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EVALUATION OF MIDPALATAL SUTURE OSSIFICATION USING CONE-BEAM COMPUTED TOMOGRAPHY

Orthodontology

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ABSTRACT

Introduction: Cone beam computed tomography (CBCT) imaging techniques are the recent rage in the field of oral diagnostic imaging modality. It is noninvasive, faster and lacks anatomic superimposition. Earlier maxillary occlusal radiographs were used to assess and evaluate the mid palatal suture, but being a two dimensional imaging modality it could not assess the ossification process which takes place in multiple planes mostly due to curved nature of the palate. In this study we assessed the mid palatal suture morphology and classify them according to the variants using CBCT images.

Materials & Methods: A total of 40 CBCT scans (19 males and 21 females) were evaluated in the present study from the archives of an imaging center. As per Angelieri classification the midpalatal suture was classified into five categories (A-E) depending on the degree of ossification that had taken place. Statistical analysis was done by Chi Square test using SPSS version 23.0

Results: There is statistically significant difference present in the stages of maturity of mid palatal suture in various age groups with Stage B is most common in Group 1(50%),Stage C most common in Group 2(60%) and Group 3 (40%) and Stage E more common in group 4 (50%)

Conclusion: The results of the present study showed a wide variation in the initiation time and the degree of ossification and morphology of the midpalatal suture in different age groups. Although there was an increase in the closure of the suture with aging, age is not a reliable criterion for determining the open or closed nature of the suture. This finding is important in providing an idea as to how diverse is the ossification of maxillary sutures.

KEYWORDS

CBCT, Midpalatal Suture, Ossification, Maturation, Maxillary Suture

INTRODUCTION:

Pristine and aesthetically beautiful smile is important to many, and so to get their smiles as beautiful as possible more and more people are opting for orthodontic corrections. And it is not just for aesthetics that orthodontic treatments are done, the more the awareness penetrates deep into the society the more people are understand that proper alignment of teeth not only helps in aesthetics but also helps in optimum function and boosts confidence and improves the quality of life of a person. For proper orthodontic planning CBCT plays a major role. CBCT is the recent rage in craniofacial imaging modality which provides for accurate three dimensional images without any kind of overlapping.

Unlike other cranial sutures in our body the midpalatal suture is the only suture that might not close up in the elderly. This midpalatal suture plays an important role in certain orthodontic procedure like Rapid Maxillary Expansion (RME) which helps in correcting transverse discrepancies of the maxilla by applying force with in office appliances to expand the maxillary width **(Lione R et al, 2008) (Baccetti et al,2001)**. But with the fusion of the maxillary suture the procedure of correcting the transverse discrepancy cannot be done only with appliances and needs to be surgically assisted thus giving rise to a procedure known as Surgically Assisted Rapid Maxillary Expansion (SARME) **(Chrcanovic BR et al,2009)**. Different studies on the morphology and degree of fusion of the suture and its initiation time in different individuals have yielded wide variations of the time of initiation and progression of the closure of the suture; some cases of completely open sutures have been reported in subjects over 18 years of age **(Poorsattar et al, 2016)(Wehrbein et al,2001)** and hence the decision whether to do a RME or SARME cannot be based only on the chronological age and needs to be assessed as per individual patients.Earlier the assessment of the midpalatal suture was done by the use of maxillary occlusal radiographs but this method was not without flaws. Since the occlusal radiographs are a 2D representation of a 3D structure and so due to the superimposition of the nasal structures and the vomer bone on the midpalatal area, misinterpretation of the radiography and discrepancy with morphologic findings are possible. This is where the CBCT comes in as the latest offering in the field of dental imagery solving the problems faced with the 2D imaging techniques. CBCT provides high-resolution 3D images of craniofacial structures **(Genevive L et al, 2014) (Kamburoğlu K. et al, 2015)**. Added advantages are high dimensional accuracy, noninvasive nature, time saving, easy access, and lack of any anatomic superimpositions.Given the discrepancies amongst the results of studies regarding the initiation time and maturation of the midpalatal suture **(Korbmacher H et al, 2007)(Angelieri F et al, 2013)(Sina Haghanifar et al, 2017).** In the light of above literature, this study was conducted to evaluate the midpalatal suture morphology in various age groups.

