

# A Morphological Cross-Sectional Study of Metopic Suture in Human Adult Cadaveric Skulls

Archana Kundlikrao Tale<sup>1</sup>, Fatima Bhopalwala Ali<sup>2</sup>, Suvarna Kundlikrao Tale<sup>3</sup>,  
Jitendra Gupta<sup>4</sup>, Santosh Shravanrao Fupare<sup>5</sup>

<sup>1</sup>Department of Anatomy, Shri Vasantnao Naik Government Medical College, Yavatmal, Maharashtra, India.

<sup>3</sup>Department of Biochemistry, Shri Vasantnao Naik Government Medical College, Yavatmal, Maharashtra, India.

<sup>2, 4</sup>Department of Anatomy, Government Medical College, Ratlam, Madhya Pradesh, India. <sup>5</sup>Department of Biochemistry, Government Medical College, Ratlam, Madhya Pradesh, India.

## ABSTRACT

### BACKGROUND

Metopic suture is located anterior to the coronal suture. There are two types: complete and incomplete metopic sutures. Knowledge regarding the metopic sutures in adults is necessary to avoid misinterpretation of radiographs as frontal bone fracture. Knowledge with regard to metopic suture is helpful for anatomists and medico legal experts. This study has been done to find out the incidence of metopic suture, classify the metopic sutures into complete and incomplete type and further classify the incomplete variety based on shape.

### METHODS

This study was conducted on 50 skulls from the Department of Anatomy, Autonomous Government Medical College and Hospital, Ratlam (MP). Skulls with signs of disease and damaged skulls were excluded from the study.

### RESULTS

In the present study, out of 50 dry adult cadaveric skulls, 2 skulls (4 %) showed complete metopism. Incomplete metopic sutures were present in 28 / 50 (56 %) and absent in 20 / 50 (40 %). Out of 28 incomplete metopic sutures, single linear metopic sutures were present in 12 / 28 (42.85 %). Double linear metopic sutures were present in 7 / 28 (25 %). V-shaped metopic sutures were present in 5 / 28 (17.85 %) and U shaped metopic sutures were present in 4 / 28 (14.28 %).

### CONCLUSIONS

Detailed knowledge of the metopic suture is important for neurosurgeons and radiologists in routine practice. Vertical frontal bone fractures may be easily misdiagnosed with persistent metopic sutures. This anatomical knowledge of metopic sutures is very useful for doctors while treating traumatised patients and during surgical intervention including frontal craniotomy.

### KEYWORDS

Suture, Metopism, Frontal Bone, Nasion, Bregma

*Corresponding Author:*

*Dr. Santosh Sharavanrao Fupare,*

*Associate Professor,*

*Department of Biochemistry,*

*3<sup>rd</sup> Floor College Building,*

*Government Medical College,*

*Ratlam – 457001,*

*Madhya Pradesh, India.*

*E-mail: drsantoshfupare@rediffmail.com*

*DOI: 10.18410/jebmh/2021/79*

*How to Cite This Article:*

*Tale AK, Ali FB, Tale SK, et al. A*

*morphological cross-sectional study of*

*metopic suture in human adult cadaveric*

*skulls. J Evid Based Med Healthc*

*2020;8(08):405-409. DOI:*

*10.18410/jebmh/2021/79*

*Submission 08-08-2020,*

*Peer Review 14-08-2020,*

*Acceptance 04-01-2021,*

*Published 22-02-2021.*

*Copyright © 2021 Archana Kundlikrao*

*Tale et al. This is an open access article*

*distributed under Creative Commons*

*Attribution License [Attribution 4.0*

*International (CC BY 4.0)]*

## BACKGROUND

The frontal bone is one of the flat pneumatic bones in the cranium and is made of two parts. Squamous part forms the forehead whereas orbital part forms the roof of the orbit.<sup>1</sup> The two halves of frontal bone is often closed by median suture by the first year after birth but it may not close and remain as the metopic suture in few individuals and many ethnic groups.<sup>2</sup> The metopic suture is a vertical fibrous type of joint, located anterior to the coronal suture dividing the two halves of the frontal bone. It is also known as the frontal, interfrontal, or median frontal suture. According to Gray, glabella which is a meeting point of the superciliary margin may show remains of two halves of the frontal bone (metopic suture) which is present in 9 % of the adult human skulls.<sup>3</sup> A. K. Dutta stated that the two equal parts of the frontal bone are separated at birth as metopic suture which is overgrown by bone by about 2 years after birth and remnants of which may remain in few skulls at glabella.<sup>4</sup>

