Applications of Reverse Panoramic Radiography for Age and Gender Determination- A Radiographic Study

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Abstract

Objectives: This study was conducted to establish if any correlation exists between individual's chronological age and lambdoid sutures closure status in mortals through modified reverse panoramic radiograph.

Materials and Methods: Total number of 140 subjects, 10 years and beyond were included in the study, and divided into seven groups with an age interval of 5 years. Assessment of lambdoid suture closure was done according to Frederic Rating Scale on modified reverse panoramic radiographs. Data obtained was subjected to statistical analysis using Cramer's V test.

Results: A significant correlation was observed between the age group and suture closure. Cramer's test gave value of 0.000, and was interpreted as a good correlation between the age and suture closure status with a P value of <0.05

Conclusion: Lambdoid suture can be very effective and reliable practical tool for age assessment in mortalsthrough modified reverse panoramic radiography (ectocranially).

Keywords: *Forensic odontology,lambdoid, suture,age estimation, reverse panoramic radiography, orthopantamograph*

Introduction

Forensic odontology and anthropology render valuable support with regards tohuman identification and age estimation. Of late, prediction of age from the pattern and degree of closure of cranial suture is gaining popularity[1].

The sutures form an integral part of the craniofacial skeleton, but their role in cranial biomechanics has been questionedby vertebrate morphologists and palaeontologists. The morphology and growth pattern of sutures are believed to reflect their functional environment[2].Gratiolet observed that ectocranial suture closure progressed sequentially: First sagittal, lambdoid, and then coronal in that order. Parsons and Box suggested that less serrated (simple) sutures closed before all other sutures, and that there were no differences in closure periods for the left or right side of the skull. They also proposed that the lambdoid was the last of the vault sutures to reach complete closure[3].

Lambdoid suture has been suggested to attain closure at around 45to 50 years (Indians) and has its forensic importance. Anatomically, lambdoid suture has been divided into threedifferent positional parts from medial to lateral into pars lambdica, pars intermedia, and pars asterica. Closure pattern of lambdoid suture has been proposed to take place from endocranial to ectocranial aspect and from most medial to lateral aspect[4].

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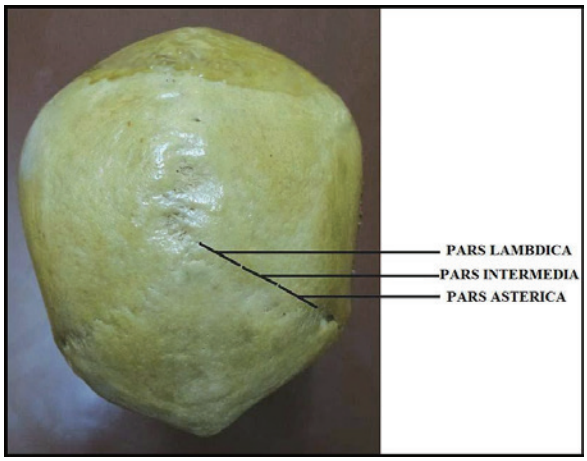

Fig 1 Anatomic parts of lambdoid suture

Markus and co-investigators in 1986 described a radiographic technique known as "Reverse Panoramic Radiography" (RPR)which can provide a better view of various anatomic structures on posterior part of skull, like mastoid air cells, lambdoid suture and occipital bone, but not practiced regularly in routine diagnostic dental imaging due to its limitations[4].

Studies evaluating the practise of Reverse OPG (rOPG) for age & gender assessment among different facial skeleton in mortals are very limited. Considering this, the present study was carried out to evaluate the correlation of individual's chronological age & gender with lamboid suture closure status through rOPG.

Materials & Methods

The study was conducted on randomly selected 140 healthy subjects visiting the Department of Oral Medicine & Radiology at JSS Dental college&hospital, Jagadguru Sri Shivarathreeshwara University. Study was approved by the Institutional Ethical Review Board. The selected subjects were divided into 7 groups according to their age – 10-15, 16-20, 21-25, 26-30, 31-35, 36-40 and 41-45 years. Age of the subjects were confirmed by checking their legal valid documents like birth certificate, driving license, passport etc. Subjects with a history of skull surgery, trauma, or developmental anomaly related to skull, subjects with history, clinical or radiographic characteristics of any pathologies affecting the skull including, endocrinedisturbances, nutritional diseases or hereditary facial asymmetries and without valid age proofs, were excluded.

In the present study, after obtaining informed consent, detailed history of the patients were taken, followed by a thorough clinical examination. For radiological evaluation, subjects were positioned in reverse, with the back of their head facing the focal trough, maintaining the mid sagittal plane centered within the image layer of the X-ray unit. The occiput of the patient was placed within the focal trough to obtain a clear radiographic image and to avoid any distortion and the chin was lowered at 20-30 degree below the horizontal plane.X-ray exposures were made with the recommended prefixed parameters based on the built of the patient (80 kVp, 10 mA and 16 seconds).