MATERIALS AND METHODS:

CBCT being easily accessible these days orthodontists are not leaving anything to chance and are referring for CBCT scans when in doubt and are asking for opinion regarding the radio analysis of mid palatal suture ossification and maturation. The sample of this particular study has been taken from one such scan center where patients are referred for CBCT analysis.

A total of 40 CBCT scans were collected using NewTom® Giano CBCT machine with the NNT software. Out of the 40 scans, 19 were of male and 21 were of female patients. The mean age of the patients was 30.33 ± 13.31 years with the ages ranging from 11 years to 50 years. Precaution was taken to not in any ways disclose the identity of the scans. The scans were then grouped into 10 year age groups, like 11-20years, 21-30years, 31-40years and 41-50years. These groups were named as group 1-4. The classification of the morphology of the midpalatal suture was done based on the classification done by **Angilieri et al** in their study. The classification is as follows –

In stage A, the midpalatal suture is almost a straight high-density sutural line with no or little inter digitations. (Fig 1)

In stage B, the midpalatal suture assumes an irregular shape and appears as a scalloped high density line. (Fig 2)

In 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). (Fig 3)

In stage D, the fusion of the midpalatal suture has occurred in the palatine bone, with maturation progressing from posterior to anterior. In the palatine bone, the midpalatal suture cannot be visualized at this stage, and the parasutural bone density is increased (highdensity bone) compared with the density of the maxillary parasutural bone. In the maxillary portion of the suture, fusion has not yet occurred, and the suture still can be seen as 2 high density

lines separated by small low-density spaces. (Fig 4)

In 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)

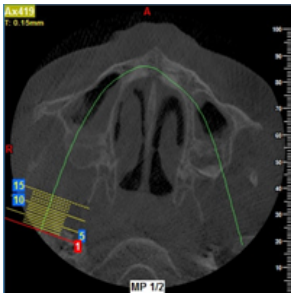


Figure1

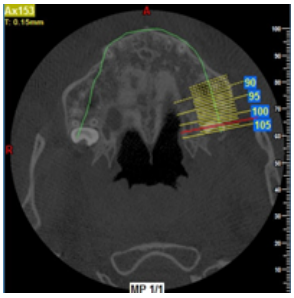
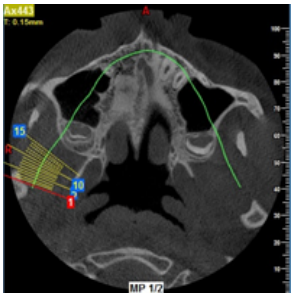


Figure2



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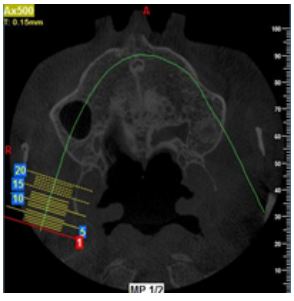


Figure4

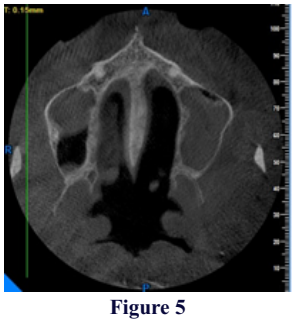


Figure 5

The scans were assessed in a well lit room by a single observer, twice after a gap of 5days to do away with any intra-observer ambiguity. Thus the scans were classified into A, B, C, D or E and were grouped as per the age groups. It was then analyzed by Chi Square test to find out if any significant differences are there amongst the groups. The statistical analysis were done using SPSS version 23.0.

RESULTS:

After the 40 scans were analyzed by the observer, they were classified under the 4 groups which were the groups 1-4 as per the Angelieri classification. After analyzing twice by the observer there were no significant changes in both the readings.

