Research Article

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A Novel Classification Method for Midpalatal Suture Morphology in South Indian Population: A CBCT Study

Mahalakshmi Krishnakumaran[1*] Sumanth Rangarajan[2] Sudhakar V[3] Ramya Rajendran[4] Nidhin Philip Jose[5] Ananda Devi Chinnasamy[6]

[1]Senior Lecturer, Department of Orthodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai, Tamil Nadu, India.
[2]Reader, Department of Orthodontics, Adhiparasakthi Dental College and Hospital, Melmaruvathur, Tamil Nadu, India.
[3]Professor and Head, Department of Orthodontics, Adhiparasakthi Dental College and Hospital, Melmaruvathur, Tamil Nadu, India.
[4]Reader, Department of Orthodontics, Adhiparasakthi Dental College and Hospital, Melmaruvathur, Tamil Nadu, India.
[5]Associate Professor, Department of Orthodontics, Manipal College of Dental Science, Mangalore, Karnataka, India.
[6]Senior Lecturer, Department of Orthodontics, Adhiparasakthi Dental College and Hospital, Melmaruvathur, Tamil Nadu, India.

ABSTRACT

Background: The aim of this present study is to classify midpalatal suture morphology in South Indian population by CBCT images.

Materials and methods: CBCT scan for 90 subjects in the age group of 8 to 25 years were taken for the study. Cross sectional image analysis in axial plane using CBCT was performed and radiographic stages of midpalatal suture maturation were assessed for the above age group of 8-25 years, as described in the study by Angeleri et al (AJODO 2013) into stage A/B/C/D/E.

Results: Stage A and B typically were observed up to 13 years of age, whereas stage C was noted primarily from 11 to 14 years. Fusion of the palatine (stage D) and maxillary (stage E) regions of the midpalatal suture was completed after 14 years.

Conclusion: This new non-invasive method of classification might provide reliable parameter for the clinical decision between conventional and surgically assisted RME for adolescent and young adult patients.

Keywords: Mid Palatal Suture, Palate, Sutural Ossification, Expansion, CBCT.

INTRODUCTION

Expansion of maxillary arch was introduced by ANGELL in orthodontics over 150 years ago. Opening of mid palatal suture through slow or rapid expansion appliances was advocated by many authors for correction of transverse discrepancies like the posterior crossbites and for coordination of the maxillary and mandibular dental arches prior to orthopedic or functional treatment of Class II and Class III malocclusions [1-7]. The effectiveness of skeletal and dental movement depends on the rate of expansion, the age of the patient, the amount of force applied, and the appliance type [8-12].

The expansion of the maxilla can be achieved through various methods such as rapid maxillary expansion appliance, slow maxillary expansion appliance, miniscrew assisted rapid palatal expansion or surgically assisted rapid palatal expansion methods. Various skeletal age maturation indices is used to decide about the timing and selection of the appliance. There are conflicting views about the closure of midpalatal suture as a reliable indicator of skeletal maturation. Chronological age is no longer an indicator for a real morphological status of the midpalatal suture

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*Correspondence **Dr. Mahalakshmi Krishnakumaran.**
Department of Orthodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai, Tamil Nadu, India.
Email: mahakrishnasai@gmail.com

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closure. According to PEARSON and THILANDER earliest obliteration can be seen in the posterior palate of a 15-year-old girl and there may be no obliteration at all in a 27-year-old female. Earliest obliteration in male was found in 21 years and no obliteration at all in a 32-year-old male.[13] However, details of the morphology and the maturation of the midpalatal suture in Indian population have been investigated only in histologic studies, occlusal radiographs and animal studies with multislice computed tomography. [14-17]

Many research studies have promoted the use of the computed tomography for the diagnostic procedure like localization of impacted teeth, amount of root resorption, study of cleft palate, site planning for orthodontic implants, diagnosis of deformities of face and jaws, bone regeneration, evaluation of ossification of different craniofacial sutures, the position of the condyle in the glenoid fossa of the temporomandibular joint, etc. [18-23]

Therefore we studied the midpalatal suture morphology in South Indian population and classified them according to their maturational stages by CBCT images.

