Section: Anatomy

Original Research Article

COMPREHENSIVE STUDY OF METOPIC SUTURE IN ADULT DRY HUMAN SKULL AND ITS MEDICO-LEGAL ASPECT IN WESTERN UTTAR PRADESH REGION

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ABSTRACT

The metopic suture is a temporary midline frontal suture that generally fuses within the first years of life. Nevertheless, its persistence into adulthood constitutes a significant anatomical variation, which has clinical and medico-legal implications. This cross-sectional osteological study aims to evaluate the incidence, pattern, and medico-legal relevance of the metopic suture in 100 adult dry human skulls from the western Uttar Pradesh region. We inspected each skull for the presence or absence of the metopic suture. In the event of its presence, the suture was identified as complete or incomplete based on its extent. Twelve percent of the skulls showed persistence of the metopic suture. Moreover, incomplete sutures were more numerous than complete forms, and the majority of the incomplete sutures were near the nasion. These results point out that metopism is a considerable number of anatomical variations in this population, which, if not properly, can be confused with fractures of the frontal bone. The study delivers anatomically accurate information specific to the area, which is useful for the anatomical education, forensic identification, radiological interpretation, and medico-legal investigations.

Keywords: Metopic suture, Metopism, Adult dry human skull, Cranial suture variation, Forensic anatomy, Medico-legal importance.

INTRODUCTION

The metopic suture is an intraosseous median fibrous seam halves of the frontal bone; between the two it normally closes by 30-33 months of age, completing a process that typically begins in the third month postnatally and may be indicative according to some studies, of responsiveness to human olfactory cues. It is a developmental normality seen in fetal and infantile skull for during growth of the frontal lobes as well as flexibility child birth. In healthy children, the metopic suture has a closure that starts in life and is the first year of nearly fully completed from 6 to 8 years. This suture is known as metopic and its continuation into the adulthood has been noted to be common anatomical variant.[1,2]

Incidence varies widely in different populations, from less than 1% to more than 10% in various osteological studies. This variability has been attributed to genetic, environmental, nutritional, and evolutionary factors. Due to this fact, region-specific studies are very necessary to provide baseline anatomical data and to understand population-specific cranial characteristics.[3,4]

The metopic suture has immense significance anatomically, clinically, and radiologically. A persistent metopic suture bears a striking resemblance to a frontal bone vertical fracture on radiographs or computed tomography scans in cases of head injury. Lack of recognition may lead to misdiagnosis, superfluous investigations, or incorrect medico-legal conclusions. On the other hand, the premature closure of the metopic suture, defined as metopic craniosynostosis, is linked with abnormal skull morphology and problems relating to neurodevelopment, lending great importance to it both in terms of development and the clinic.[5,6]

The metopic suture has an important role in forensic medicine and medico-legal practice for skeletal identification, estimation of age, and differentiation between normal anatomical variants and traumatic lesions. Accurate identification of a persistent metopic suture in cases of medico-legal autopsy and examination of skeletal remains is of paramount importance since the suture may easily be confused with an ante-mortem or post-mortem fracture. Moreover, the presence, pattern, and extent of the metopic suture can contribute to anthropological assessments and population studies.[7]

However, very little information exists in the literature on the prevalence and morphological patterns of the metopic suture in the skulls of adults from western Uttar Pradesh. By reason of its large and varied population with a consequent heavy medico-legal work profile, such a piece of morphological information is immensely useful. Thus, the present study was conducted to comprehensively analyze the occurrence and patterns of the metopic suture in adult dry human skulls from western Uttar Pradesh, discussing its medico-legal implications, thereby adding worthy regional data to existing anatomical and forensic literature.[8]

MATERIALS AND METHODS

Study Design and Source of Specimens: The present study was a descriptive, cross-sectional osteological study conducted on adult dry human skulls. Specimens were obtained from the department of Anatomy, Rajshree medical College, Rajshree group of institutions and hospital, Bareilly, Uttar Pradesh. Only intact skulls suitable for detailed examination were selected to ensure correct observation of cranial sutures. Skulls showing gross damage, deformity, or pathological changes affecting the frontal bone were excluded from the study.