A total of 3 scans were in A, 8 were in B, 14 scans were classified as C, 5 were in D and 8 in E. Thus over 50% of the sample had no fusion of the mid palatal suture.

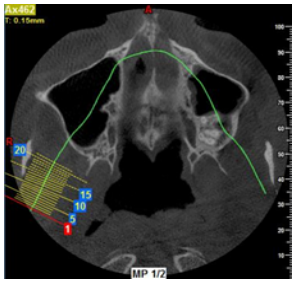


Figure 6

Apart from the 5 morphological classifications mentioned we found that there was one more variant of midpalatal suture maturation where the ossification process was not continuous but in bouts along the suture line. We named this as class D' which was a modification of D and only two samples were there in this class (Fig 6). A noteworthy thing in the results is that about 15 scans of subjects over 20 years of age were either in the class A, B or C. that means 50% of the samples over 20 years of age had open sutures.(Table 1,2) (Graph 1,2)

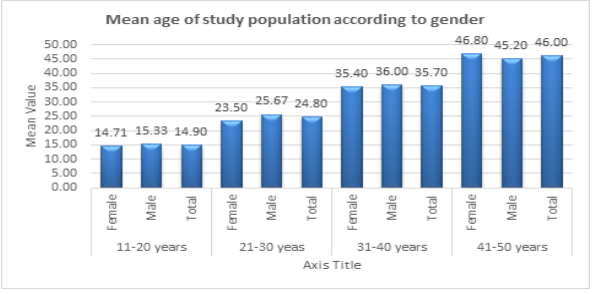
Table 1: Mean and SD Of Age In Various Age Groups According To Gender

Age Group	Gender	N	Minimum	Maximum	Mean	Std. Deviation
11-20 years	Female	7	11.0	17.0	14.71	1.98
	Male	3	13.0	18.0	15.33	2.52
	Total	10	11.0	18.0	14.90	2.02
21-30 yeas	Female	4	21.0	30.0	23.50	4.36
	Male	6	22.0	30.0	25.67	2.88
	Total	10	21.0	30.0	24.80	3.49
31-40 years	Female	5	31.0	40.0	35.40	4.28
	Male	5	31.0	40.0	36.00	4.58
	Total	10	31.0	40.0	35.70	4.19
41-50 years	Female	5	45.0	50.0	46.80	2.17
	Male	5	41.0	50.0	45.20	3.83
	Total	10	41.0	50.0	46.00	3.06

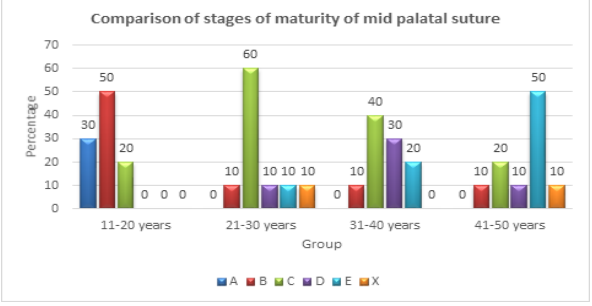
Table2: Comparison Of Stages Of Mid Palatal Suture Maturation

Stage	Group				Total
	1	2	3	4	
A	3(30%)	0	0	0	3(7.5%)
B	5(50%)	1(10%)	1(10%)	1(10%)	8(20%)
C	2(20%)	6(60%)	4(40%)	2(20%)	14(35%)
D	0	1(10%)	3(30%)	1(10%)	5(12.5%)
E	0	1(10%)	2(20%)	5(50%)	8(20%)
X	0	1(10%)	0	1(10%)	2(5%)
Total	10(100%)	10(100%)	10(100%)	10(100%)	40(100%)
Chisq	30.943		Pvalue	0.009*	

*- Statistically Significant (p<0.05)



Graph 1. Depicting Mean Age Of Study Population As Per Gender



Graph 2. Comparing The Stages Of Maturity Of Mid Palatal Suture

There was statistically significant difference in the stages of maturity of mid palatal suture in various age groups with Stage B (50%) is most common in Group 1, stage C most common in Group (60%) and Group 3 (40%) and Stage E more common in group 4 (50%).