MATERIALS AND METHODS

CBCT scan for 90 subjects in the age group of 8 to 25 years were taken for the study (Table 1). Radiographic stages of midpalatal suture maturation were assessed for the above age group of 8-25 yrs, as described in the study by Angeleri et al (AJODO 2013)(24) .CBCT equipment used in this study is Kodak 9500. The settings were 90 kVp; 10 mA; field of view 18x21cm; exposure time 15 seconds with a spatial resolution of 10 line pairs per centimeter and an isotropic 0.2-mm voxel size was used. The institutional review board of Bharath University reviewed and approved the study. Informed consents were obtained from all patients or their parents or guardians.

CareStream3D Imaging software was used to assess the mid palatal suture maturation stage. Each subject was seated in an upright position with the Frankfort horizontal plane (superior aspect of the external auditory canal to infraorbital rim line) parallel to the ground during the scanning process. In the sagittal view, the patient's head was adjusted so that the anteroposterior long axis of the palate

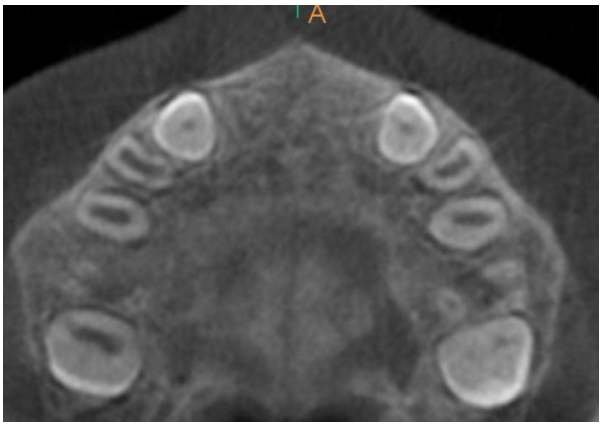

Fig 1: Stage A.

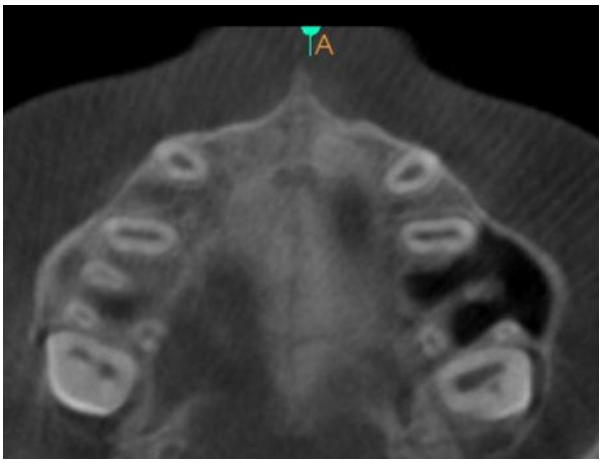

Fig 2: Stage B.

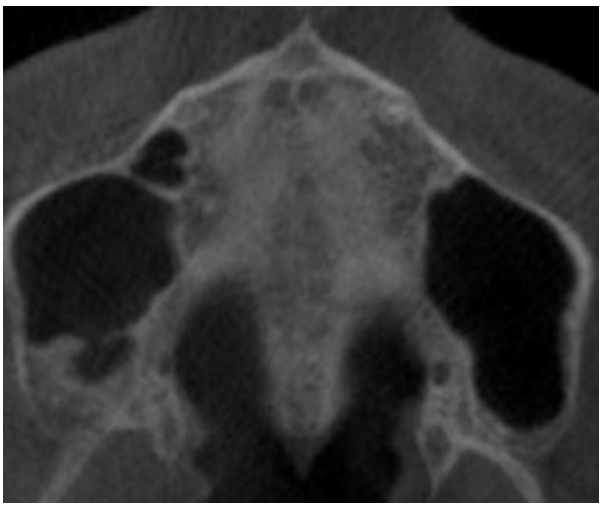

Fig 3: Stage C.