Sample Size and Selection Criteria: For the purpose of this study, a total of 100 adult dry human skulls of unknown sex were used. The presence of fully erupted permanent dentition and general morphology indicated that the skulls belonged to adults. Since the samples formed part of the teaching collections, details such as age, sex, and cause of death were not available. Ethical clearance for the study was obtained from the institutional ethics committee before the research work was started.

Examination Procedure: Each skull was carefully examined in adequate natural and artificial lighting. The frontal region of each skull was studied in detail for the presence or absence of the metopic suture. In those cases where it existed, the suture traced the midline of the frontal bone from the nasion to the bregma. Careful observation was made to distinguish between cracks or post-mortem artifacts and true sutural lines by their morphologic structure, symmetry, and continuity.

Classification of Metopic Suture: When present, the metopic suture was further categorized according to its extent. A suture that extended continuously from the nasion to the bregma was considered to be a complete metopic suture. A suture present in only a portion of the frontal bone was categorized as incomplete. Further evaluation of incomplete sutures included their location and length, without any subdivisions for statistical comparison.

Data Recording and Analysis: Observations were recorded in a systematic manner considering the metopic suture and its type: present or absent. The data collected was tabulated and analyzed using descriptive statistical methods. The results are represented as frequency and percentage in order to find out the incidence of metopism among the population under study.

Medico-Legal Considerations: The findings were interpreted in relation to their medico-legal implications, especially regarding the differentiation between anatomical variations and traumatic fractures of the frontal bone. The patterns observed were compared with various earlier studies that had been published, pointing out regional differences and their implications in forensic identification and medico-legal examinations.

RESULTS

A total number of 100 adult dry human skulls were investigated to assess the occurrence and pattern of the metopic suture. The skulls considered for the study were intact and suitable for thorough observation of the frontal bone area. Persistence of the metopic suture was found in a significant number of the studied specimens, indicating thereby that metopism is not a very rare anatomical variation in the population under study in western Uttar Pradesh.

[Table 1] shows the overall incidence of the metopic suture. The metopic suture was found in a total of 12 skulls and completely obliterated in 88 out of the total 100 skulls studied. Thus, the overall incidence of metopism in the present study was 12%. This finding emphasizes the importance of recognizing this variation during anatomical, radiological, and medico-legal examinations.

Of the skulls that presented a metopic suture, further classification of this suture into extent was conducted. Both incomplete and complete varieties were found to exist. Incomplete sutures were more common than complete sutures, indicating a tendency toward partial persistence rather than full-length retention into adulthood.

[Table 2] shows the distribution of complete and incomplete metopic sutures. Among the skulls with metopism, 4 of the 12 skulls showed a complete metopic suture extending from the nasion to the bregma, while 8 skulls showed incomplete sutures limited to a portion of the frontal bone.

Table 1: Incidence of Metopic Suture in Adult Dry Human Skulls

Presence of Metopic Suture	Number of Skulls	Percentage (%)
Present	12	12.0
Absent	88	88.0
Total	100	100

Table 2: Distribution of Complete and Incomplete Metopic Sutures

Type of Metopic Suture	Number of Skulls	Percentage (%)
Complete	4	33.3
Incomplete	8	66.7
Total	12	100

The pattern of persistence of incomplete metopic sutures was further evaluated by studying the anatomical location. The incomplete sutures were more commonly seen to persist in the lower part of the frontal bone about the nasion while being present in only a few cases in the upper segment which approaches the bregma. This anatomical variation bears important medico-legal implications because the lower frontal sutures can give an appearance very similar to that of vertical fracture lines in forensic cases.

