) apart from their being obscured from view by the premaxillary bones.

Analysis of protrusive premaxillary deformity

Comparison of representative diagrams in which the distinct skeletal structures were demarcated anteroposteriorly and labelled with the letters A, B, C, and D showed that the deformity involved mainly the premaxillary bones. Structures A and B in the cleft condition were comparable to the same structures in the control. These represented the medial crura of the alar cartilages and their relationship to the nasal septum (Figures 7 and 8). The structures that differed were the anterior nasal spine and the alveolar process of the premaxillae. These components, indicated by C and D, were advanced and protruded to the extent of almost complete superimposition upon the components A and B in the bilateral cleft condition (Figures 7 and 8). Intrinsic deformity of the premaxillary bones was illustrated by the protrusion of the alveolar process relative to the anterior nasal spine. These structures (C and D), in contrast to the control specimen, were superimposed one upon the other.

Discussion

Next to the presence of the clefts themselves, the main abnormality of the bilateral cleft palate infant was the abnormal protrusion of the premaxillary alveolar process. Part of this represented an advanced position of the basal premaxillary bone, and part was because of a grossly protruding alveolar process. During development, the basal premax-

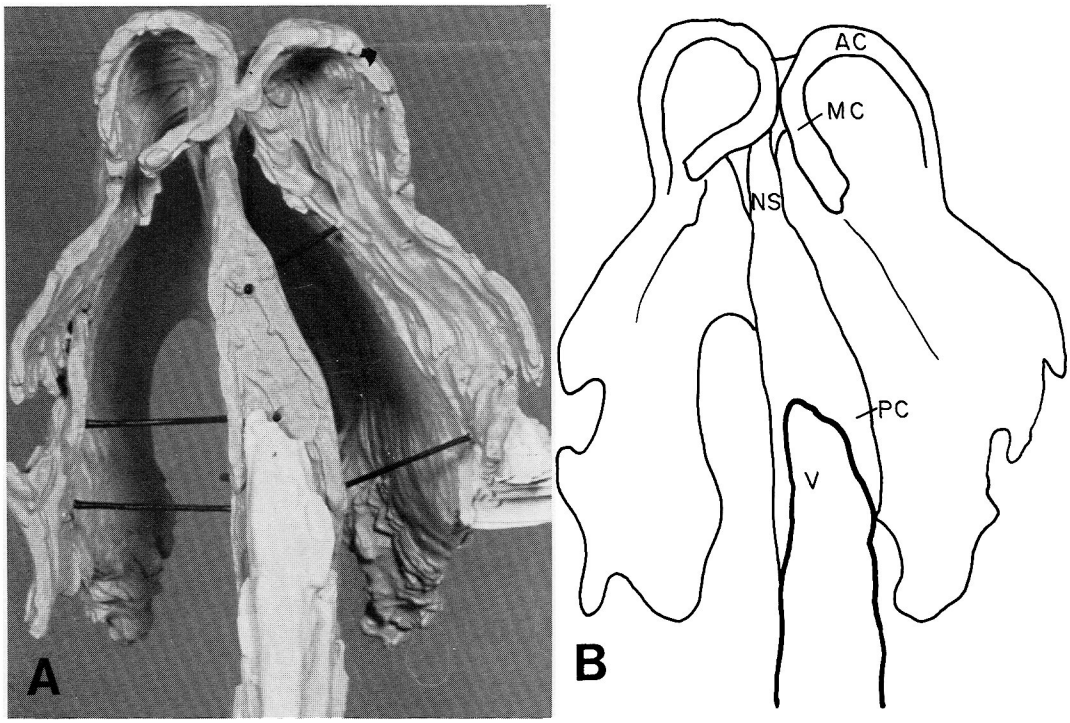


FIGURE 6A. Inferior view of reconstructed bilateral cleft with premaxillary bones removed. Medial crura of alar cartilages appear in normal relation to nasal septum as compared with relationships seen in normal specimen. (Figure 4A).