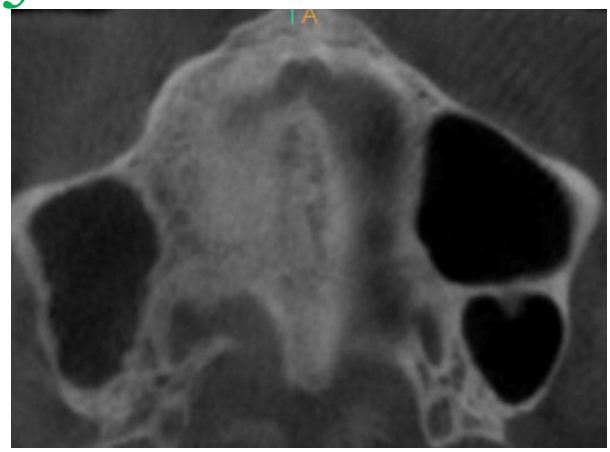

Fig 4: Stage D.

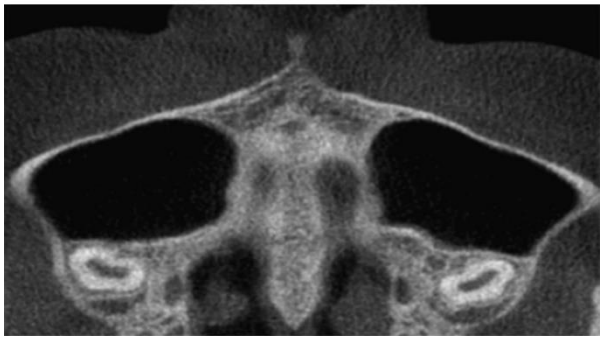

Fig 5: Stage E

was horizontal. Cross sectional image analysis in axial plane using CBCT were performed and following steps were executed for defining the maturational stages of the midpalatal suture.

Stage A, the midpalatal suture is almost a straight high-density sutural line with no or little interdigitation(Fig 1) Stage B, the midpalatal suture assumes an irregular shape and appears as a scalloped high-density line.(Fig 2) Stage C, the midpalatal suture appears as 2 parallel, scalloped, high-density lines that are close to each other, separated by small low-density spaces in the maxillary and palatine bones (between the incisive foramen and the palatino-maxillary suture and posterior to the palatino- maxillary suture).The suture can appear either in a straight or an irregular pattern(Fig 3).

Stage D, the fusion of the midpalatal suture has occurred in the palatine bone, with maturation progressing from posterior to anterior. The suture still can be seen as 2 high density lines separated by small low density spaces.(Fig 4)

Table 1: Demographics of Sample according to age and sex.

SEX	8-11 YRS	11-14 YRS	14-18 YRS	18-25 YRS	TOTAL
Female	8	19	12	11	50
Male	8	16	8	8	40
Total	16	35	20	19	90

Stage E, fusion of the midpalatal suture has occurred in the maxilla. The actual suture is not visible in at least a portion of the maxilla. The bone density is the same as in other regions of the palate.(Fig 5)

RESULTS

The maturational stages of the midpalatal suture observed in the sample are shown in Table 2. The data is given in number(absolute) and percentage (relative) frequencies .Stage A was noted in the early childhood period from 8 to almost 10 years of age. Stage B was present mainly up to 13 years of age (11 boys, 11 girls).In stage B, 9 out of 11 girls and 5 out of 9 boys were in the age group of 11-14 years respectively. Stage C was observed mainly from 11 to 15 years of age (11 boys and 6 girls).. However, one 11-year-old girl was in stage C. No subject from 5 to almost 11 years of age had fusion of the midpalatal suture. For subjects between 14 and 18 years of age, 9 of 12 girls and 7 out of 8 boys had fusion of the midpalatal suture in palatine (stage D) bone. 1 boy was in stage C while 3 girls were in stage E. 10 of 11 girls and 6 of 8 boys in 18-25 group had fusion of maxillary bone(stage E).

DISCUSSION

The sutures of the skull are identified as the sites of skeletal growth .With advancing age, bony spicules are seen on the margins,which later become interdigitated and obliterated by calcified tissue. The midpalatal suture has been described as an end-to-end type of suture with characteristic changes in its morphology during growth[25] and shows remodeling changes during skeletal growth period with the controlled application of mechanical forces.

Assessment of skeletal development becomes necessary as the chronological age is not a very

Table 2: Distribution of maturational stages of mid palatal suture in South Indian Population.

