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# Study of Pattern of Fusion of Coronal Suture Using Skull Radiography and its Association with Documented Age in Males

**Ishita Thakur[1], Rashid Nehal Khan[2], Thippesh Kumar[3], Abhijit Rudra[3]**

*[1]Asst Prof, Department of Forensic Medicine and Toxicology, Command Hospital Kolkata, West Bengal, [2]Assoc Prof, Department of Forensic Medicine and Toxicology, Armed Forced Medical College, Pune, [3]Asst Prof, Department of Forensic Medicine and Toxicology, ACMS, New Delhi, [4]Prof, Department of Forensic Medicine and Toxicology, Armed Forced Medical College, Pune*

## Abstract

Cases of age estimation are seen by Forensic Practitioners. Identification is the establishment of the individuality of a person. A medico-legal dispute can arise at any age. Age estimation is needed to apply for government posts or pension or in cases of amnesia. Legal enforcement agencies often bring cases for estimation of age, a few examples are that for employment, superannuation, pension settlements and benefits. Use of fusion of sutures on the skull with other factors has been found reliable for age estimation. In the present study we studied skull roentgenogram of patients. These patients were advised roentgenogram for diagnostic and therapeutic purpose from other clinical departments. We studied the stage of fusion of coronal sutures in those roentgenograms where age of the patient was documented after verification against a standard identity proof. The suture was divided into upper half and lower half and stage of fusion was documented. We followed the Key stage of fusion of sutures. The earliest age of commencement of suture fusion was at 34 years and 30 years in its upper half and lower half respectively in our study. The earliest age of completion of suture fusion was 56 years in upper half and 50 years at lower half.

***Keywords****: Coronal Suture; Roentgenogram; Skull; Male; Fusion; stage*

## Introduction

Law enforcement agencies often refer cases of dispute of age to Forensic Practitioners [1,2]. Identification is the establishment of the individuality of a person. It is either Complete/ absolute or Partial / Incomplete. Complete identification is where all factors are known. Incomplete identification is where certain facts are ascertained and others are unknown[3,4,5]. Race, age, sex and stature are considered the four parameters in forensic identification [4,5]. Age of an individual is determined from teeth, bones, secondary sexual characters, general development and other features [2, 4, 5].

**Corresponding author**:
**Dr Ishita Thakur,**
atihsi532@gmail.com , 7263077907

The aim of the study is to study the pattern of fusion of coronal suture using skull radiographs and its association with documented age in male population in Western India. The objective is to study the stages of progression of closure of coronal sutures and compare with the existing literature.

## Materials and Methods

The present study was conducted in Department of Forensic Medicine and Toxicology at Tertiary set up in Western India from November 2015 to November 2017. The study was a descriptive cross-sectional study.

Cases included were those who had been advised skull roentgenograms from clinical departments for therapeutic and diagnostic purposes. After informing the patients that on their approval their approval will be used for the study. An informed consent form was given

to the patients who were advised roentgenograms. Only those who consented and whose age was verified with a documented identity card were included in the study. Cases with fracture skull or no age proof document were not included in the study. Antero-posterior view or Postero-anterior view or lateral view of skull were included in the study.

**The study was approved by the institutional ethics committee.**

## Methodology

1. Roentgenograms of cases where skull radiograph were taken were used for the study. The roentgenograms were studied in the computer where digital roentgenograms were taken. The digital roentgenograms were stored on a Compact disc. The roentgenogram of the patient where documented age (with reference to the stated Date of Birth in Dependent Card/ Aadhar card/Birth certificate/ Driving license/ Voter's ID) was recorded were studied. Coronal suture was divided into upper and lower parts[6] as shown in **Table 1**. Stage of fusion of the sutures was studied on the roentgenogram as 1- not commenced, 2- in process of fusion and 3-fused [7] as illustrated in Figure 1,2,3 Respectively).

## Results

A total of 221 male individuals were included in the study for fusion of coronal suture in males. Table 1 shows the distribution of the stage of fusion in coronal suture in males in our study.

