

ORIGINAL ARTICLE

An Autopsy based unaided Eye Study of Lambdoid Suture of Skull– the Science of Forensic Estimation of Age

ZULFIQAR ALI BUZDAR¹, MUBARAK MEHMOOD AHMAD KHAN²¹Associate Professor, Forensic Medicine and Toxicology, Sahara Medical College, Narowal.²Postgraduate Trainee, M. Phil Criminology and Criminal Justice System, Minhaj University LahoreCorrespondence to Dr. Zulfiqar Ali Buzdar, Email: forensicatitsbest@gmail.com, Cell No:+92 333 6011 247

ABSTRACT

Background: The criminal investigation starts at crime scene and ends in the laboratory. The most vital of which is mortuary where the postmortem examination of the deceased is carried out to answer the questions of interest in that investigatory menu.

Aim: Unaided eye estimation of age from the lambdoid suture of skull on autopsy.

Methods: The subjects under study were taken from mortuary of the department of Forensic Medicine and Toxicology in the King Edward Medical University Lahore during the year 2016. The targeted population for study was the draining area of the mortuary of King Edward Medical College having designated police station. A pretested questionnaire was used to collect the calculated sample among the research population as a research method. A non-probability convenient consecutive sampling technique was applied to collect the data. The comparative descriptive study design was utilized to analyze the results.

Results: The study revealed that among the targeted population a higher percentage more than third of the sample size were adolescents of age between 21 – 30 years being 35% followed by elderlies of age between 41 – 50 years amount to 20%. The research depicted that age can be determined from degree of closure of lambdoid suture in the dead body on the autopsy table with closure taking place earlier in males as compared to that of females.

Conclusion: This study concludes that it is possible to estimate age from the degree of lambdoid suture closure of the deceased skull vault during the postmortem examination.

Keywords: Age, Lambdoid, Suture, Autopsy, Cranial, Post-mortem Examination, Skull

INTRODUCTION

The science of Forensic Medicine is given the prime responsibility to constitute the individuality of the unknown in face of mass disasters or any single individual with not known identity.¹The identity is required in each and every discipline irrespective of its nature being civil or criminal case. This identity then than paves the ways to probe the investigations in a specific direction and hence resolving the questions of intricate nature. Age is the first parameter to be determined in this complex web of establishing one identity.²Age estimation, beside other responsibility of legal nature of criminal spheres, is also required for regular societal norms like that of schooling, identification cards, seeking jobs and voting rights. In the face of difficult situations and unavailability of normal physiological parameters the age is generally determined either from the bony skeleton or otherwise of the human body parameters³.

The age from the physiological parameters is depicted through the general development in height and weight along with pubertal changes in terms of menarche and thelarche etc. The pathological changes can be cataract of eye produced as a factor of aging⁴. As long as the dead body brought for postmortem examination is fresh and no sign of ensuing decomposition the determination of age, from these parameters, poses no difficulty. But the problem arises when the cases of deceased are brought with moderate to advanced stage of decomposition whereas sometime even totally skeletonized remains are brought for investigation.⁵ Skeletal remains are the hardest part of the human body and so are resistant to general decomposition changes and hence after the normal physiological changes of the soft tissue the bones help better for determination of identity including age.⁶ The teeth up to 6 – 12 years, the long bones up to 30 years and after 30 years the cranial sutures can help age estimation in case of decomposition or mutilated bodies⁷.

The ossification centers of the long bones, the sternal rib ends and the degree of ossification of the cranial sutures from inwards to outwards help in age estimation on the autopsy table. The naked eye examination after 30 years of age and especially in decomposed dead bodies the cranial vault suture are the only

Accepted on 16-11-2022

helpful tool for the said purpose.⁸ The sutures are the embryonic cracks remnants that holds different skull bones together⁹. These cracks or gaps gets fibrous and start ossifying with passage of time and this degree of closure helps in estimation of age till 50 or sometime even 60 years.¹⁰This closure pattern of the lambdoid suture like any other is detrimental for age estimation.¹¹No significant alteration have been influenced on the pattern or the degree of closure was observed by any environmental, dietary or genetics factors¹².