		STAGE										
		A		B		C		D		E		Total
Age(y)	Sex	n	%	n	%	n	%	n	%	n	%	
8-11	F	5	62.5	2	25	1	12.5	0	0.00	0	0.00	8
	M	4	50	4	50	0	0.00	0	0.00	0	0.00	8
	F+M	**9**	**56.3**	**6**	**37.5**	**1**	**6.25**	**0**	**0.00**	**0**	**0.00**	**16**
11-14	F	0	0.00	9	47.4	6	31.6	4	21.1	0	0.00	19
	M	0	0.00	5	31.3	10	62.5	1	6.25	0	0.00	16
	F+M	**0**	**0.00**	**14**	**40**	**16**	**45.7**	**5**	**14.3**	**0**	**0.00**	**35**
14-18	F	0	0.00	0	0.00	0	0.00	9	75	3	25	12
	M	0	0.00	0	0.00	1	12.5	7	87.5	0	0.00	8
	F+M	**0**	**0.00**	**0**	**0.00**	**1**	**5.00**	**16**	**80**	**3**	**15**	**20**
18-25	F	0	0.00	0	0.00	0	0.00	1	9.1	10	90.9	11
	M	0	0.00	0	0.00	0	0.00	2	25	6	75	8
	F+M	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**3**	**15.8**	**16**	**84.2**	**19**
Total		**9**		**20**		**18**		**24**		**19**		**90**

reliable method for determining the developmental status of the skeletal system. According to our study, subjects above 11 years showed variations in midpalatal suture maturation stages. Circumpubertally, 40% of patients were in stage B, while 45% were in stage C, and 14% were in stage D respectively. Post pubertal age of more than 14 years showed more than 80% of patients were in stage D or E. Our finding was also in accordance with the Melsen , who also reported that there is greater sutural activity during the period of pubertal growth spurt.[13]

Our study also showed that, sutural ossification proceeds from posterior to anterior region and there is increased sutural activity with increase in age. The progress in the ossification in the anterior part of the suture is irregular with advancement in the skeletal maturity as reported by REVELO and FISHMAN[26]. Study was also consistent with PEARSON and THILANDER[17],who histologically studied the ossification of intermaxillary suture in 15-35 year old human autopsy specimens. They have also speculated that there is a greater sutural activity between 20-25 years of age and concluded that if the sutural fusion index is less than 5% then conventional RME orthopedic appliances can be given for expansion of the midpalatal suture. DAVIDA also reported similar results which showed greater degree of obliteration posteriorly than in anterior to incisive foramen.

BACETTI[1] has reported that increased expansion of circummaxillary sutures occurs only when the treatment is done before the peak skeletal growth velocity. WERTZ[6] also stated that with increase in age, the fulcrum of maxillary separation is inferiorly displaced while in children, the fulcrum is nearer to frontomaxillary suture. These age dependent effects in expansion of maxillary sutures might be due to the increased calcification of sutural structures. Thus our study was conducted to assess the exact amount of ossification seen at each stage. As concluded by ANGELIERI ,subjects in stage A or B are best candidates for conventional RME expansion appliance as more skeletal effects can be achieved while subjects in stage D or E can be treated with surgically assisted RME or Miniscrew assisted RME as the fusion of midpalatal suture would have occurred either partially or totally.[24] Thus the exact amount of ossification and the site of ossification will help the orthodontists and the oral and maxillofacial surgeons to plan the exact site for the midline cortical osteotomy. Limitations of our study was uneven sample size, as CBCT imaging is not done routinely due to higher risk of radiation exposure in children and is done only when it is deemed necessary.

The findings of this study could elucidate the diagnostic stage of sutural maturation, which also helps in assessing the surgically assisted RME that increases morbidity and treatment costs. This new non-invasive method of classification might provide reliable parameters for the clinical decision between conventional and surgically assisted RME or MARPE for adolescent and young adult patients.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1.Tiziano Baccetti, Lorenzo Franchi, Christopher G. Cameron, James A. McNamara Jr Treatment Timing for Rapid Maxillary Expansion Angle Orthod 2001;71:343–350

2. Haas AJ. Rapid expansion of the maxillary dental arch and nasal cavity by opening the mid-palatal suture. Angle Orthod. 1961;31: 73–90.

3. Davis WM, Kronman JH. Anatomical changes induced by splitting of the midpalatal suture. Angle Orthod. 1969;39:126–132.