Two halves of frontal bones are separated in utero by sutural space.<sup>5</sup> The ossification centre of frontal bone is located in intramembranous part of each half. At the ninth week, in the fetus, in the middle of supraorbital part of the frontal bone an ossification centre arises and spreads. By the eleventh weeks of gestation two halves of frontal bone meet at the midline in the nasal area which will lead to apparent closure at the supranasal area by the 32 weeks of gestation. The metopic suture is characteristically the first suture to close.<sup>6</sup> In 95 % of the normal population, complete fusion occurs between two to fourteen months of postnatal age with 8.24 months being the average. Premature fusion of the suture may also occur and is termed metopic synostosis (a type of craniosynostosis) which can then result in trigonocephaly.<sup>7</sup> However, Janusz Skrzat reported that metopic suture may remain unclosed for up to seven-years in few cases. Non-fusion of the metopic suture leads to metopism. In such cases, metopic suture persists from bregma to nasion. The incidences of metopism and metopic suture vary in different populations.<sup>8</sup>

The incidence of metopism was observed to be 7 - 8 % in Europeans, 1 % in Africans, and 4 - 5 % in a Mongolian population. Overall, the incidence rate varies from 1 % to 12 %. The incidence rate is a bit higher in the male population.<sup>9,10</sup> Many authors also reported the geographical variation in the incidence of metopic sutures. The presence of metopic suture, when observed in different countries was as follows - 0.82 % in Lebanon, in Nigeria 3.14 %, in India 2.66 %, and Europe 7 to 10 %. Metopic sutures may simulate as vertical traumatic skull fractures occurring in the mid-line and may be misdiagnosed in the head injury patients and thus, this information about the presence of metopic suture should always be kept in mind by the diagnosing physician.

Though the persistence of the metopic suture has been found as an associated finding in numerous disorders in adults, it does not cause any abnormalities by itself in any report.<sup>11</sup> According to Ashley and Del Sol M et al. there are some causative factors which may be responsible for metopism, which are stenocrotaphy, scaphocephaly, encephalic pressure, diminution of muscular pressure,

growth retardation, plagiocephaly, endocrine dysfunction, brachycephaly, atavism, hydrocephaly, sexual influence and mechanical causes.<sup>12,13</sup>

Metopic suture is formed because of the lack of union of the two frontal bones during embryonic development and it is thought to be a normal variant of the cranial sutures. Various theories have been proposed for the persistence of metopic suture. Most of scientists say the genetic factor is responsible for the current cause of metopism.<sup>14</sup> Abnormal growth of the cranial bones, hydrocephalus, heredity and atavism are the other causes of metopism.<sup>15</sup> According to Longaker, metopism can be due to cytokines active expression during cranial fusion and even chondroidal tissue resorption can be one of the causes.<sup>16</sup> According to Faro C, in Apert syndrome the impaired closure of the metopic suture is common.<sup>17</sup> Le J has mentioned that active resorption of the chondroidal tissue results in metopism.<sup>18</sup> According to Falk D et al. the persistent metopic suture may be an adaptation for giving birth to those babies who have larger brains. They have further stated that metopism may be for the rapidly growing brain of babies after birth.<sup>15</sup> There are two types; complete and incomplete metopic sutures. Complete metopic suture extends from nasion (i.e., the root of the nose) to bregma (i.e., the meeting point of coronal and sagittal suture). Whereas, the incomplete metopic suture starts from nasion but does not reach till bregma and occupies a small area between these two points.<sup>14</sup> These incomplete metopic sutures are also known as median frontal sutures and usually found between the two superciliary arches. Knowledge regarding the metopic sutures in adults is necessary to avoid misinterpretation of radiographs as frontal bone fracture.<sup>15</sup> knowledge of it is helpful for anatomists and also for medico-legal purposes.