The world of today has population grown to several folds higher as compared to the decades ago. The cities and the roads have become crowded too. The need of road traveling and air travel has become congested, fast and technology driven. The failures and the accidents are common resulting into the deaths, mass disasters and unexpected fatalities.

The unclaimed and unidentified dead bodies are brought to the medical facilities where those are reported dead. After that the dead bodies are shifted to the nearby mortuaries for an autopsy or postmortem based identification. To rise on the ladder of identification the first and foremost step is to establish the age of the deceased. There are different methods for determining the age.³⁻⁶The age estimation from the bones especially the skull or the cranial vault is advantageous specifically in the face advanced stage of putrefaction or decomposition of the body. In that situation even the teeth are fallen of or are not available because of increased age, the skull sutures like the lambdoid studies here play a vital role in estimation of the age of an unknown deceased individual⁹⁻¹².

MATERIAL AND METHODS

The study was carried out at the mortuary of the Forensic Medicine department of King Edward Medical University during the year 2016. The study participants are included through a pre-designed and pretested questionnaire incorporating Acsádi- Nemeskéri score i.e. a method of scoring the lambdoid suture designed by two great scientists of their time. G. Acsádi, and J. Nemeskéri were renowned archaeologists, writers and researcher of late twentieth century who devised a method of estimating the age from the cranial suture is commonly referred as Acsádi- Nemeskéri scale¹³.

Received on 07-07-2022

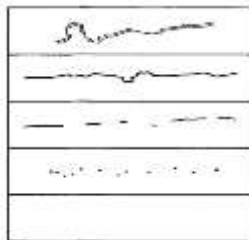
After approval of the Institutional Review Board (IRB) all the cases with skull abnormality, fractured skull and with age less than 20 or more than 70 were excluded in order to ensure the desired age range and any factor compromising lambdoid suture naked eye examination. Similarly the deceased objects with given age bracket as mentioned above and normal skull contours. The standard autopsy protocol for dissection of the scalp and skull for proper exposure of the lambdoid suture.

The sample size of 90 dead bodies were selected through a non-probability consecutive purposive sampling technique. A descriptive comparative cross-sectional study design was applied to infer the results and observation in order to determine the age of the deceased on the autopsy table during the postmortem examination in cases of unclaimed or unidentified dead bodies.

The Acsádi- Nemeskéri score¹³ for degree of closure of the lambdoid suture for its three parts as L1, L2 and L3 was applied to assess closure stage from 0, 1, 2, 3, to 4 being observed as open, with incipient closure, with closure in progress, advanced closure and completely closed. The exercise was executed both for ectocranial closure as well as endocranial closure from outside and inside the skull cavity respectively of the lambdoid suture.

The Acsádi- Nemeskéri¹³scoring scale is schematically presented as below

- 0= open. There is still little space left between edges of adjoining bones.
- 1=incipient closure. Clearly visible as a continuous often zigzagging line.
- 2=closure in process. Line thinner, less zigzags, interrupted by complete Closure
- 3=advanced closure. Only pits indicate where the suture is located (almost complete closure)
- 4= closed. Even location cannot be recognized.



location cannot be

RESULTS

Age versus gender distribution: For the purpose of convenience table 1 shows the subjects under study were classified into 5 categories of each expanding over a decade. The each categories contained the number of subjects and their gender is elaborated in the same table. The 21 – 30 years age bracket contained at total of 32 subjects with 10 having male gender and 22 as females. There were 15 cases in the age span of 31 – 40 years containing 08 males while 07 were females. There were 10 males with 08 females making a total of 18 subjects in the age range of 41 – 50

years. The age scale 51 – 60 years was represented by 14 subject with contribution of 08 males and just 06 females. A total of 11 cases in the age group of 61 – 70 years comprised of 09 males and 02 females. The category of age 21 – 30 years encompassed 35.5% with female preponderance more than 50% of the said category, the 31 – 40 years contained 16.7%, the 41 – 50 years comprised of 20% almost equal contribution of both the gender in the middle 3 age groups. The last group of age span 61 – 70 years accommodated 12.2% with almost all of male genders. However the overall composition of gender proportions was equal.