FIGURE 6B. Outline tracing of photograph in Figure 6A. Vomer (V) articulates with nasal septum (NS) superiorly. Anterolaterally, it is flanked by paraseptal cartilages (PC). These are bilateral appendages of nasal septum.

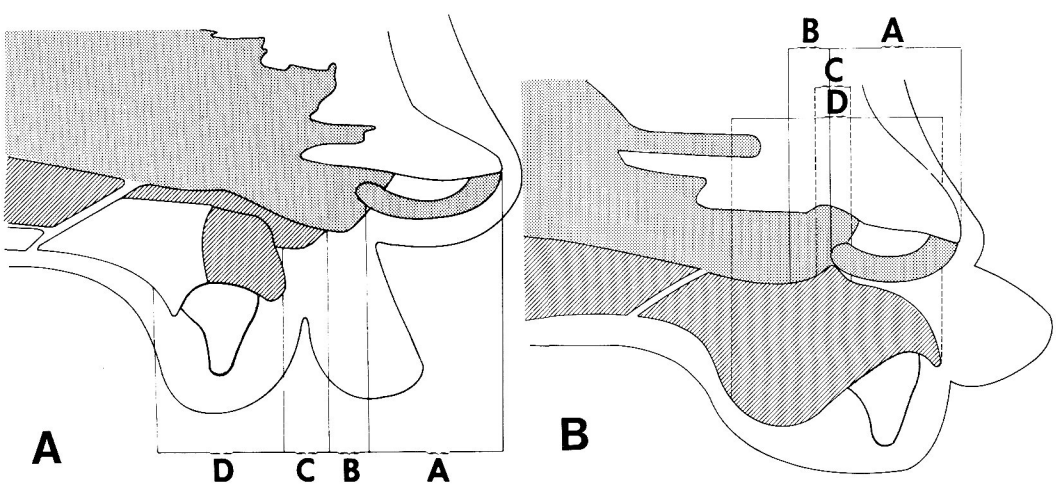


FIGURE 7A. Diagrammatic outline of normal naso-premaxillary structure. Soft tissue profile has been added to show relationship to underlying cartilage and bone. Major structural features of midline are identified anteroposteriorly: A. Medial crus of alar cartilage; B. Free inferior border of cartilaginous nasal septum; C. Anterior nasal spine; D. Alveolar process. Note anteroposterior arrangement A-D. (Modified from J. M. Converse, Editor, Reconstructive Plastic Surgery, 2nd ed., Chapt. 40. Philadelphia: W. B. Saunders Co., 1977.)

FIGURE 7B. Diagrammatic lateral view of bilateral cleft naso-premaxillary region. Comparable structures Figure 7A. are identified by same letters A-D. Note superimposition of premaxillary bone (D) on columellar cartilage (A). (Modified from J. M. Converse, Editor, Reconstructive Plastic Surgery, 2nd ed., Chapt. 40. Philadelphia: W. B. Saunders Co., 1977.)

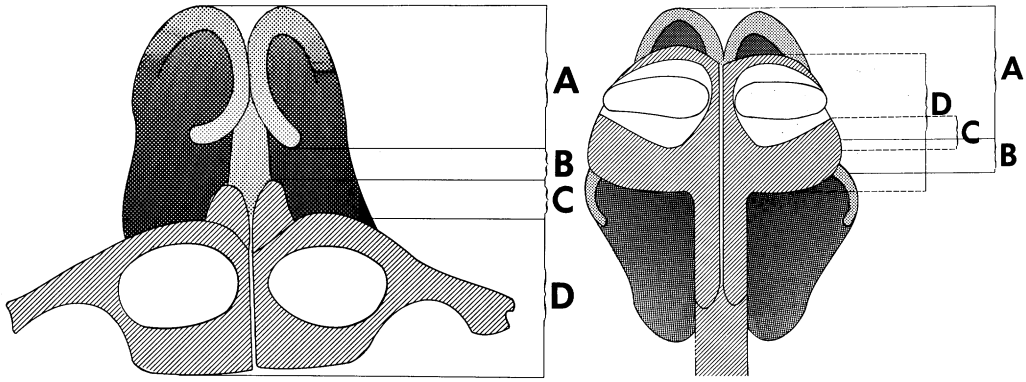


FIGURE 8A. Diagrammatic inferior view of normal naso-premaxillary region based on Figure 4. Letters A-D correspond to those in Figure 7A.

