

A Cross Sectional Descriptive Study of Analysis of Lambdoid And Squamous Sutures Closure by Ct Scan for Age Estimation

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Abstract

Background– Identification is fixation of an individuality by various physical and biological parameters. An individual's age determination is very important in various civil and criminal medicolegal cases. Age estimation by cranial sutures closure is an old method. This study was conducted to analyze closure of lambdoid and squamous sutures for age estimation in living individuals by CT scan.

Objectives– To study the pattern of closure of lambdoid and squamous sutures with relation to age of person. To detect bilateral and bisexual variations in same.

Materials & Methods–We had done a descriptive cross-sectional study by CT scan head of 130 living adult persons and analyzed them for closure status of lambdoid and squamous sutures in co-relation to age.

Results– In Lambdoid suture complete closure observed 5yrs earlier in upper 2/3rd(L1&L2) parts of right side than left side in both sex while complete closure observed very late ages(>75yrs) or not at all(lapsed union) in lower 1/3rd(L3) part. Both sides of Squamous sutures follow more or less same pattern for closure in relation to age and sex while complete closure observed at very late ages(>75yrs) or not at all(lapsed union).

Conclusion– Closure of Lambdoid and Squamous sutures should be used only as corroborative to other criteria and evidences for age estimation as they might be unreliable as standalone until proven otherwise.

Key Words: Age determination, Lambdoid suture, Squamous suture, CT scan, Identification.

Introduction

Age is a primordial parameter for identification of an individual. Determination of exact age is needed for living individuals in various civil disputes like employment, marriage, attainment of majority, property dispersal, voting rights, senior citizenship, competency as witness and in various crime disputes like rape, infanticide, kidnapping, juvenile delinquency, mercy for capital punishment and criminal responsibility¹. At different periods of life, different methods are utilized for scientific age estimation like weight, head-circumference and crown heel length in fetus and newborn; dentition and radiological examination of bones in children and adults under age of 25 years. Scientific age estimation is more complex after age of 25 years. Only few parameters are helpful in this stage of life such as

closure of cranial sutures, changes of symphysis pubis, appearance and fusion of segments of sternum and sacrum²⁻⁵.

Closure of the skull suture is considered a fairly reliable index for age determination between 25 and 40 years of age. It can estimate age only in range of a decade^{2,3}.

Morphological methods are studied & being used in autopsy cases. Radiological methods like X-ray, computed tomography(CT) scans, MRI and 3D constructed CT scanning & MRI, though costly is being used now in living persons and in virtual autopsy.

Materials and Methods

This study was conducted during September 2012 to October 2014 by Forensic Medicine &

Toxicology department in collaboration of Radiology department at Govt. Medical College & New Civil Hospital, Surat. Institutional ethics committee approval obtained for this research. We included the living adult subjects of of 18 yrs & above with minimum two valid age or birthdate proof documents e.g. birth certificate, driving licence, rationcard, aadharcard etc. Persons with medical history of head injury or disease with cranium damage. pregnant females were also excluded due to radiation hazards.

The age of subjects were ranging from 15 years to 92 years. For equal distribution of samples, we made total 13 strata of age groups with difference of 5 years of age i.e. 15-19yrs, 20-24yrs, ..., 70-74yrs and 75yrs and more. In each group, 5 male and 5 female subjects were enrolled by simple randomization. So, total 65 male and 65 female subjects were studied after obtaining informed consent. Because of high cost of CT scan imaging procedure and only healthy (cranium wise) subjects included in our study, the size of study sample remained quiet restricted. Axial CT scans of skull done at different

level for bony window. CT scan machine used was 6/16 slice Siemen Company model ‘SOMATOM Emotion 6’. CT scan images were analysed for ectocranial fusion of segments of Lambdoid and Squamous sutures bilaterally.

The Squamous sutures were analysed as a whole on both sides whereas, based on the methods of Broca⁶ and Singer⁷, the Lambdoid suture was subdivided into three parts upper 1/3rd-L1-Pars Lambdica, middle 1/3rd-L2-Pars Intermedia & lower 1/3rd-L3-Pars Asterica on both sides.

Grading of suture status/ectocranial closure:

The sutures showing clear radiological joint space in whole length were considered as ‘completely open’. The suture line seen thinner & interrupted by partially closed few areas of suture were considered as ‘in closing process’. Sutures show only few black dots and otherwise radiological joint-space so obliterated that suture location is not recognizable were considered as ‘complete closure’.

Observations & Results

Table 1: Age and gender co-related findings for ectocranial closure status in Lambdoid suture.

