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Original Article

Pre-maxillary complex morphology in bilateral cleft and hypothesis on laterality of deviated pre-maxilla

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ABSTRACT

Introduction: Pre-maxillary complex (pre-maxilla [PMX] + vomer) morphology in bilateral complete cleft of primary and secondary palate (BCLCP) is very complex and less reviewed in literature. **Materials and Methods:** In this retrospective cross-sectional study, 200 consecutive BCLCP patients were selected. Their pre-operative clinical photographs and dental casts were evaluated by a single investigator at two different points of time, to study the morphology of PMX and vomer with special emphasis on deviation of vomer and rotation of PMX. **Results:** It is found that in above 70% of patients, PMX and vomer both displaced or deviated towards left side in horizontal plane and PMX rotated anticlockwise at PMX vomerine suture (PVS). In 10% of cases, both PMX and vomer are displaced towards the right side, PMX rotated clockwise at PVS. In 11% of cases, vomer is displaced towards the left side, but PMX rotated clockwise at PVS. In 5% of cases, vomer is displaced towards the right side, but PMX rotated anticlockwise at PVS. Both PMX and vomer are in midline in 4% of cases. **Conclusion:** Specific morphological deviation of vomer and PMX has been studied. We put forward the probable hypothesis to explain the deviation and rotation of PMX.

KEY WORDS

Anticlockwise; bilateral complete cleft of primary and secondary palate; clockwise; cross-sectional; pre-maxilla; pre-maxillary-vomerine complex; pre-maxillary-vomerine suture; retrospective

INTRODUCTION

The discovery of the pre-maxillary bone (os incisivum, os intermaxillare or pre-maxilla [PMX]) in humans has been attributed to Goethe, and it has also been named os Goethei.[1] Coiter (1573) was the first to present an illustration of the sutura incisiva in the human.[1] The PMX (or os incisivum) is an autonomous paired bone develops from the frontonasal process comprising three parts: first, the alveolar part with facial process which encompasses two pairs of incisor teeth, second, the palatine process and third, the processus Stenonianus that fuses with the nasal cartilaginous

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septum and the vomer.[2] The PMX acts as a stabilising element within the facial skeleton comparable with the keystone of a Roman arch.

Embryology and anatomy of pre-maxilla-vomerine complex

Victor Veau accurately predicted this: 'All cleft surgery is merely applied embryology'.[3] Moreover, therefore, understanding embryology of PMX is of paramount importance, especially in bilateral cleft of lip and palate. Of all facial bones, the development of PMX is the most controversial. The nasomaxillary complex is a series of neural crest bones, each of which is innervated by a specific branch of V2. These neural crest cell populations migrate forward into the developing face in a strict temporospatial order leading to the formation of pre-maxillary complex in the following order (from oldest to newest):[4]

Sphenoid > perpendicular plate of ethmoid (PPE) > PMX > cartilaginous septum > vomer.

At an early period, the septum of nose consists of a plate of cartilage i.e., the ethmovomerine cartilage. The posterosuperior part of this cartilage is ossified to form the PPE, its anteroinferior portion persists as the septal cartilage, while the vomer ossified in the bilaminar membrane from r2` neural crest. The thin bony vomer is really an amalgam of two separate embryonic laminae, supplied by the proximal segment of medial sphenopalatine artery. It has four borders, three of which bear articulations:

- Along the superior border is a grooved receiving rostrum of sphenoid, and lateral horizontal wings projecting laterally articulating with vaginal processes of the medial pterygoid plate
- The inferior border articulates with a both the maxillae and the palatine bones through the nasal crest
- The anterior border slopes downward and forward which bears two articulations, posteriorly with the PPE and anteriorly with septum
- The posterior border of vomer is free and concave.

The growth of the vomer takes place backwards and downwards. Deficiency of the vomer at the inferior and posterior border will lift the vomer out of its proper horizontal fusion plane with the palatal shelves leading to a cleft of the secondary hard palate.[3]

PMX position is determined by the nasal septum which forms the base of PMX that can be explained by the presence of 'septopremaxillary ligament' which is a principal bundle of fibres arising from the anteroinferior border of the nasal septum and coursing posteroinferiorly to an insertion on the anterior nasal spine, to the tissues of the interpremaxillary suture and a broad insertion on the facial and nasal surface of the pre-maxillary bones. The nasal septum is growing downwards and forwards would apply a 'pull' upon the pre-maxillary bone, rather than a push leading to rotation at PMX vomerine suture (PVS) due to tension at vomer stalk.[5] Pre-maxillary complex shows considerable lateral mobility because the bones and cartilages that attach to it to the base of the skull are particularly frail.[6] In unilateral complete cleft of primary palate with/without secondary palate, distal septum deviates to contralateral side and proximal septum at internal valve shift ipsilaterally with hypertrophy of inferior turbinate on cleft side.[7] The biomechanics and dynamics in bilateral complete cleft of primary and secondary palate (BCLCP) are entirely different.

