

Analysis of Fetal Palate to Assist Pre-natal Ultrasound

ANJALI SHASTRY¹, YOGITHA RAVINDRANATH², ROOPA RAVINDRANATH³

ABSTRACT

Introduction: Cleft palate is one of the major facial congenital malformation in newborns. Pre-natal detection of this malformation is limited to detection of clefting of hard palate but isolated soft palate clefting still remains challenge for sonologists. As Indian literature is limited present study was attempted to provide dimensions and position of fetal palate by digitized images.

Aim: To study dimensions, position and differences in parameters between second and third trimester fetuses.

Materials and Methods: Median sagittal section of 32 formalin fixed fetuses was selected from the Department of Anatomy, St John's Medical College, Bangalore, Karnataka, India. Anatomical landmarks-The Nasion (N), Sellaturcica (S), Anterior Nasal Spine (ANS), Posterior Nasal Spine (PNS), tip of Uvula (U) were marked on sections. Length of hard palate (from ANS to PNS), Length of soft palate (from PNS to U), Hard palate/soft

palate angle was defined. The anterior position of soft palate and its posterior position in relation to anterior cranial base were marked as N-S-PNS and N-S-U angle, respectively. The measurements were acquired directly from the digitized images using ImageJ software. Statistical analysis was done using SPSS 16.

Results: The mean values of ANS-PNS and PNS-U were 23.59 ± 3.69 mm and 14.39 ± 2.70 mm, respectively. The mean values of hard palate/soft palate angle, N-S-PNS and N-S-U angle were 144.720 ± 11.11 , 51.150 ± 9.09 and 93.370 ± 9.58 , respectively. Significant difference was noted between trimesters for length of hard and soft palate but not for palatal angles.

Conclusion: During Pre-natal assessment of cleft palate, it is important for sonologist to keep in mind that the dimensions of palate proportionately increased in last two trimesters while the position remains constant.

Keywords: Cleft palate, Facial growth, Fetal development, Pre-natal diagnosis, Soft palate, Ultrasonography

INTRODUCTION

The palate forms the roof of the mouth. It is divisible into two regions, namely the hard palate in front and soft palate behind [1]. The primary palate includes the lips and jaw, nasal bone and secondary palate consists of hard palate, which runs behind and horizontally of the incisive foramen and soft palate or velum, which curves downwards and backwards from the posterior part of the hard palate and ends in the uvula [2]. Usually the clefting of the secondary palate is always in midline and results from failure of the palatine processes to elevate and grow [2]. Even with an isolated cleft lip there is an increased risk of chromosomal abnormality and over 250 syndromes are associated with clefting which necessitates appropriate genetic, surgical and psychological counseling [3-5]. The role of Pre-natal education and support is extremely important in the preparation of prospective parents. Only 0% to 22% of cases are being detected Pre-natally [5-7]. Visualization of soft palate is difficult. Angled insonation and 3D-ultrasound visualization helps to get better picture of fetal palate. The obstruction of viewing the palate is more caused by maxillary shadow which makes it necessary to study the morphometry of palate. The development of an ultrasound technique to view the fetal soft palate might have been impeded by sonographers' lack of knowledge of the appearance of the fetal soft palate on 3D ultrasound examination [8]. With invention of in-utero surgeries, repair of cleft lip and palate has led to scarless repair since there is tremendous healing power in fetus. Information regarding dimensions and repair of cleft palate will help in these surgeries and reduce postnatal reconstruction which might result in scarring.

Considering above facts present study has been done to aid Pre-natal ultrasound visualization in fetuses of different periods of gestation.

AIM

To study morphometry, position of fetal palate and difference in these parameters between last two trimesters of pregnancy.

MATERIALS AND METHODS

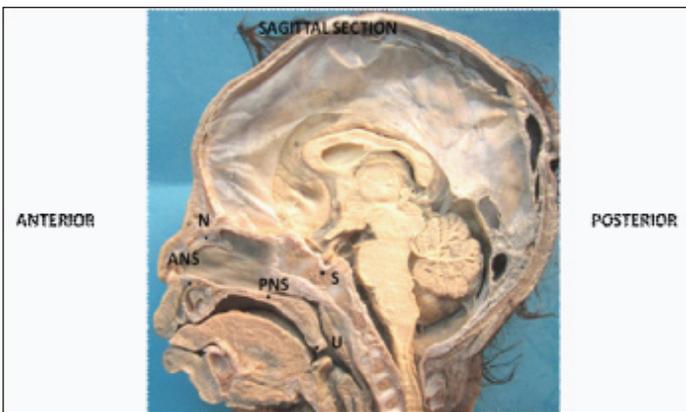
A cross-sectional observational study was done on median sagittal section of 32 formalin fixed fetuses (16-2nd trimester, 16-3rd trimester) for 3 months from the collection of Department of Anatomy, St John's Medical College, Bangalore over period of 10 years. Consent of the voluntary parental donors and the institutional ethical review committee was obtained prior to foetal study as per the norms of the Institute. These fetuses were donated following spontaneous abortion/delivered following intrauterine death/still birth reason of which is not known. Fetuses with congenital malformation and deformities were excluded. Sample size was calculated using mean and standard deviation from literature done by Captier G et al., using N master software [9].