## Objectives

1. To determine the incidence of metopic suture.
2. To classify the metopic sutures into the complete and incomplete type.
3. To categorise the incomplete variety based on its shape.
4. To correlate the data with previous studies.
5. Discuss the morphology and importance of metopic suture.

## METHODS

This descriptive cross-sectional study was conducted from 1<sup>st</sup> June 2019 to 30<sup>th</sup> September 2019 on 50 dry cadaveric adult human skulls in the Department of Anatomy, Autonomous Government Medical College and Hospital, Ratlam (MP). Skulls with signs of diseases and / or damaged skulls were excluded from the study. All the skulls were examined macroscopically and carefully inspected in the region of norma frontalis and also norma verticalis for the presence or absence of the metopic suture. The method of classification of the metopic sutures was based on the earlier studies on metopic suture. The specimens were photographed and the findings were carefully observed and noted. The frequency of complete and incomplete metopic

sutures was also analysed using simple calculator. The results obtained were compared with that of other studies published previously. Complete metopic suture is a metopic suture extending from bregma to nasion. Incomplete metopic suture is a metopic suture not extending fully from bregma to nasion further incomplete metopic suture is categorised as a single linear type, double linear, V-shape, and U-shape.

**RESULTS**

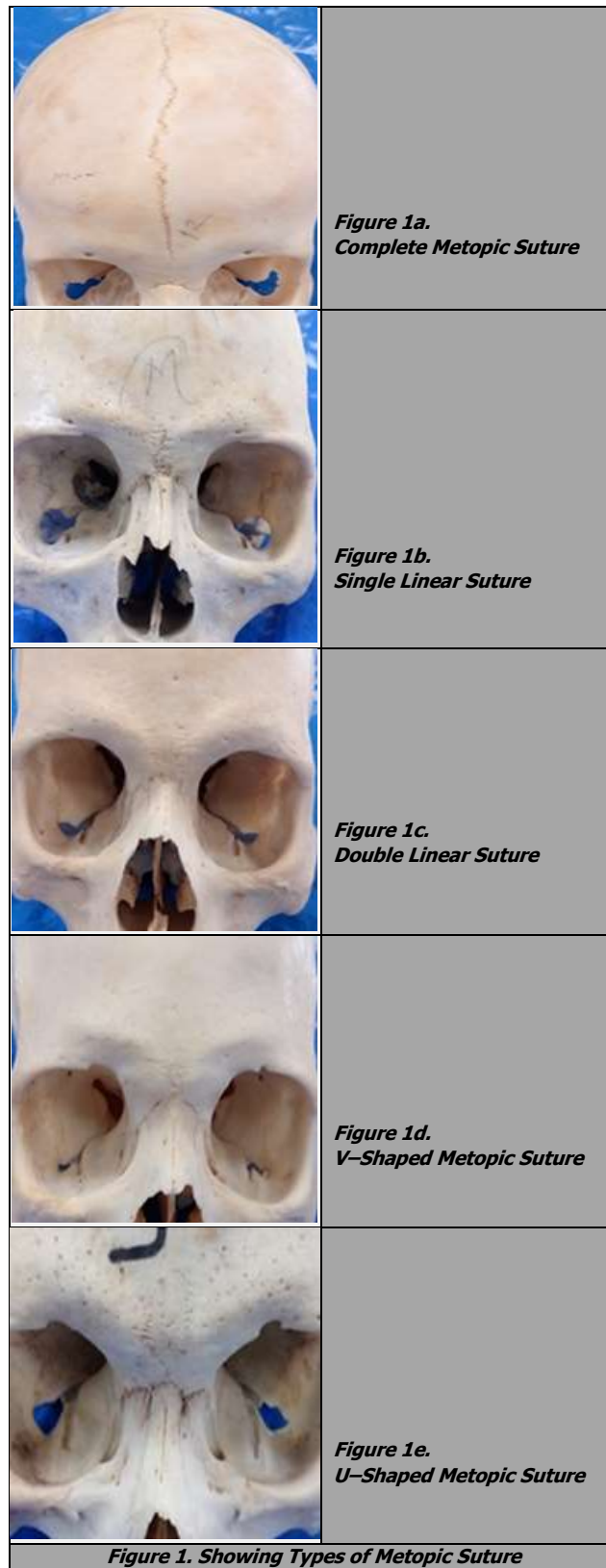
Frequency of different parameters was analysed using simple calculator. In the present study, out of 50 dry adult cadaveric skulls, 2 skulls (4 %) showed complete metopism. Incomplete metopic suture was present in 28 / 50 (56 %) and absent in 20 / 50 (40 %). Out of 28 incomplete metopic sutures, single linear metopic suture was present in 12 / 28 (42.85 %), double linear metopic suture was present in 7 / 28 (25 %), V-shaped metopic suture was present in 5 / 28 (17.85 %), and U-shaped metopic suture was present in 4 / 28 (14.28 %). (Table 1) From the above results it is obvious that incomplete metopism is very common compared to complete metopism, in fact complete metopism is very rarely seen. In incomplete metopism single linear type is far more frequent than others, followed by double linear type.