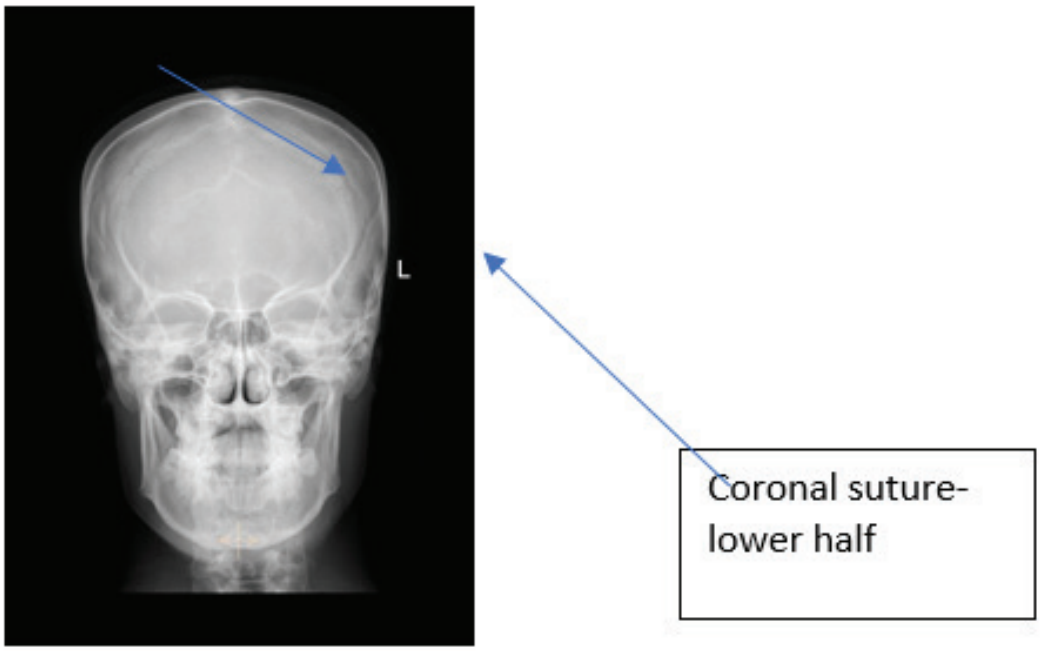



**Figure 1:21 years/ Male(stage 1)**

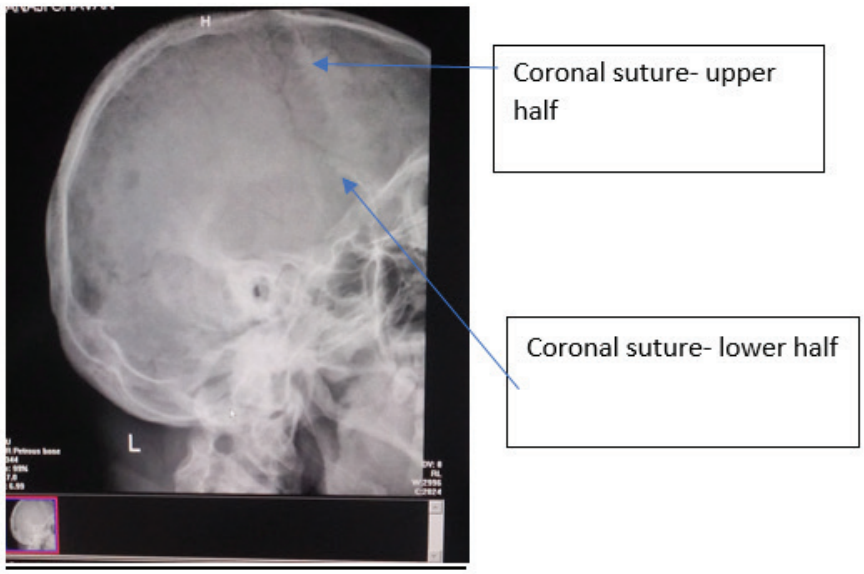



**Figure 2: 48/ Male showing coronal suture in the process of fusion in male.**

Legend to Table Number 1

Upper half: upper half of coronal suture in male

Lower half: lower half of coronal suture in male

Stage of fusion of suture

Not commenced: fusion not commenced in coronal suture

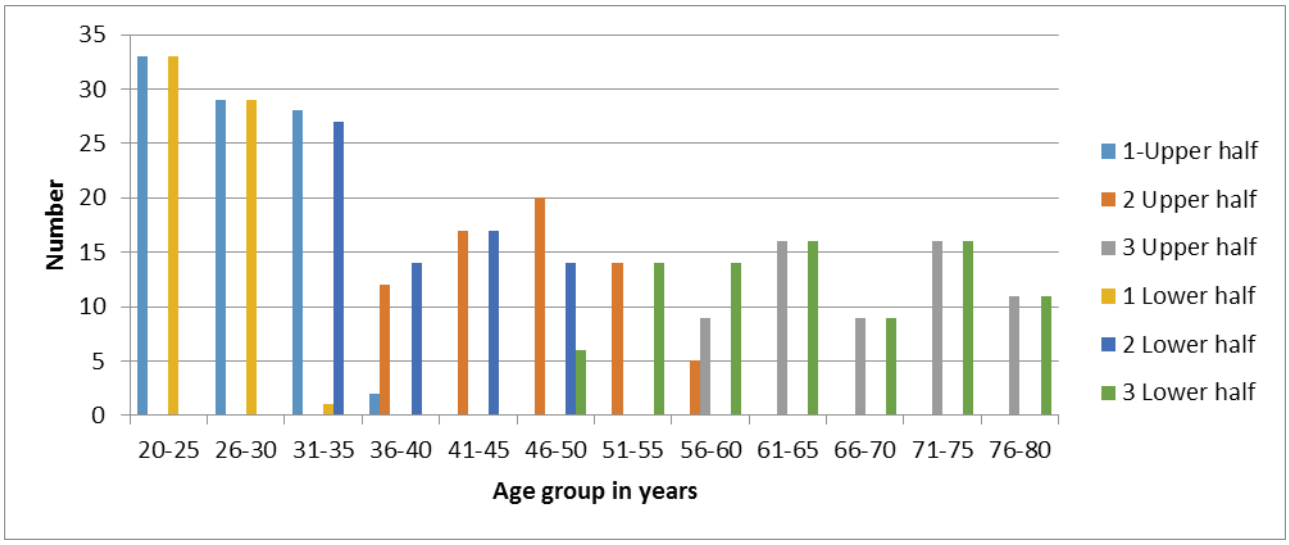
In process : in process of fusion in coronal suture

Fused: fused sutures in coronal suture

| AGE in years | NUMBER OF CASES | | UPPER HALF | | | | | | LOWER HALF | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER | PERCENTAGE | NOT COMMENCED | | IN PROCESS | | FUSED | | NOT COMMENCED | | IN PROCESS | | FUSED | |
| | | | NO | % | NO | % | NO | % | NO | % | NO | % | NO | % |
| 20-25 | 33 | 16% | 33 | 100% | 0 | - | 0 | - | 33 | 100% | 0 | - | 0 | - |
| 26-30 | 29 | 13% | 29 | 100% | 0 | - | 0 | - | 29 | 100% | 0 | - | 0 | - |
| 31-35 | 28 | 13% | 28 | 100% | 0 | - | 0 | - | 1 | 4% | 27 | 96% | 0 | - |
| 36-40 | 14 | 6% | 2 | 12% | 12 | 88 % | 0 | - | 0 | - | 14 | 100 % | - | - |
| 41-45 | 17 | 8% | 0 | - | 17 | 100 % | | - | 0 | - | 17 | 100 % | 0 | - |
| 46-50 | 20 | 9% | 0 | - | 20 | % | 0 | - | 0 | - | 14 | 70% | 6 | 30% |
| 51-55 | 14 | 6% | 0 | - | 14 | 100 % | 0 | - | 0 | - | 0 | - | 14 | 100% |
| 56-60 | 14 | 6% | 0 | - | 5 | 36 % | 9 | 64 % | 0 | - | 0 | - | 14 | 100% |
| 61-65 | 16 | 7% | 0 | - | 0 | - | 16 | 10 0% | 0 | - | 0 | - | 16 | 100% |