- Anatomical landmarks-The Nasion (N), Sellaturcica (S), Anterior Nasal Spine (ANS), Posterior Nasal Spine (PNS), tip of Uvula (U) were marked on sections [Table/Fig-1].

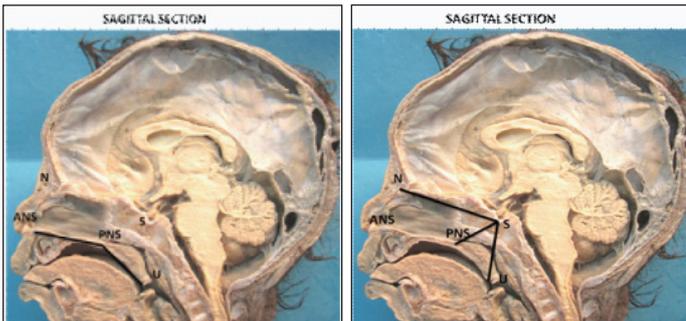
- Length of hard palate (from ANS to PNS), Length of soft palate (from PNS to U), Hard palate/soft palate angle was defined [Table/Fig-2].

- The anterior position of soft palate and its posterior position in relation to anterior cranial base were marked as N-S-PNS and N-S-U angle respectively [Table/Fig-3].

- Digital photographs of sagittal section of all 32 formalin fixed fetuses were taken. To best of our knowledge this is a novel method of using digital photograph and ImageJ analyser. The sections were placed on osteometric board in such a way that its



[Table/Fig-1]: Anatomical landmarks defined on sagittal sections.



[Table/Fig-2]: Measurement of hard palate (ANS-PNS), Soft palate (PNS-U), Hard palate/soft palate angle. [Table/Fig-3]: Measurement of N-S-PNS and N-S-U angle.

sagittal section was pointing upwards. A digital camera was fixed to stand of osteometric board for proper focus and centered along with sections on the board. A scale was placed near sections to convert it into pixels to obtain measurements.

• The measurements were acquired directly from the digitized images using ImageJ software. ImageJ is a Java based application for analysing images. ImageJ runs either as an online applet or as a downloadable application which you'll find here. ImageJ can display, edit, analyse, process, save and print 8-bit, 16-bit and 32-bit images and supports most major formats including TIFF, GIF, JPEG, BMP, DICOM, FITS and "raw". The main use of ImageJ is that it can calculate area and pixel values which may be useful for graphic designers. It does, however, go a little beyond that too, allowing you to measure distances and angles, create density histograms and also line profile plots. A single user can operate this software.

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS version 16. Differences in trimesters were estimated using Independent sample t-test (p -value < 0.05 considered significant).

RESULTS

As seen in [Table/Fig-4] significant difference was noted between trimesters for length of hard and soft palate ($p < 0.05$). There was no significant difference between last two trimesters in hard palate/soft palate angle, as well as N-S-PNS and N-S-U angle.

Parameters	2 nd trimester	3 rd trimester	p-value
	Mean \pm SD	Mean \pm SD	
Hard palate length (mm)	21.36 \pm 2.99	25.83 \pm 2.92	.000
Soft palate length (mm)	13.02 \pm 2.32	15.71 \pm 2.43	.003
Hard palate/soft palate angle	143.37 $^{\circ}$ \pm 11.21	146.07 $^{\circ}$ \pm 11.58	0.52
N-S-PNS	50.89 $^{\circ}$ \pm 8.74	51.42 $^{\circ}$ \pm 9.67	0.87
N-S-U	96.29 $^{\circ}$ \pm 6.27	90.45 $^{\circ}$ \pm 11.52	0.86

[Table/Fig-4]: Mean, SD, p-value of the measured parameters of 2nd and 3rd trimester fetuses.

DISCUSSION

In present study, done on formalin fixed fetuses dimensions of hard as well as soft palate proportionately increased in last two trimesters of pregnancy. This shows that there is rapid growth in measurements of both hard and soft palate with growth of facial skeleton. But position of soft palate with respect to hard palate (hard palate/soft palate angle) and anterior cranial base (N-S-U & N-S-PNS) remained same.