[Table 3] presents the incomplete metopic sutures according to their distribution at the site on the frontal bone. Most incomplete sutures were limited to the lower one-third of the frontal bone.

Table 3: Location of Incomplete Metopic Sutures on the Frontal Bone

Location of Incomplete Suture	Number of Skulls	Percentage (%)
Lower part (near nasion)	5	62.5
Middle part	2	25.0
Upper part (near bregma)	1	12.5
Total	8	100

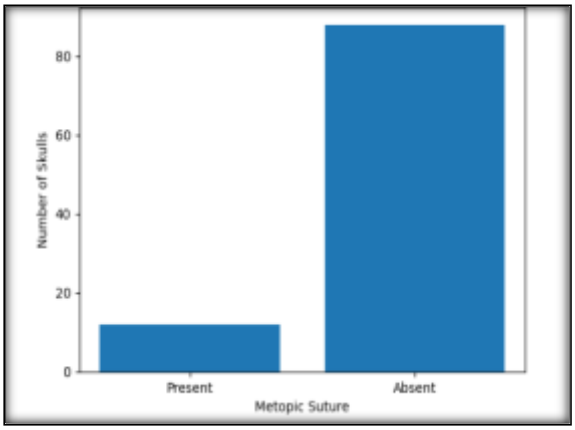

Figure 1: Incidence of Metopic Suture in Adult Dry Human Skulls

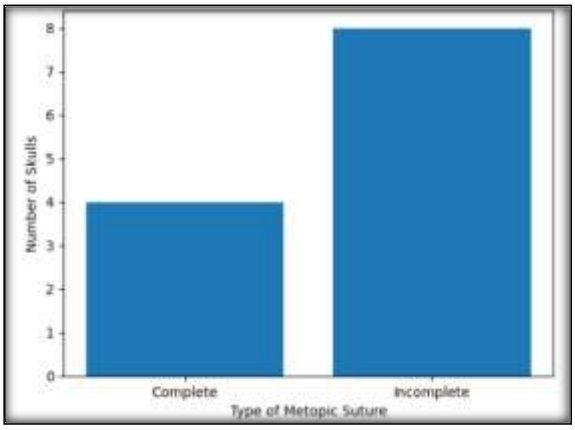

Figure 2: Distribution of Complete and Incomplete Metopic Sutures

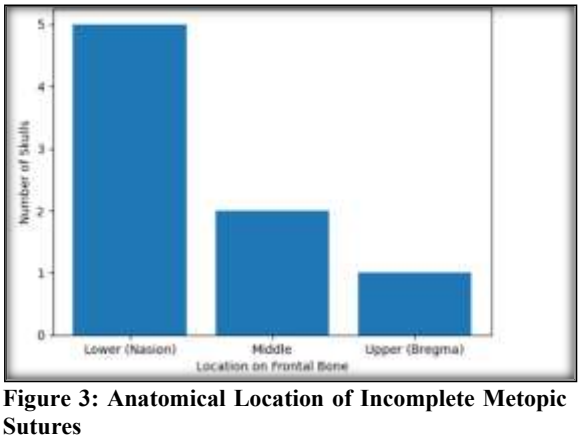

Figure 3: Anatomical Location of Incomplete Metopic Sutures

Figure 4: Persistent metopic suture in an adult dry human skull.

The results, therefore, show that there is a measurable incidence of persistence of metopic suture in adult

skulls of western Uttar Pradesh inhabitants, the incomplete sutures being more frequent than the complete forms. These observations highlight the importance of careful differentiation of the anatomical variations from traumatic lesions during medico-legal examinations.

DISCUSSION

The present study documents the incidence and morphological patterns of the metopic suture in adult dry human skulls from the western Uttar Pradesh region and highlights its medico-legal relevance. The persistence of the metopic suture was found in 12% of the skulls under study, and the incomplete sutures were more frequent than the complete ones. These observations confirm the view that metopism is a relatively frequent anatomical variation rather than a rare anomaly and that it must be taken into account during anatomical, radiological, and forensic evaluations.