| 66-70 | 9 | 4% | 0 | - | 0 | - | 9 | 10 0% | 0 | - | 0 | - | 9 | 100% |
| 71-75 | 16 | 7% | 0 | - | 0 | - | 16 | 10 0% | 0 | - | 0 | - | 16 | 100% |
| 76-80 | 11 | 5% | 0 | - | 0 | - | 11 | 10 0% | 0 | - | 0 | - | 11 | 100% |
| TOTAL | 221 | 100 | 175 | | 31 | | 28 | | 138 | | 56 | | 40 | |

**Figure 3 : 76 years/Male with fused coronal suture.**

Fusion of Coronal Suture in Male




**Graph 1 showing the number of samples in different stages of suture fusion in upper and lower half of coronal suture in male .**

In our study, earliest age of commencement of fusion was 34 and 31 years in the upper and lower half respectively.

In the lower half earliest age of completion of fusion was 56 and 50 years in upper and lower half respectively.

P value for age versus upper half of coronal suture is < 0.001as the age increases the trend is not commenced to fused.

P value for age versus lower half of coronal suture is < 0.001as the age increases the trend is not commenced to fused.

Test used is Fisher's exact test.

## Discussion

Due to faulty documentation of birth of an individual, many a dispute arise in the civil and criminal courts. Instances of it are documentation in refugee asylums, cases of amnesia or dementia, pension benefits, state benefits in the case of senior citizenship. Need for scientific confirmation of age is required even when birth documents are available [1,2].

Chronological age is the time passed since birth. Bone age is the degree of maturation and fusion of the parts of bones. Bone age depends up on genetic, dietary and environmental factors[8].