In a cadaveric study done by Captier G et al., on French population by digital images there is disparity in dimensions of palate as seen in [Table/Fig-5] [9,10]. Possible variation in values may be due to change in ethnicity or environmental factors. Hosapatna et al., studied sagittal sections of 24 formalin fixed Indian dead fetuses of second and third trimester by direct caliper method where hard palate length was higher and soft palate length was lower when compared with our study [Table/Fig-5] [9,10]. The change in dimensions may be due to adoption of different methodology. In study done by Captier G et al., and Hosapatna et al., there was significant difference in hard palate and soft palate length between second and third trimester fetuses. This is in correlation with present study, which indicates there is rapid growth in palatal length in last two trimesters of gestation [Table/Fig-5] [9,10].

Captier et al., studied the anterior position of soft palate and its posterior position in relation to anterior cranial base which is in correlation with our study which reveals that position of soft palate with respect to cranial base does not alter with increase in period of gestation [Table/Fig-6] [9]. Hence, it can be taken as landmark for better visualization of anatomy and position of soft palate throughout the pregnancy.

According to Captier et al., the hard palate/soft palate angle was found to be 150.33 $^{\circ}$ \pm 7.62, 150.20 $^{\circ}$ \pm 6.67 in second and third trimesters, respectively. A 3D ultrasound study done by Faure et al., (2007) calculated the velopalatal or Hard palate/soft palate angle at GA of 20 - 25 weeks which was 150 $^{\circ}$ \pm 7 [11]. In study done by Hosapatna et al., the angle was 141.75 $^{\circ}$ \pm 13.16, and 140.88 $^{\circ}$ \pm 11.72 in second and third trimester respectively which is in correlation with our study [Table/Fig-7] [9-11] indicating there was no significant change in angle with respect to gestational age.

Author / year/ population /n*	Type of study	Hard palate length (mm)		Soft palate length (mm)	
		2 nd trimester	3 rd trimester	2 nd trimester	3 rd trimester
Captier G et al., 2008/ France n=18 [9]	Cadaver	16.52 \pm 0.34	27.44 \pm 0.34	8.74 \pm 0.15	15.83 \pm 0.3
Hosapatna et al., 2013 India /n=24 [10]	Cadaver	29.7 \pm 2	35.6 \pm 3.7	12.5 \pm 2.6	14 \pm 2.3
Present study 2016 India /n=32	Cadaver	21.36 \pm 2.99	25.83 \pm 2.92	13.02 \pm 2.32	15.71 \pm 2.43

[Table/Fig-5]: Comparison of measurements of hard and soft palate with previous studies [9,10]. * n is sample size.

Author / year/ population /n*	Type of study	Hard palate length (mm)		Soft palate length (mm)	
		2 nd trimester	3 rd trimester	2 nd trimester	3 rd trimester
Captier G et al.,/ 2008/France/ n=18 [9]	Cadaver	48.8 $^{\circ}$ \pm 3.13	52.26 $^{\circ}$ \pm 3.31	89.66 $^{\circ}$ \pm 5.51	92.97 $^{\circ}$ \pm 4.01
Present study/2016 India /n=32	Cadaver	50.89 $^{\circ}$ \pm 8.74	51.42 $^{\circ}$ \pm 9.67	96.29 $^{\circ}$ \pm 6.27	90.45 $^{\circ}$ \pm 11.52

[Table/Fig-6]: Comparison N-S-PNS and N-S-U angle with previous studies [9]. * n is sample size.

Author / year / population /n*	Type of study	Hard palate length (mm)	
		2 nd trimester	3 rd trimester
Captier G et al., 2008 France n= 18 [9]	Cadaver	150.33°± 7.62	150.20°±6.67
Faure J.M. et al., 2008 France n= 15 [11]	Ultrasound	150°±7	
Hosapatna et al., 2013 India /n=24 [10]	Cadaver	141.75° ± 13.16	140.88° ± 11.72
Present study /2016 /India (n=32)	Cadaver	143.37°±11.21	146.07°±11.58

[Table/Fig-7]: Comparison of hard palate/soft palate angle with previous studies [9-11].
* n is sample size.

To best of our knowledge very few studies has been done on palate of cadaveric fetuses in Indian literature. With advent of in-utero and plastic surgeries more information regarding normal anatomy and embryology of fetal palate is necessary for surgeons to ensure scarless repair of cleft lip and palate.

Hence, present study can aid in prompt diagnosis of isolated cleft lip and palate which further helps to rule out syndromic association as well as screening of other congenital anomalies.

CONCLUSION

In last two trimester, fetuses position of palate remained constant but dimensions of palate proportionately increased. This should be considered during Pre-natal diagnosis of cleft palate as well

as early intervention during fetal or postnatal period to prevent postnatal complications.

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