The incidence recorded in this research is in line with several population-based studies reported in the literature, but also significant regional and ethnic differences exist. Bareša et al. reported the frequencies of metopic sutures in modern and archaeological Croatian populations and emphasized the impact of genetic background and population history on the persistence of cranial sutures.[9] Similarly, studies performed on the Brazilian and other populations have revealed different rates of metopism, which has led to the requirement of region-specific osteological data.[12] The results from western Uttar Pradesh provide substantial data for the Indian subcontinent, where the number of localized studies is limited.

The predominance of incomplete metopic sutures in the current study is consistent with the findings of Murlimanju et al., who reported that partial persistence of the median frontal suture is more frequent than the complete forms in adult skulls.[14] Incomplete sutures, especially those located close to the nasion, are of special concern as they can resemble vertical fracture lines of the frontal bone very closely. This similarity creates a considerable risk of misinterpretation in the case of head trauma, especially at medico-legal autopsy or during radiological investigations. Thus, being aware of this variation is vital in ensuring that no trauma is falsely attributed to the case.

The anatomical position of the incomplete sutures in this research is also of clinical and forensic importance. The lower frontal persistence close to the nasion has earlier been reported as the most frequent site, which is in agreement with this and previous osteological and radiological studies.[14] These sutures may be confused with linear fractures, especially on post-mortem skeletal remains when the clinical history is unknown. In forensic work, identifying anatomical sutures and differentiating them from fracture lines depends on the investigator's ability to judge the morphology, symmetry, and edge characteristics carefully.

Relationships between metopic sutures and other cranial variations have also been proposed in the literature. Cirpan et al. reported the association of metopism with Wormian bones, thus indicating a more extensive pattern of altered cranial ossification in some individuals.[10] Although this study has not been designed to evaluate the presence of certain cranial anomalies that coexist, it is important to know such associations during skeletal and anthropological assessments.

Nikolova and colleagues have discussed radiological and developmental implications of the persistence of the metopic suture and reported that the persistence of the metopic suture is related to the development of the frontal sinus and the closure of the sagittal suture.[11,15] Their research points out that metopism may be indicative of more extensive developmental patterns of cranial growth than just a single isolated case. These revelations are of great help to clinicians, radiologists, and surgeons on the one hand, and on the other hand, wrongly identifying sutures may have an impact on surgical approaches in craniofacial and neurosurgical procedures.[13]

From a medico-legal point of view, the results of the present study emphasize the pivotal role of anatomical knowledge in forensic investigations.

In places like West Uttar Pradesh, where medico-legal cases resulting from head injuries are numerous, it is necessary to be aware of the normal anatomical variations such as the metopic suture in order to avoid both diagnostic and legal mistakes. The precise identification can be very instrumental in differentiating genuine anatomical features from traumatic lesions and thus help in making reliable forensic conclusions.

Thus, the present study validates previous research and, at the same time, supplies epidemiological data on the occurrence and morphology of the metopic suture. The findings of this work raise the issue of the awareness of this anatomical variation by the professionals involved: anatomists, forensic experts, radiologists, and clinicians, as well as its potential implications in medico-legal practice.[9–15]

CONCLUSION

This research clearly indicates that the metopic suture persistence is a significant anatomical variation in the adult dry human skulls of the western Uttar Pradesh area. Additionally, it points out that there are more cases of incomplete forms than complete sutures. The results of this study emphasize the point that metopism should be recognized as a typical variation rather than a disease. An understanding of its occurrence and morphological features is quite necessary for anatomists, radiologists, clinicians, and forensic experts to avoid the mistake of identifying it as a fracture of the frontal bone, especially in medico-legal cases. This work adds to the local skeletal

dataset and highlights the necessity of a detailed investigation of cranial sutures in forensic and clinical scenarios.

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