4.Wertz RA. Skeletal and dental changes accompanying rapid midpalatal suture opening. Am J Orthod. 1970;58:41–66

5.Haas AJ. Palatal expansion: just the beginning of dentofacial orthopedics. Am J Orthod. 1970;57:219–255.

6. Wertz R, Dreskin M. Midpalatal suture opening: a normative study. Am J Orthod. 1977;71:367–381

7. Berger JL, Pangrazio-Kulbersh V, Borgula T, Kaczynski R. Stability of orthopedic and surgically assisted rapid palatal expansion over time. Am J Orthod Dentofacial Orthop. 1998;114:638–645

8. Story E. Tissue response to movement of bones. Am J Orthod Dentofacial Orthop. 1973;64:229–247.

9.Lander PT, Mulh ZF. Changes concurrent with orthodontic treatment when maxillary expansion is a primary goal. Am J Orthod Dentofacial Orthop. 1995;108:184–193.

10. Bishara SE, Staley RN. Maxillary expansion: clinical implications. Am J Orthod Dentofacial Orthop. 1987;91:3–14.

11. A. I. Karaman The Effects of Nitanium Maxillary Expander Appliances on Dentofacial Structures, Angle Orthod 2002;72:344–354

12. Ryuzo Kanomi; Toru Deguchi; Eriko Kakunoa; Teruko Takano-Yamamoto; W. Eugene Roberts, CBCT of skeletal changes following rapid maxillary expansion to increase arch-length with a development-dependent bonded or banded appliance, Angle Orthod. 2013;83:851–857

13. Melsen B. Palatal growth studied on human autopsy material. A histologic microradiographic study. Am J Orthod. 1975;68:42–54.

14. Brieden.CM, KulbershVP , Kulbersh .R Maxillary skeletal and dental change with frankel appliance therapy - an implant study ,Angle Orthodontist ,Vol 54 No 3 226-32

15.Parr.AJ, Lawrence.P.G, Wohlford,Gordon.R,Eugene Roberts, Sutural expansion using rigidly integrated endosseous implants:an experimental study in rabbits , Angle Orthodontist 1997:67(4) : 283-90

16. Susanne Fricke-Zecha; Rudolf M. Gruberb; Christian Dullinc et al ,Measurement of the midpalatal suture width :A comparison of flat-panel volume computed tomography to histomorphometric analysis in a porcine model, Angle Orthod. 2012;82:145–150.

17. Pearson Maurits, Thilander Birgit. Palatal suture closure in man from 15 to 35 years of age. American Journal of Orthodontics 1977;72:1:42-52

18. Manish Thadani, Usha Shenoy, Bhaskar Patle, Anshu Kalra ,Shirish Goel, N Toshinawal Midpalatal Suture Ossification and Skeletal Maturation: A Comparative Computerized Tomographic Scan and Roentgenographic Study, Journal of Indian Academy of Oral Medicine and Radiology, April-June 2010;22(2):81-87

19.Schmuth GPF, Freisfeld M, et al. The application computerized tomography (CT) in cases of impacted maxillary canines. European J Orthodontics 1992;14:296-301.

20.Valiathan Ashima, Ravinder V, et al. 3-Dimensional Computed tomography: A new method for localization of impacted canines. J Indian Ortho Society 2002;35:73-75.

21.Krennmair G, Lenglinger FX. Imaging of uneruted and displaced teeth by cross-sectional CT scans. International J Oral Maxillofac Surg 1995;24:413-16.

22.Fuhrmann Robert, Frohberg UWE. Treatment prediction with three-dimensional computer tomographic skull models. American J Orthod Dentofacial Orthopaedics 1994;106:156-60.

23.Sune Ericson, Juri Kurol. CT diagnosis of ectopically erupting maxillary canines: A case report. European J Orthodontics 1988;10:115-20.

24. Fernanda Angelieri, Lucia H. S. Cevidanes, Lorenzo Franchi et al , Midpalatal suture maturation: Classification method for individual assessment before rapid maxillary expansion, Am J Orthod Dentofacial Orthop 2013;144:759-69 25. Cohen, Sutural biology and the correlates of craniosynostosis. Am J Med Gen 1993;47:581-616.

26. Revelo B, Fishman LS. Maturational evaluation of ossification of the midpalatal suture. Am J Orthod Dentofacial Orthop 1994; 105:288-92.