Sl. No.	Metopic Suture	Number	Percentage
1.	Absent	20 / 50	40 %
2.	Complete	2 / 50	4 %
3.	Incomplete	28 / 50	56 %
3. A	Single linear	12 / 28	42.85 %
3. B	Double linear	7 / 28	25 %
3. C	V – shaped	5 / 28	17.85 %
3. D	U – shaped	4 / 28	14.28

**Table 1. Incidence of Complete and Incomplete Metopic Suture**

**DISCUSSION**

Metopic suture was present in 30 / 50 (60 %) of cases in our study and 20 skulls showed no evidence of metopic suture (40 %). Commonly, linear type of metopic suture is observed and only in few cases, other forms of the suture are found. These sutures are radiating or having a wide side to side extensions. In our study out of 50 skulls, incidence of the complete metopic suture was 4 %. The incidence of the incomplete metopic suture was 56 %. The incidence of metopic suture varies from 1 - 10 %. Marco Antonio et al.<sup>14</sup> observed complete metopic suture in 5 (7.04 %) skulls, and incomplete metopic suture in 23 (32.39 %) skulls, in his study of 71 skulls belonging to the South Brazilian population. Ivon do et al.<sup>19</sup> observed complete metopic suture in 6 skulls (4.48 %) and incomplete in 7 skulls (5.22 %) in his study of 134 skulls in Macei AL. Kimapora et al.<sup>20</sup> found complete metopic suture in 20 skulls (2.83 %) and incomplete metopic suture in 33 skulls (4.67 %) in his study of 706 skulls collected from the graveyard in Thailand.



**Figure 1. Showing Types of Metopic Suture**

In a study on 1020 skulls of the North Indian population done by Anjoo Yadav et al.,<sup>21</sup> reported complete metopic suture in 184 (18.04 %) skulls and incomplete metopic suture in 148 (14.5 %) skulls. Hussain sahib et al.<sup>22</sup> reported, complete metopic suture seen in 4 (3.2 %) and incomplete metopic suture in 33 (26.4 %) in his study of 125 skulls belonging to the South Indian population. Neelima P et al.<sup>23</sup> studied 180 skulls belonging to the South Indian population and observed complete metopic suture in 9 (5 %) and

incomplete metopic suture in 68 ( 37.77 %). K Kalyan et al.<sup>24</sup> found complete metopic suture in 5 ( 6 - 25 %) skulls and incomplete metopic suture in 31 (38.75 %) skulls in his study of 80 skulls of the South Indian population. Dilip Kumar et al.<sup>25</sup> reported a study of 50 skulls, complete metopic suture in 1 and incomplete metopic suture in 22 skulls. The maximum incidence of metopic suture was reported by Agarwal et al.<sup>26</sup> (1979), as 38.17 % in Indian skulls, but the incidence of Metopism observed by him was comparatively low, i.e. 2.66 %. Pankaj R.<sup>27</sup> study showed the incidence of metopic sutures in Indian adults was complete metopic suture (1.25 %) and the incomplete suture was (22.5 %). Ajmani et al.<sup>28</sup> carried out a study on 206 adult Nigerian skulls for the incidence of the metopic suture. They noticed that metopism was present in 3.4 % of cases, but an incomplete metopic suture was observed in 34.97 % of the skulls. Sabita Singh, et al.<sup>29</sup> carried out a study on 80 skulls, the metopic suture (complete & incomplete) was found in 13.75 % (11 / 80) of the skulls, of which complete metopic suture was found in 2 skulls (2.5 %), while an incomplete suture was observed in 9 skulls (11.25 %) described the variation as single linear (in 6.25 %) and double linear (3.75 %).