Skull roentgenograms are advised by Oto-rhino-laryngologist, dental surgeons, surgeons and physicians for common complaints in clinics. The same roentgenograms were taken if the patient consented for the study.

Sutures are like epiphyseo-diaphyseal plane. Edges of the sutures are the loci of growth [6]. In skull roentgenograms, the suture is divided into upper and lower halves. An antero-posterior view and postero-anterior view of the radiograph of the skull shows the Sagittal, Coronal and Lambdoid sutures [7,9].

On roentgenogram evaluation, where lucency of line is seen to be less than 2 cm, known age of the patient helps in deciding if it is a fracture or a part of a suture. Persistent lucency beyond the age of fusion indicates towards a fracture [10]. Plain film Radiography is the most cost effective method in evaluating skull fractures, major sutures and common vascular grooves [11,12].

Interobserver variation is common in roentgenogram assessment [13]. Film is affected by the shadows of the damaged tissue and subcutaneous tissue. It can be reduced by taking into account a second factor like documented age in this study.

Description of Sutures where Fusion has not commenced

Interdigitations are present in the anatomical location of sutures. They are radiolucent in appearance with a characteristic serrated appearance in the Outer Table [14, 15].

Description of Sutures in Process of Fusion

Beginning of fusion in sutures is identified by irregular radio-opacity on each side of the suture. With progress in fusion, radiolucent appearance of fusion and margins decreases [14, 15].

**Description of Fused Sutures**

Fused sutures are described as disappearance of all or part of the affected suture lines with loss of the normal inter-digitations.They appear straight rather than a serrated radiolucent line [14, 15].

In Legal Medicine[16], Anthropology [17], Neurosurgery [18] a lot of research has been done in the correlation between the fusion of cranial sutures and age of the individual. The incidence of Roentgenogram or Computed tomography for age correlation has been variable [19].

The age range of our study is 20 years to 80 years which is similar to other studies. [7, 16, 17, 20, 21, 22, 23.]

Sutures can be seen in a majority of roentgenograms [20, 24]. Antero-posterior view of the skull showed lambdoid sutures and a portion of the sagittal suture, sometimes coronal suture was also seen. The lateral view will showed the lambdoid and coronal sutures [1,2, 25]

Obliteration of cranial suture on roentgenograms has been studied with with greying of hair, wrinkles, arcus senilis and menopause [7] or with documented age [21, 22, 23.]

In our study the fusion of sutures started at 32 years and were fused by 60 years in all the cases similar to many studies in India [21, 22, 23] and in the west [16, 20, 26,27, 28].

It has been opined if male skull is seen with serration of Coronal suture, age is assumed to be less than thirty years in [16, 17, 25, 29, 30.] Similar to our study, fusion was observed to begin in the upper part of the suture [21,22,23,24, 31, 32, 33, 34]. A comparative account is given in **Table 2**.

**Table Number 2: Comparative account of Coronal suture fusion**

| Author | Method | Time of closure of Coronal Suture |
|---|---|---|
| Krogman6 | Gross skeleton | 24 years to 38 years |
| Parikh 35 | Roentgen ray | 35 years to 40 years |
| Vij 3 | Roentgen ray | Lower half – 40 years to 50 years<br>Upper half – 50years to 60 years |
| Ramachandran 36 | Roentgen ray | Lower half – 40 years to 60 years<br>Upper half – 50 years to 60 years |
| Dikshit40 | Roentgen ray | Start – 25 years to 30 years<br>Complete – 40 years |
| Mukherjee 37 | Roentgen ray | Lower half – 25 years to 30 years<br>Upper half – 40 years to 45 years |
| Karmakar38 | Roentgen ray | Start – 25 years to 30 years<br>Complete – 30 years to 40 years |
| Pillay 39 | Roentgen ray | 40 years to 50 years |
| Gaur et al.22 | Roentgen ray | 31 years -50 years |

Table Number 2: Comparative account of Coronal suture closure

## Conclusion

We studied the radiological stages of fusion of Coronal suture of the skull in association with the documented age and found a significant correlation between the two using a Scoring method. Coronal suture was found to start fusion by 31 years and earliest completion was at 50 years. Ectocranial suture closure can be used for age estimation with other associated factors. In our study the trend of correlation is increasing with age which strengthen the view that there is a significant relationship between suture closure and age. It is important to refine the methods of scoring or quantifying these structures to make it an unbiased observation.

Ethical clearance : a prior approval was obtained from the institutional ethical committee :IEC/DEC/ AFMC/FM&T

**Conflict of Interest:** None to Declare

**Source of Funding:** None to Declare

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