MATERIALS AND METHODS

This is a retrospective cross-sectional study conducted at cleft and craniofacial tertiary care centre. Two hundred consecutive BCLCP patients were selected. These children were non-syndromic without any pre-operative orthopaedic manipulation of vomer and PMX. Pre-operative clinical photographs i.e., frontal and worms view [Figure 1], pre-operative dental casts were taken from the cleft centre records and evaluated whichever was more informative and clear for studying the positioning of pre-maxillary complex. The most anterior midpoint of PMX (P), most anteromedial point on both lateral segment (M and M`) and an arbitrary fixed point corresponding to the PVS were taken as reference points on casts to see the deviation in horizontal plane [Figure 2]. Vomer was found to be displaced towards one side and PMX found to be displaced and rotated at an axis of rotation passing through PVS.

RESULTS

There is a tendency of vomer to shift or deviate towards one side i.e., mostly on left side and PMX found to be rotated; most of the times, it rotates anticlockwise leading to superior and outward projection of PMX (into the left nostril). The following different morphology was noted of PMX-vomerine complex and lateral palatine shelves.

Figure 1: The deviation of pre-maxilla and vomer in worms view and frontal view

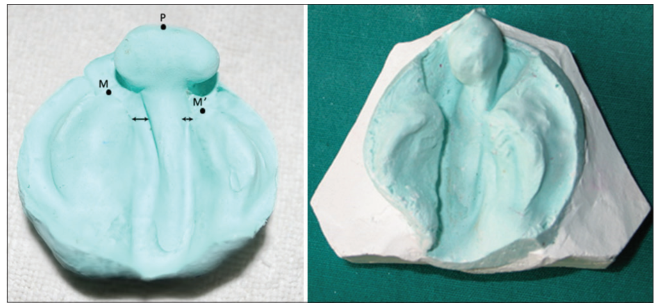

Figure 2: The displacement of vomer and pre-maxilla towards left side in dental models

1. In above 70% of patients, PMX and vomer both displaced or deviated towards left side in horizontal plane, PMX rotated anticlockwise at PVS
2. In about 10% of cases, PMX and vomer are displaced towards the right side, PMX rotated clockwise
3. Vomer and PMX are in midline in 4% of cases
4. Vomer is displaced towards left side but PMX rotated clockwise in 11% of cases
5. In 5% of cases, vomer is displaced towards the right side, but PMX rotated anticlockwise
6. The palatal shelf facing the deviated/displaced vomer is placed more vertically inclined whereas opposite side is found to be less inclined and more horizontal. In patients whom the PMX and vomer are in midline, the palatal shelves are inclined at same plane.

DISCUSSION

The most striking characteristic of complete unoperated bilateral cleft lip and palate (BCLP) is the anterosuperior and lateral projection of the basal[5,8,9] parts of the PMX. Such a characteristic becomes evident at the 45th day of intrauterine life.[10,11] According to Handelman and Pruzansky,[12] the cause of pre-maxillary protrusion is the result of tension and the resulting bony overgrowth produced at PVS combined with the pushing force of the tongue fitting within the cleft.[12]

We propose hypothesis for anatomical deviation of vomer and pre-maxillary complex:

1. Foetal ventilatory dynamics has a major role to play in facial growth and its morphological changes.[6] First breathing movement start at 10 weeks of gestation and the foetus starts inhaling amniotic fluid through the nostril at 4 months. The foetus actually inhales as twice as the mother swallows.[13,14] Amniotic fluid is incompressible and has a very high density as compared to air.[7] At 18–20 weeks, foetal breathing is superficial, regular and paradoxical. This continuous to-and-fro movement of amniotic fluid corresponding to inspiration and expiration fifty times a minute provides a significant stimulus for morphogenesis. The breathing is dominant in right nostril more than left nostril as explained by lateralisation in brain. As per Yogic sciences, nostril side changes every 90 min, there is one side is predominant[15] in every individual according to the type of hemisphere dominance. As per the literature,[16,17] right side movements (muscle action) will be dominant in foetus. Asymmetric brain development and behaviour in two hemispheres may be the reason for the right side dominance breathing. The differential movement of amniotic fluid with right-side dominance of breathing leads to flexing of vomer towards left side. There is also rotation of PMX leading to superior into the left nostril to give way for amniotic fluid flow during foetal breathing
2. By around 22 weeks of gestation, the left cerebral hemisphere compared to the right is significantly larger in both male and female foetuses, so the right side of the foetal face would show more movement.[18] Difference in muscular dynamics leading to more lateral pull on the right maxillary segment as compared to the left lateral segment resulting in an apparent deviation of vomer towards the left side. This early lateralisation is also responsible for the right-handedness of the individual as two-third of the population is right-side dominant[19]
3. The palatal shelve side facing the deviated vomer is placed more vertically inclined as compared to opposite lateral palatal shelves. When vomer is not deviated, lateral palatal shelves are found to be equally vertically inclined. The deviated vomer likely to cause obstruction of respective palatal shelf movement to come to horizontal position, leading to more vertically inclined palatal shelf compared to other side.

CONCLUSION

The exact reason for this interesting finding is not clear, whether developmental embryology or physiology has a major role to play. The morphological findings described in our study establish in early foetal life which imply spectrum of repercussions of physiological processes and facial envelope dynamics.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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