Age Group (In Yrs)	Sex	Lambdoid Suture																	
		Right									Left								
		LR1			LR2			LR3			LL1			LL2			LL3		
		Open(n)	In Closing Process(n)	Complete closure(n)	Open(n)	In Closing Process(n)	Complete closure(n)	Open(n)	In Closing Process(n)	Complete closure(n)	Open(n)	In Closing Process(n)	Complete closure(n)	Open(n)	In Closing Process(n)	Complete closure(n)	Open(n)	In Closing Process(n)	Complete closure(n)
15-19	M	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
	F	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
20-24	M	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
	F	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
25-29	M	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
	F	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
30-34	M	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
	F	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0
35-39	M	4	1	0	5	0	0	5	0	0	4	1	0	5	0	0	5	0	0
	F	4	1	0	5	0	0	5	0	0	3	2	0	5	0	0	5	0	0
40-44	M	1	4	0	4	1	0	5	0	0	1	4	0	4	1	0	5	0	0
	F	0	5	0	5	0	0	5	0	0	0	5	0	4	1	0	5	0	0

Cont... Table 1: Age and gender co-related findings for ectocranial closure status in Lambdoid suture.

45-49	M	0	3	2	0	4	1	2	3	0	0	3	2	0	4	1	2	3	0
	F	1	4	0	1	4	0	4	1	0	0	5	0	0	5	0	4	1	0
50-54	M	0	1	4	0	2	3	0	5	0	0	2	3	0	2	3	0	5	0
	F	0	3	2	0	2	3	0	5	0	0	3	2	0	3	2	0	5	0
55-59	M	0	1	4	0	3	2	1	4	0	0	1	4	0	3	2	2	3	0
	F	0	2	3	0	4	1	1	4	0	0	2	3	1	3	2	1	4	0
60-64	M	0	1	4	0	1	4	0	4	1	0	2	3	0	2	3	0	4	1
	F	0	1	4	0	4	1	1	4	0	0	1	4	0	3	2	1	4	0
65-69	M	0	0	5	0	2	3	0	3	2	0	0	5	0	1	4	0	3	2
	F	0	1	4	0	1	4	0	3	2	0	1	4	0	1	4	0	2	3
70-74	M	0	0	5	0	2	3	0	3	2	0	0	5	0	2	3	0	3	2
	F	0	0	5	0	1	4	0	4	1	0	0	5	0	2	3	0	4	1
>75	M	0	0	5	0	0	5	0	2	3	0	0	5	0	0	5	0	2	3
	F	0	0	5	0	0	5	0	2	3	0	0	5	0	0	5	0	2	3
TOTAL		50	28	52	60	31	39	69	47	14	48	32	50	59	33	39	70	45	15

Table-1 age and gender co-related findings for ectocranial closure status in Lambdoid suture.

The LR1 part of suture noted open in subjects of age group of 35-39 years and younger in both sex, but it was in closing process in early fifties and found closed in majority(4 or more in strata) in age group of 60-64 years and older in both sex. The closure starting observed earliest at 36 years of age in male and 35 years of age in female and complete closure observed earliest at 45 years in male and 51 years in female. The LR2 part of suture was open in subjects of age group of 40-44 years and younger in both sex, but it was in closing process in late fifties and found closed in majority in age group of 60-64 years and older in male and 65-69 years and older in female. The closure starting observed earliest at 45 years of age in in both sex while complete closure observed earliest at 60 years in male and 65 years in female. The LR3 part of suture was open in subjects of age group of 40-44 years and younger in both sex, but it was in closing process in late fifties and but no complete closure found in clear majority till last age group of study in both sex. The closure starting observed earliest at 45 years of age in in both sex and complete closure observed earliest at 60 years in male and 65 years in female.

The LL1 part of suture was open in subjects of age group of 30-34 years and younger in both sex, but it was in closing process in late forties and found closed in majority(4 or more in strata) in age group of 65-69 years and older in both sex. The closure starting observed earliest at 36 years of age in male and 35 years of age in female and complete closure observed earliest at 45 years in male and 51 years in female. The LL2 part of suture was open in subjects of age group of 40-44 years and younger in both sex, but it was in closing process in late fifties and found closed in majority in of 65-69 years and older in both sex. The closure starting observed earliest at 40 years of age in in male and 44 years in female while complete closure observed earliest at 48 years in male and 51 years in female. The LL3 part of suture was open in subjects of 40-44 years and younger in both sex, but it was in closing process in late fifties in both sex and no complete closure found in clear majority till last age group of study in both sex. The closure starting observed earliest at 45 years of age in in both sex and complete closure observed earliest at 60 years in male and 65 years in female. Lambdoid suture closure observed from Lambda point towards base of skull on both sides.

Table 2: Age and gender co-related findings for ectocranial closure status in Squamous suture.

Age Group(In Years)	Sex	Squamous(Temporo-Parietal) Suture					
		SQR			SQL		
		Open(n)	In closing process(n)	Complete closure(n)	Open(n)	In closing process(n)	Complete closure (n)
15-19	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
20-24	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
25-29	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
30-34	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
35-39	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
40-44	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
45-49	M	5	0	0	5	0	0
	F	5	0	0	5	0	0
50-54	M	5	0	0	5	0	0
	F	4	1	0	4	1	0
55-59	M	2	3	0	2	3	0
	F	3	2	0	2	3	0
60-64	M	1	4	0	0	5	0
	F	2	3	0	4	1	0
65-69	M	0	5	0	1	4	0
	F	1	4	0	1	3	1
70-74	M	0	4	1	1	3	1
	F	0	4	1	0	4	1
>75	M	0	2	3	0	2	3
	F	0	3	2	0	3	2
TOTAL		88	35	7	90	32	8

Table-2 describes the age and gender co-related findings for ectocranial closure status in Squamous or Temporo-Parietal suture.