Table 1: The age groups versus gender distribution

Age Group	Male (n=45)	Female (n=45)	Total (n=90)	Valid %age
21 to 30 years	10	22	32	35.5%
31 to 40 Years	08	07	15	16.7%
41 to 50 Years	10	08	18	20%
51 to 60 Years	08	06	14	15.6%
61 to 70 Years	09	02	11	12.2%

The Lambdoid Suture Stages and Estimated Age: The age was estimated by the stage of the closure of the Lambdoid Suture through Acsádi- Nemeskéri score as described in the methodology section from 0 as open to 4 as completely closed. The suture was divided into 3 equal halves as L1, L2 and L3. Those of the ectocranial surface was labelled as 'Ecto-' as prefix and for the endocranial surface the prefix of 'Endo-' was labelled. The table 02 shows the degree of suture closure in 45 males and table 03 shows the same for equal number of females.

In table 2 complete closure of the lambdoid suture endocranial subsections as Endo-L1, Endo-L2 and Endo-L3 whereas on the ectocranial surface Ecto-L1 was observed as completely closed in the age group of 61 to 70 years. The rest of the subsections were all above the advanced closure and just short of complete closure which also may be regarded as completely closed in the age range 61 -70 years. Within the age scale of 51 – 60 years the Endo-L1 subsection was observed as completely closed. Endo-L2 subsection in 41 – 50 years age group was observed as having advanced closure, subsection Ecto-L3 depicted closure in progress in 31-40 years of age and subsection Endo-L3 in age bracket of 21-30 years showed incipient closure. Among the females the subsections Ecto – L1, Endo – L1, Endo – L2 and Endo – L3 among ages 61 – 70 years showed complete closure whereas in subsections of Ecto – L2 Endo – L2 and Ecto – L3 there was advanced closure in age ranges 51 – 60 years of age and subsection Ecto – L1 41 – 50 years exhibited advanced closure as well. Incipient closure was observed in subsection of n Ecto – L2 in the age of 31 – 40 years.

Among both the genders when combined in there was complete closure in all the subsections of the Lambdoid Suture in the age group 61 – 70 years endocranially and sparing Ecto-L2 there was complete closure in all the subsections ectocranially as well.

Table 2: The lambdoid suture closure stage in males (n=45)

Age group	n	Ecto -L1	Endo-L1	Ecto-L2	Endo-L2	Ecto-L3	Endo-L3
		Mean ± SD		Mean ± SD		Mean ± SD	
21-30 years	10	0.90±0.316	1.30±0.483	0.10±0.316	1.20±1.033	0.70±0.483	1.00±0.000
31-40 Years	08	1.88±0.641	2.38±0.518	1.25±0.463	1.75±0.707	2.00±0.535	2.38±0.744
41-50 Years	10	3.30±0.675	3.50±0.527	2.30±0.483	3.00±0.000	3.20±0.632	3.60±0.516
51-60 Years	08	3.88±0.354	4.00±0.000	3.38±0.518	3.75±0.164	3.50±0.535	3.25±0.463
61-70 Years	09	4.00±0.000	4.00±0.000	3.56±0.527	4.00±0.000	3.89±0.333	4.00±0.000

Table 3: The lambdoid suture closure progress in females (n=45)

Age group	n	Ecto -L1	Endo-L1	Ecto-L2	Endo-L2	Ecto-L3	Endo-L3
		Mean ± SD		Mean ± SD		Mean ± SD	
21 - 30 years	22	0.95±0.486	1.59±0.734	0.41±0.503	0.77±0.685	0.86±0.744	1.41±0.734
31-40 Years	7	1.86±0.690	1.86±0.378	1.00±0.000	1.57±0.535	1.71±0.488	1.71±0.488
41-50 Years	8	3.00±0.535	3.63±0.518	2.50±0.926	2.75±0.463	2.75±0.463	3.13±0.835
51-60 Years	6	3.17±0.408	3.67±0.516	3.00±0.000	3.00±0.000	3.00±0.000	3.67±0.516
61-70 Years	2	4.00±0.000	4.00±0.000	3.50±0.707	4.00±0.000	3.50±0.707	4.00±0.000