FIGURE 8B. Diagrammatic inferior view of bilateral cleft nasopremaxillary segment based on Figure 5. Lettering A-D identifies same structures that are arranged in anteroposterior sequence in the control specimen. Abnormality of premaxillary form and position is considerable. Indicated by superimposition of components C and D upon A and B.

illary bone may have moved anteriorly in relationship to the nasal septum. On the other hand, if the forward position of the basal bone represented an earlier embryonic relationship, then there would have been a failure of the premaxillae to move posteriorly during growth. The position of the basal premaxillary bone appears to be determined by a fibrous attachment to the nasal septum. Histological examination of the septo-premaxillary junction in normal embryos and fetuses has revealed a distinct attachment by fibrous tissue arising from the antero-inferior border of the nasal septum and inserting onto the anterior nasal spine of the maxillae. There is some evidence that this attachment may be important in the normal prenatal development of the middle third of the face. The forward growing cartilage of the nasal septum appears to apply a downward and forward force to the maxillae by means of the septo-premaxillary attachment (Scott, 1953; Latham, 1970). Normally the cartilaginous nasal septum must slide forward in relationship to the premaxillary region which is under restraint laterally by the continuity of structure maxillary bone, mucogingival gum-pads, and lips. Thus the anterior nasal spine normally comes to occupy a position posterior to the anterior border of the nasal septum. In the bilateral cleft condition, the behaviour of the isolated premaxillary segment is a reflection of its two remaining attachments with the nasal septum anteriorly and the vomer posteriorly. As the nasal septum grows forward, placing a tension on both of these two joints, their respective responses differ. The septo-premaxillary attachment does not yield or adjust and a static relationship persists at that position, whereas, at the premaxillo-vomeral suture, such tension stimulates growth, osteogenesis at the sutural surfaces, and a continuing adjustment of the collagenous connections between these bones. The premaxillo-vomeral stem abnormally elongates and the premaxillary segment remains at the antero-inferior angle of the nasal septum in an unchanged protrusive relationship.

The term *columella* refers to the fleshy distal margin of the nasal septum consisting of skin supported by the medial crura of the alar cartilages. The failure of columellar development cannot be attributed to abnormality of the medial crura of the alar cartilages because these are relatively normal in both their structure and their relationship to the nasal septum. In normal anatomy, columellar skin develops between the nasal tip and the upper lip. The upper lip is attached to the underlying premaxillary bone by muscle fibers and adapts further by the sphincteric form of the obicularis oris muscle (Latham and Deaton, 1976). Therefore, the position of the underlying bone appears to be an important factor affecting columellar growth and development.

In the bilateral cleft condition, the nasal tip and the alveolar process are juxtaposed. Therefore, the skin of the nasal tip passes directly into the skin of the lip covering the

alveolar process. It is probable that, during prenatal growth, there is a lack of tension between the tip of the nose and the upper lip which normally stimulates growth of the columellar skin. The space usually occupied by columellar skin has been invaded and occupied by the premaxillary bones in such a way as to compete with the normal growth and development of the columellar skin. It may, however, be quite the reverse of an invasion with the lip inducing anterior alveolar growth.

The abnormal positioned and malformed premaxillary segment of the bilateral cleft condition cannot be considered to represent precocious growth along the normal growth pattern. From a clinical point of view, only intervention that would tend to remove the premaxillae from the space that should be columella would initiate a normal growth pattern in the columellar region.

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