The SQR(right squamous suture) was observed open till age group of 50-54 years and in closing process in late sixties but no complete closure found in clear majority till last age group of study in both sex. The closure starting observed earliest at 55 years in male

and 54 years in female. Complete closure was observed earliest at 72 years in male and 70 years in female. The SQL(left squamous suture) was observed open till age group of 50-54 years and in closing process in late sixties but no complete closure found in clear majority till last age group of study in both sex. The closure starting observed earliest at 55 years in male and 54 years in female. Complete closure was observed earliest at 72 years in male and 65 years in female.

Table 3: Suture closure status in relation to age and age groups:

Suture	Part Of Suture	Sex	SUTURE STATUS			
			Closure started earliest at age (years)	Suture completely closed observed earliest at age (years)	Suture completely closed observed in 4 or more out of 5 subjects at age (years)	
Lambdoid Suture	LR1	M	36	45	60-64	
		F	35	51	60-64	
	LR2	M	45	48	60-64	
		F	45	50	65-69	
	LR3	M	45	60	>75	
		F	45	65	>75	
	LL1	M	36	45	65-69	
		F	35	51	65-69	
	LL2	M	44	48	65-69	
		F	40	51	65-69	
	LL3	M	45	60	>75	
		F	45	65	>75	
	Squamous (Temporo-Parietal) Suture	SQR	M	55	72	>75
			F	54	70	>75
SQL		M	55	72	>75	
		F	54	65	>75	

Table-3 concise the findings described in earlier tables. In Lambdoid suture it was observed that closure complete 5yrs earlier in upper 2/3rd(L1&L2) parts of right side than left side in both sex while while complete closure observed very late ages(>75yrs) or not at all(lapsed union) in lower 1/3rd(L3) part. Both sides of Squamous sutures follow more or less same pattern for closure in relation to age and sex while complete closure seems occur at very late ages(>75yrs) or not at all(lapsed union).

Discussion:

Here is the comparison of this study to other studies done by various researchers from different regions of India and other countries by various methods.

Table 4: Comparison of various studies- Age of closure of Lambdoid suture

Researcher/Author	Year	Race	Age of closure(Yrs)
Vij K2	2011	Indian	55
Dikshit PC3	2007	Indian	50-60
Reddy KSN4	2007	Indian	50-60 in L1,L2 60-70 in L3
Nandy A5	2001	Indian	55
Mukharjee JB8	2011	Indian	55
Aggrawal A9	2014	Indian	45
Modi K10	2012	Indian	>70(lapsed union)
Pillay VV11	2008	Indian	40-50
Krogman WM, Iscan MY12	1986	USA	60-69
Parmar P, Rathod G13	2012	Indian	45 to 55
Todd TW & Lyon DW14	1924-25	USA	Start – 26 Complete – 31
Shetty U15	2008	Indian	>70
Present study	2014	Gujarat-Indian	60-69 L1,L2 >75 L3

Table-4 shows comparison of various studies from India and USA regarding complete closure of Lambdoid sutures.

Table 5: Comparison of various studies- Age of closure of Squamous suture

Researcher/Author	Year	Race	Age of closure(Yrs)
Dikshit PC3	2007	Indian	60 to 90 in both sex
Reddy KSN4	2007	Indian	80yrs in both sex
Nandy A5	2001	Indian	70yrs or above
Mukharjee JB6	2011	Indian	70yrs or above
Pillay VV9	2008	Indian	Around 60yrs
Parikh CK16	1990	Indian	60
Singh P et al17	2001-04	Panjab	55 to 65
Parmar P, Rathod G11	2012	Indian	60 to 70
Verma RK, Goyal MK, Kochar S18	2002	Rajasthan-Indian	80yrs
Moondra AK19	2000	Indian	>75yrs
Present study	2013-14	Gujarat-Indian	>75(lapsed union)

Table-5 shows comparison of various studies from India and USA regarding complete closure of Squamous sutures ectocranially at ages.

So, we can see that Lambdoid sutures and Squamous sutures closure noted at different ages in different populations.

Limitations & Recommendation:

Sample size is quite small due to feasibility issues. More studies may be done in other regions enrolling identical populations to limit bias factors like climate, diet & nutrition, inheritance, race which was not considered in present study.

Conclusion

Cranial suture closure is a fairly reliable method for age estimation in elderly age with Lambdoid suture & Squamous sutures. Very much variation is observed in terms of age of complete closure especially in lower 1/3rd of Lambdoid suture and Squamous suture. Incomplete closure and lapsed union seems common until at and over the age of 75yrs in same. No significant difference observed in age of closure of these sutures between male

and female sex. However, upper two thirds of Lambdoid suture closure is observed 5yrs earlier on right side than left side. Closure of Lambdoid & Squamous sutures should be used only as corroborative to other criteria & evidences for age estimation.

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