Suture closure pattern on rOPGswereassessed with the help of anX-ray viewer box as routinely done for panoramic radiographs, but under reduced lighting. Frederic Rating Scale[4], which is based on anatomic appearance of suture from 0 to 4 was used for suture closure assessment.Scoring was done by two observers to avoid bias and to minimize error rates and were recorded in specially designed proformas.

Suture score	Amount of suture closure
0	Open
1	Less than 50% closed
2	More than 50% closed
3	Most of the part of suture is closed
4	Totally closed with no visible suture line

Reliability of the method was tested by assessing the selected reverse panoramic radiographs twice by a single observer, with one month interval between the observations. A descriptive analysis of the stage of lambdoid suture closure in accordance with age was done. The level of significance was set at $p<0.05$.

Obtained data was entered into Microsoft Excel [Microsoft Corp., Redmond, WA, USA] and IBM SPSS Statistics version 20 [SPSS Inc., Chicago, IL, USA] was used for statistical analyses.

Results

The present study comprised of total 70 males and 70 females divided into 7 groups according to their age. The results obtained from the present study are listed below –

1. Co-relation between suture closure and age – (Table 1)

Co-relation between suture closure score for different age groups were assessed in relation to both right and left side. It was observed that suture closure scores increased as the age of the patient increased. This pattern was observed for both right and left side.

Cramer's test was performed to assess the co-relation between the suture closure and age of the patient with respect to right and left side. Values for both right and left sides obtained were 0.000 ($p<0.05$) hence, the co-relation between suture closure pattern and age was statistically significant.

2. Co-relation between suture closure and gender – (Table 2 & 3)

Co-relation between suture closure score and gender of the patient was assessed with respect to both right and left side. It was observed that there was no particular relation between the individual's gender and his/her suture closure score in relation to both right and left side. Cramer's test showed values to be 0.482 and 0.415 on the right and left respectively, hence, there was no significant co-relation between gender and the suture closure pattern.

3. No significant correlation was found between sutures on right and left side and their closure patterns.

Score right- Age group- Table 1

		Age group in years					
		10-15	16-20	21-25	26-30	31-35	36-40
Score Right	Suture Open	8	4	1	0	2	0
		40.0%	20.0%	5.0%	0.0%	10.0%	0.0%
	Less Than 50% Closed	9	11	16	6	5	3
		45.0%	55.0%	80.0%	30.0%	25.0%	15.0%
	More Than 50% Closed	2	1	2	9	6	4
		10.0%	5.0%	10.0%	45.0%	30.0%	20.0%
	Most Of The Part Of The Suture Is Closed	0	1	1	1	4	8
		0.0%	5.0%	5.0%	5.0%	20.0%	40.0%
	Totally Closed	1	3	0	4	3	5
		5.0%	15.0%	0.0%	20.0%	15.0%	25.0%
Total		20	20	20	20	20	20
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Crosstab – Table1

		Age Group	Total
		41-45	
Score Right	Suture Open	1	16
		5.0%	11.4%
	Less Than 50% Closed	5	55
		25.0%	39.3%
	More Than 50% Closed	4	28
		20.0%	20.0%
	Most Of The Part Of The Suture Is Closed	5	20
		25.0%	14.3%
	Totally Closed	5	21
		25.0%	15.0%
Total		20	140
		100.0%	100.0%

Symmetric Measures- Table 1

		Value	Approx. Sig.
Nominal by Nominal	Phi	0.725	0.000
	Cramer's V	0.363	0.000
N of Valid Cases		140	

Symmetric measures- Table 2

		Value	Approx. Sig.
Nominal by Nominal	Phi	.158	.482
	Cramer's V	.158	.482
N of Valid Cases		140	

Symmetric measures- Table3

		Value	Approx. Sig.
Nominal by Nominal	Phi	.168	.415
	Cramer's V	.168	.415
N of Valid Cases		140	

Discussion

The word suture is originated from a Latin word "Sutura",meaning seam like or series of stitches. A suture is a type of fibrous joint (or synarthrosis) which only occurs in the skull (or," cranium"). Many of the cranial bonesremain unfused at birth. The relative positions of thesecranial bones continue to change during the life of the adult (though less rapidly), which can provide useful information in forensics and archaeology[5].

Cranial sutures were among the first areas of the skeleton to be used for age estimation, based on the hypothesis that suture closure is part of an age-related physiological process. Cranial sutures can be seen on both the ectocranial (outer surface of skull bone) and endocranial (inner surface of skull bone) surfaces. They fuse progressively at various times, and each has a different time to attain complete closure.Krogman& co-investigators[6] concluded in their study that suture closure seems promising for age estimation despite the less number of studies devoted to suture obliteration. Taking this into consideration,an investigation intended for age estimation of the individual and its correlation with closure stages of cranial suture was taken up.