Based on the shape, incomplete suture types were described in various literature as linear type, double type, 'V' shape, 'n' shape, 'H' shape, or 'U' shape.<sup>26,27,28</sup> In our study prevalence of U-shaped sutures was in 4 skulls (14.25 %), V-shaped suture was in 5 skulls (17.85 %) and the single linear suture was in 12 skulls (42.85 %), and double linear suture was in 7 skulls (25 %). Inderjit and Shah<sup>30</sup> (1948) described variations in the lower part of frontal bone V-shaped in 11.25 % of cases and while Das et al.<sup>31</sup> (1973) described the variations as a single linear midline suture in 17.57 % of skulls, U-shaped in 1.01 %, V-shaped in 1.93 % skulls. Shanta Chandrasekaran.<sup>32</sup> (2011) described the variations as a linear suture in 17 %, U-shaped in 15 %, V-shaped in 7.5 % of skulls.

## CONCLUSIONS

In a head injury patient, it is very difficult to differentiate between incomplete metopic suture and vertical fracture close to the central line on plain x-ray. There is a probability that the presence of the metopic suture may be misinterpreted as a vertical fracture. To overcome this confusion, reconstructed tomography scans can be used instead of plain x-ray in an emergency condition. The knowledge of metopic sutures is useful for forensic experts and radiologists. Thus, to avoid confusion and to prevent the wrong diagnosis in emergencies, while reading the x-ray / computed tomography (CT) / magnetic resonance imaging (MRI) films, one should think of the incidence of the metopic suture. A persistent metopic suture may be associated with other clinically significant anatomical variations including frontal sinus abnormalities.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

With sincere gratitude, we acknowledge the Head of the Department of Anatomy, Government medical college, Ratlam for the wholehearted support and permission granted to utilise the resources to conduct this study.

## REFERENCES

- [1] Dutta AK. Essentials of human osteology. Kolkata, India: Current Books International 2005: p. 89.
- [2] Susan S. Gray's Anatomy: the anatomical basis of clinical practice. Churchill Livingstone 2016: p. 622.
- [3] Susan S. Gray's Anatomy: the anatomical basis of clinical practice. Churchill Livingstone 2016: p. 409, 472.
- [4] Dutta AK. Essentials of human anatomy-head & neck. Chap - 1. The Skull. 5<sup>th</sup> edn. Kolkata: Current Book International 2012: p. 15.
- [5] Manzanares MC, Goret-Nicaise M, Dhem A, et al. Metopic sutural closure in the human skull. *J Anat* 1988;161:203-215.
- [6] Faro C, Benoit B, Wegrzyn P, et al. Three-dimensional sonographic description of the fetal frontal bones and metopic suture. *Ultrasound Obstetr Gynecol* 2005;26(6):618-621.
- [7] Mandeep B, Srinivasan D, Hiroshi N, et al. Normal fusion of the metopic suture. *Journal of Craniofacial Surgery* 2013;24(4):1201-1205.
- [8] Skrzat J, Walocha J, Zawiliński J. A note on the morphology of the metopic suture in the human skull. *Folia Morphol (Warsz)* 2004;63(4):481-484.
- [9] Nikolova S, Toneva D. Frequency of metopic suture in male and female medieval cranial series. *Acta Morphologica et Anthropologica* 2012;19:250-252.
- [10] Tavassoli MM. Metopism: as an indicator of cranial pathology: a good example from Iranian plateau. *Acta Medica Iranica* 2011;49(6):331-335.
- [11] Nikolova S, Toneva D, Georgiev I. A case of skeletal dysplasia in bone remains from a contemporary male individual. *Acta Morphologica et Anthropologica* 2015;22:97-107.
- [12] Ashley-Montagu MF. The medio-frontal suture and the problem of metopism in the primates. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 1937;67:157-201.
- [13] Del Sol M, Octavio B, Andre PD, et al. Metopismo no individuo brasileiro. *Revista Paulista de Medicina* 1989;107(2):105-107.
- [14] Castilho MAS, Oda YJ, Santana GDM. Metopism in adult skulls from Southern Brazil. *International Journal of Morphology* 2006;24(1):61-66.
- [15] Falk D, Zollikofer CPE, Morimoto N, et al. Metopic suture of Taung (*Australopithecus Africanus*) and its implications for hominin brain evolution. *Proc Natl Acad Sci U S A* 2012;109(22):8467-8470.
- [16] Longaker MT. Role of TGF-beta signaling in the regulation of programmed cranial suture fusion. *J Craniofac Surg* 2001;12(4):389-390.