The results showed a gradual maturation in ossification of the midpalatal suture with increase in age but specific age could not be determined in which the suture fuses completely. Also no significant finding could be assessed regarding the maturation pace in relation to gender.

DISCUSSION:

The increasing awareness of oral health and smile appeal are making people more concerned with proper aesthetics and overall health of the oral cavity. This is one of the main reasons of the ever increasing cases at the orthodontists. Dental treatment being individual specific as always, the midpalatal suture ossification of an individual carries an important role in orthodontic treatment if there is discrepancy in the palatal width. Since after many previous studies no particular age could be confirmed for the fusion of the midpalatal suture this particular study was done to assess the ossification process on CBCT scans and classify as per there maturation progress. CBCT was chosen as it is better to any 2D imaging modality for its 3D analysis and majorly due to no structural overlap.

The results of the present study in relation to the degree of ossification of the suture in the age groups 1-4, showed that ossification increased with aging; however, some cases of completely open sutures were observed in people over 20year age groups.

Nguyen et al (2008) carried out a study on 20 patients over 70 years of age and reported that the midpalatal suture is the only suture that might not close completely even in the elderly. In addition, in a study by **Poorsattar et al.(2016)** some cases of incomplete ossification of the suture were observed at ages >40 years which was similar to the findings in our study. In another study **(Nguyen et al., 2007)** with the use of CBCT images, in only 13% of the adult subjects completely closed sutures were detected.

In addition, the results of 30 micro-CT analyses in a study by **Krobmacher et al.(2007)** in 28 patients 14 to 17 years of age showed no significant relationship between closure of the suture and age. Based on a hypothesis by **Cohen et al., (1993)**, there is no relationship between the termination of growth and closure of the suture, i.e., even if 95% of the growth of the maxilla ends at 7 years of age, the suture is not necessarily closed.

The open suture in adults is attributed to a decrease in the functional forces of muscles due to aging and loss of teeth or use of a softer diet due to poor health **(Curtis et al., 2013)**; thus, the relative course of development of the midpalatal suture depends on the masticatory forces exerted on the maxillary bone during life, and, contrary to other cranial sutures, the mechanical forces such as the forces of mastication affect the ossification process and morphology of the suture.

In a study by **Angelieri et al (2012)** on CBCT images of 140 patients with an age range of 5.6-58.4 years, subjects over 11 year of age exhibited all the developmental stages mentioned above for the midpalatal suture. The authors also reported that the chronological age was an invalid criterion for determining the developmental stage of the midpalatal suture during growth. In the present study, too, evaluation of the morphology of the suture in 10-year age groups revealed wide variations in subjects over 20 years of age, with 50% of the subjects over 20 years of age in stages A, B, and C of the development of the suture; in these stages, completely open sutures are observed.

In a study by **Fricke-Zech et al. (2012)**, it was reported that morphologic changes in suture are wide in different individuals and are not related to age only. In the present study, evaluation of the suture morphology did not reveal any significant differences between males and females, which is consistent with the results of a study by **Revelo et al (1994)** on 84 subjects (39 males and 45 females) with an age range of 8 to 18 years. The results of the present study showed the postero-anterior direction of ossification of the suture.**Melsen et al (1975)**, too, showed the formation of several osseous bridges in adults in the postero-anterior direction and from the oral side to the nose which is similar to the findings made in our study but with two exceptions where there were interrupted bouts of ossification along the suture line which could be said as a modification of D.

CONCLUSION:

There is a wide variation in the initiation time and the degree of ossification and morphology of the midpalatal suture in different age groups. Based on the results of the present study, although there was an increase in the closure of the suture with aging, age is not a reliable criterion for determining the open or closed nature of the suture. This finding is important in preparing an appropriate orthodontic treatment plan, irrespective of the patients' age. Our study was done on a small sample size on a retrospective basis. Further studies in this area with larger sample size will spread more light on the maturation process of midpalatal suture.

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