The skull vault comprises mainly of three major sutures i.e., coronal, sagittal, and lambdoidal sutures. The average age of lambdoid suture closure is about 40 – 50 years. Parsons and Box proposed that the lambdoid was the last of the vault sutures to reach complete closure[4]. Patency or obliteration of suture can be attributed to the presence or lack of physical forces acting on the skull. Relative to the lambdoid suture, the coronal and sagittal sutures areaffected by far fewer associated muscular attachments like frontalis, temporalis and occipitalis. The smalleramount of forces exerted on the coronal and sagittal sutures may explain their tendency to be more obliterated than the lambdoid suture. Hence patency of lambdoid sutures are obliterated at a later stage making it a useful diagnostic tool for assessing age of the individual[7].

Parmar& co-investigatorsanalyzed sagittal, lambdoid and coronalsuture closure and the correlation with age in living beings, and concludedthat the best results for age estimation can be achieved fromsagittal suture followed by lambdoid& coronal sutures,and suggested use of both endocranial and ectocranial suture closure during age estimation.[8]

Reverse panoramic radiographyis a technique where the patient is placed in the panoramic machine backwardsin a reverse position, in such a way that x-ray beam is directed through the patient's face and the exit beam then passes through thepatient's head on the opposite side where it is captured on the receptor. Reverse panoramic radiography was initially tried way back in 1986 by Markus et al[4].Lambdoid suture can clearly be visualized in rOPG[3]. Hence, the present study was taken up with an aim to assess the reliability of rOPG for forensic age estimation.

Growth of the skull and obliteration of vault suture depends upon brain development. The premature closureof fontanelle and sutures is common in microcephaly. The suture closure has a time and sequence oftheir union and study of suture closure can be correlated to its age. Vault sutures exhibit progressive

closure from midtwenties. Any visible fusion will at least indicate that the skull is of mature individual and it is unlikely belowthe age of 20 year. The obliteration of sutures is affected by sex, race, climate, heredity and diet[9].

Present study showed stage 0, which is open lambdoid suture more to be in 10-15 years group. This is indicative of the brain development in this age group. Stage 1, which is less than 50% closure of suture was found to be more among 16-20 years group and 21-25 years group. Both 26-30 and 31-35 age groups showed prevalence of stage 2 which shows suture more than 50% closed. 36-40 years group showed stage 3 prevalence where most of the part of the suture is closed. Stage 1, 3 and 4 were present among 41-45 years group. In the total sample of 140 patients, stage 1 was seen in almost 39% of patients.

Only 41-45 years age group showed stage 4 suture closure, indicative of complete closure of lambdoid suture with no visible suture lines. This was in accordance with the study conducted by William F & co-investigators[9] in 2014, where the mean age of lambdoid suture closure was found to be 40-45 years.

This study showed significant correlation between patient's age and the stage of lambdoid suture closure (p=.000) which was in accordance with study conducted by Sunira et al in 2015[4]. Our study showed no statistically significant difference between the gender of the individual with the suture closure pattern& estimated agein relation to both right and left sides (p=.415). There were no significant differences between the closure pattern on right and left side sutures.

rOPG procedure is technique sensitive and any error in positioning of the subject or Xray source can result in diagnostically unacceptable radiographs. To achieve maximum advantage, it is not only important for the clinician to follow the correct technique, but also to understand the limitations as well as the capabilities. It is further suggested to incorporate new softwares and programmes in panoramic imaging which can aid in improved reverse panoramic tomography[5].

CONCLUSION

From the present study, it is concludedthat theectocranial analysis of lambdoid suture closure through modified reverse panoramic radiographic technique is found to be a very reliable andpractical age estimation technique in mortals. It canbe used for medico-legal cases as well as in the age estimation of elderly population. This method comes very handy in situations where teeth are not available for age estimation. It is an equally good alternative for age estimation in young adults after 25 years, where 3rd molar root formation is complete. Though this study has shown significant correlation between age of an individual and cranial suture stage, further analysis using largersample size are recommendedto device a formula for ageestimation through this technique.Studiesutilizing subject groups with smaller age gaps would allow for assessing the feasibility of this technique in younger population. Besides this, the technique of reverse panoramic radiography is technique sensitive. Hence, better software modifications in panoramic radiography which will allow for easy visualization of lambdoid sutures can be explored for more easier age estimation.

Ethical Clearance - Taken from JSS Dental College & Hospital, JSSAHER, Mysore.

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Conflict of Interest – Nil

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