- [17] Faro C, Chaoui R, Wegrzyn P, et al. Metopic suture in fetuses with Apert syndrome at 22-27 weeks of gestation. *Ultrasound Obstet Gynecol* 2006;27(1):28-33.
- [18] Levine J, Bradley JP, Roth DA, et al. Studies in cranial suture biology: regional dura mater determines overlying suture biology. *Plast Reconstr Surg* 1998;101(6):1441-1447.
- [19] Da Silva IDN, De Moraes FKJ, Ramalho AJC, et al. Occurrence of metopism in dry crania of adult Brazilians. *ISRN Anat* 2013;2013:158341.
- [20] Khamanarong K, Thamsuk P, Woraputtapora W, et al. Incidence of metopism in adult Thai skulls. *Int J Morphol* 2015;33(1):51-54.
- [21] Yadav A, Kumar V, Srivastava RK. Study of Metopic suture in the adult human skulls of north India. *J Anat Soc India* 2010;59(2):232-236.
- [22] Saheb SH, Mavishetter GF, Thomas ST, et al. Incidence of metopic suture in adult South Indian skulls. *J Biomed Sci and Res* 2010;2(4):223-226.
- [23] Pillai N, Sunder RR. Persistent metopic suture in various forms in South Indian adult skulls-a study. *International Journal of Scientific and Research Publications* 2013;3(5):1-7.
- [24] Chakravarthi K, Venumadhav N. Morphological study of metopic suture in adult South Indian skulls. *Int J Medical & Health Sciences April* 2012;1(2):23-28.
- [25] Kumar THD, Rajasekar SS. Metopic suture and its variations. *Indian J Basic Applied Medical Research* 2014;3(4):42-45.
- [26] Agarwal SK, Malhotra VK, Tewari SP. Incidence of the metopic suture in adult Indian crania. *Acta Anat (Basel)* 1979;105(4):469-474.
- [27] Pankaj RW, Sunil JP, Fulpatil MP, et al. Study of incidence of metopic suture in adult skulls. *Indian J Basic Appl Med Res* 2014;4(1):277-283.
- [28] Ajmani ML, Mittal RK, Jain SP. Incidence of metopic suture in adult Nigerian skulls. *J Anat* 1983;137(Pt 1):177-183.
- [29] Singh S, Suman P, Panigrahi AK, et al. Morphological variation and occurrence of persistent metopic suture in Indian population. *National Journal of Basic Medical Sciences* 2017;8(2):77-82.
- [30] Jit I, Shah MA. Incidence of frontal or metopic suture amongst Punjabee adults. *Ind Med Gazette* 1948;83(11):507-508.
- [31] Das AC, Saxena RC, Beg MAQ. Incidence of metopic suture in U.P. subjects. *Journal of the Anatomical Society of India* 1973;22:140.
- [32] Chandrasekaran S, Shastri D. A study on metopic suture in adult south Indian Skulls. *Int J Basic Med Sci* 2011;1(7):379-382.