Table 3: The lambdoid suture status among all the subjects (n=90)

Age group	n	Ecto-L1	Endo-L1	Ecto-L2	Endo-L2	Ecto-L3	Endo-L3
		Mean ± SD		Mean ± SD		Mean ± SD	
21 - 30 years	32	0.94±0.435	1.50±0.672	0.31±0.471	0.78±0.608	0.81±0.693	1.28±0.634
31-40 Years	15	1.87±0.640	2.13±0.516	1.13±0.352	1.67±0.617	1.87±0.516	2.07±0.704
41-50 Years	18	3.17±0.618	3.56±0.511	2.39±0.698	2.89±0.323	3.00±0.594	3.39±0.698
51-60 Years	14	3.57±0.514	3.86±0.511	3.21±0.462	3.43±0.514	3.29±0.169	3.43±0.514
61-70 Years	11	4.00±0.000	4.00±0.000	3.55±0.522	4.00±0.000	3.82±0.405	4.00±0.000

DISCUSSION

The results inferred from the study were promising for estimation of age from the degree of lambdoid suture closure. The study focussed for determination of age from the lambdoid suture only and it was confirmed that the suture closure starts occurring in late thirties, progressed during forties and fifties while it was near completion in the sixties. It started closing from the endocranial surface of the skull vault i.e. the inner surface of the cranium. The outer surface closure was followed after wards. It was also established that L1 and L2 the terminal segments of the lambdoid suture started closing earlier than L3 irrespective of its origin whether endocranial or ectocranial surfaces^{5,7,11}.

Gender disparity was also analysed in the lambdoid suture closure pattern. It has already been an established fact all the bony skeleton grows, fuse and ossify first in females than in males applicable to all the long bones and other bones part of the skeleton except the sutures of the cranial vault.^{15,16} When the process of ossification comes to the closure of the cranial suture the gender disparity becomes evident being reciprocal that of the fact as described above. The closure of the cranial suture, the one i.e. lambdoid suture studies in the current article shows the closure in females is earlier as compared to that of males, when analysed at the specific age of both the genders.¹⁷

The study revealed that closure of the lambdoid suture kept progressing with advancing age. The closure was more marked endocranially than ectocranial closure.⁴ Significant progress in terms of closure was observed relatively in older age groups as already established in existing research. The prominent age was after 40 years and complete closure in entire lambdoid suture in 61 to 70 years age bracket.² The degree of closure was incipient at age of 21 to 30 years among both male and female subjects under study. There was closure in progress and sometime even advanced closure in age groups 31 – 40 years and 41 – 50 years of age bracket. Quiet significant closure was observed in the age group 51 – 60 years whereas sparing just a section or a minute part of the entire lambdoid suture complete closure was observed from 61 – 70 years of age¹².

CONCLUSION

Determining age at autopsy of unknown, unattended and unidentified deceased is a very tidy task. When the same comes across a grossly decomposed dead body the objective becomes complicated and gruesome leaving behind the opportunity of dealing with bony skeleton which resists the putrefaction/ decomposition. In the bony skeleton the skull is the part of skeleton is best chosen for the purpose especially in age after 40 years where rest of the skeleton cannot answer the question of determining the age readily on the autopsy table. The current study was conducted on the lambdoid suture of skull to determine age.

Age can be determined and that with wide degree of certainty from the status of closure lambdoid suture of the vault of cranium. The certainty could even higher with ages above 40 years the study revealed. Significant association was observed in age groups of 51 to 60 years and 61 – 70 years age brackets. The lambdoid suture closure progress was noted as early as 30 years of age. The study concluded that there was not even in part subsection of lambdoid suture which was not closed completely or just near completion after 61 years of age up to 70 years. The study concluded that lambdoid suture starts closing from inner

surface and then turns out to the outer surface. The lambdoid suture closure takes place earlier in females than in males like all other sutures of the skull.

Conflict of interest: Noting to declare

REFERENCES

- de Souza MA, Urriaga GD, Ferreira RC, da Silva LM, Umbelino JK, de Melo FR, de Jesus S. Friction ridge analysis in disaster victim identification (DVI): Brazilian case studies. *Forensic Sciences Research*, 2022;7(2):323-9.
- Rani D, Krishan K, Sahani R, Shrestha R, Kanchan T. Characteristic Features of Ear and Ear-Prints in Forensic Identification. *Journal of Craniofacial Surgery*, 2022;33(4):1093-8.
- Deitos AR, Costa C, Michel-Crosato E, Galic I, Cameriere R, Biazovic MG. Age estimation among Brazilians: younger or older than 18?. *Journal of forensic and legal medicine*, 2015;33(1):111-5.
- İşbilir Ş, Çiftçi ZZ, Karayılmaz H, GünenYılmaz S. Is there any relationship between pubertal growth spurt and dental or bone age estimation methods?. *Australian Journal of Forensic Sciences*, 2022;1-8.
- Iscan MY, Steyn M. The human skeleton in forensic medicine. Charles C Thomas Publisher; 2013.
- Sehrawat JS, Sankhyan D, Singh M. Role of Dental Pathologies and other Anomalies in Forensic Identification of Unknown Human Skeletal Remains: a Review. *Brazilian Journal of Forensic Sciences, Medical Law and Bioethics*, 2019;9(1):40-52.
- Smith DE, Humphrey LT, Cardoso HF. Age estimation of immature human skeletal remains from mandibular and cranial bone dimensions in the postnatal period. *Forensic Science International*, 2021;327:1109-43.
- Scheuer L. Application of osteology to forensic medicine. *Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists*, 2002;15(4):297-312.
- Bailleul AM, Horner JR. Comparative histology of some craniofacial sutures and skull-basesynchondroses in non-avian dinosaurs and their extant phylogenetic bracket. *Journal of Anatomy*, 2016;229(2):252-85.
- Ruengdit S, Prasitwattanaseree S, Mekjaidee K, Sinthubua A, Mahakkanukrauh P. Age estimation approaches using cranial suture closure: A validation study on a Thai population. *Journal of forensic and legal medicine*, 2018;53:79-86.
- Milner GR, Boldsen JL. Transition analysis: A validation study with known-age modern American skeletons. *American Journal of Physical Anthropology*, 2012;148(1):98-110.
- Ruengdit S, Case DT, Mahakkanukrauh P. Cranial suture closure as an age indicator: a review. *Forensic science international*, 2020;307:110-111.
- Meyer A, van der Merwe AE, Steyn M. An evaluation of the Acsádi and Nemeskéri Complex Method of adult age estimation in a modern South African skeletal sample. *Forensic Science International*. 2021 Apr 1;321:110740.
- Khandare SV, Bhise SS, Shinde AB. Age estimation from cranial sutures—a Postmortem study. *International Journal of Healthcare and Biomedical Research*, 2015;3(3):192-202.
- Al-Khater KM, Hegazi TM, Al-Thani HF, Al-Muhanna HT, Al-Hamad BW, Alhuraishi SM, Alsfyani WA, Alessa FW, Al-Qwairi AO, Al-Qwairi AO, Bayer SB. Time of appearance of ossification centers in carpal bones: A radiological retrospective study on Saudi children. *Saudi Medical Journal*. 2020;41(9):938.
- Wiśniewski M, Baumgart M, Grzonkowska M, Małkowski B, Wilińska-Jankowska A, Siedlecki Z, Szpinda M. Ossification center of the humeral shaft in the human fetus: a CT, digital, and statistical study. *Surgical and Radiologic Anatomy*. 2017 Oct;39(10):1107-16.
- MALIK AR, BUZDAR ZA, ZAMAN FU. Macroscopic Study of the Sagittal Suture—A tool for estimation of Age. *Pakistan journal of medical and health sciences*. 2019, Apr-Jun;13(2):357-61.

ORIGINAL ARTICLE