

A roentgen-anatomic study of association between persistent inter-frontal Suture with varied presence of frontal sinus

N. Vinay Kumar^{1,*}, U. Vijayashanmugam², TS Gugapriya³, SD Nalinakumari⁴

¹Associate Professor, Govt. Medical College, Palakkad, Kerala, ³Associate Professor, ⁴Professor, Dept. of Anatomy, Chennai Medical College Hospital & Research Institute, Tamil Nadu, ²Associate Professor, Dept. of Ophthalmology, KAPV Govt. Medical College, Trichy, Tamil Nadu

*Corresponding Author:

N. Vinay Kumar

Associate Professor, Dept. of Anatomy, Govt. Medical College, Palakkad, Kerala

Email: vinaydr1981@gmail.com

Abstract

Introduction: The suture that persists between frontal bones beyond 8 years of life is termed as "Metopism". This metopic suture has been shown to exhibit ethnic variability in its incidence with an Asian incidence of up to 5.5%. Previous studies had morphologically classified metopism into complete and incomplete types. The presence of this inter-frontal suture is claimed to alter the development of frontal sinus from asymmetry to complete absence.

Methodology: Occurrence of metopic suture among 180 adult skulls was studied. The observed suture was further classified morphologically into complete and incomplete types. The skulls with either of the types were further studied radiologically for the presence and symmetry of the frontal sinus.

Result: Complete and incomplete metopism was observed in 3.88% and 46.66% of the skulls studied respectively. On radiological examination, absence of frontal sinus was seen more with complete metopism while asymmetry of frontal sinus was noted mainly with incomplete type.

Conclusion: The presence of inter-frontal suture in adults with its associated variation in the development of frontal sinuses is of interest for anatomist and significant for radiologist, neurosurgeon and forensic pathologist while examining, operating and reporting of frontal fractures.

Keywords: Metopism, Frontal sinus, Inter frontal suture, Metopic suture

Introduction

The persistence of inter-frontal suture in adults is termed as "Metopism".¹⁻³ Previous studies claim widely varying time period, from end of one year to 8 years of age for normal disappearance of this inter-frontal suture.⁴⁻⁹ Metopism is also reported to exhibit ethnic variation in its incidence. The European ethnicity stands in the upper end of the spectrum with a range of 7-10%^{6,10,11}, while Africans and Australians form the lower range of 1% incidence.¹⁰ Whereas the Indians who belong to Asian ethnicity shows 4-5.5% incidence.¹²⁻²⁵

The extent of persistence of inter-frontal suture forms the basis for classifying metopism into complete and incomplete types. The presence of continuous suture from Bregma to Nasion is termed complete, while its presence in either upper, middle or lower part alone is called incomplete metopism.^{13,16,17,20-22,24,25}

Few earlier reports suggested an association between existence of complete and incomplete metopism to absence of frontal sinus, asymmetry of sutures, presence of extra bones or prominence of existing bones and asymmetry of frontal sinuses respectively.^{26,27}

A radiological study verified that the frontal sinuses were quite bigger in males compared to females, and emphasized that the presence of metopic suture is associated with absence of the frontal

sinuses.²⁸ Meanwhile, another study with 27% incidence of persistent metopic suture stated that there exist no correlation between presence of metopism and frontal sinus asymmetry or absence.²⁹ This contradicting reports necessitated this roentgen anatomical association study of metopism with frontal sinus in Indian ethnicity.

Methodology

Presence of metopic suture and classification of observed suture morphologically was done in 180 skulls from departments of Anatomy, across different medical colleges in Tamil Nadu. The skulls that exhibited complete and incomplete metopism were further studied by x-ray and Computerised tomography for the presence or absence of frontal sinus. If present, the symmetry of the sinus was additionally noted.

Results

Complete metopic suture was found in 7 Out of 180 (3.88%) Skulls studied (Fig. 1). While 84 out of 180 (46.66%) were observed to be of incomplete type (Fig. 2). On radiological analysis, total absence of frontal sinus was observed in 57.1% of complete (Fig. 3) and 7.1% of incomplete metopic skulls (Fig. 4). Asymmetry of frontal sinus was also noticed in 92.9% of incomplete metopic skulls with predominantly

smaller sinus on the right side and extensive sinus on left side (Fig. 5).



Fig. 1: Showing complete metopic suture (CMS)

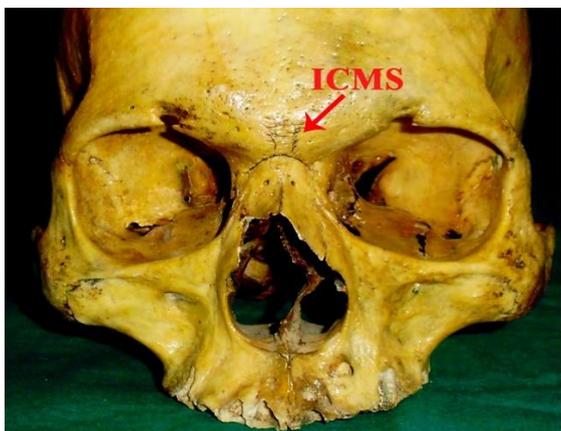


Fig. 2: Showing incomplete Metopic suture (ICMS)

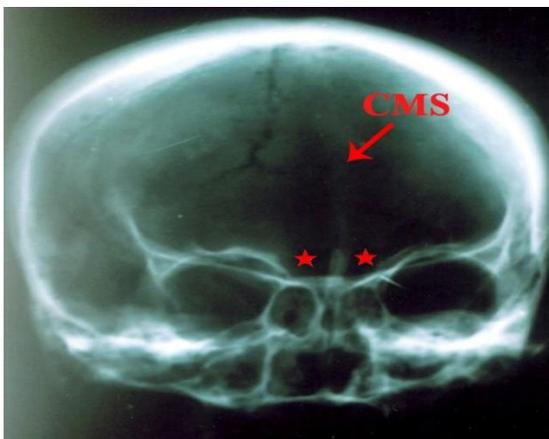


Fig. 3: X-Ray skull showing complete metopic suture (CMS) with bilateral absence of frontal air sinuses (*)

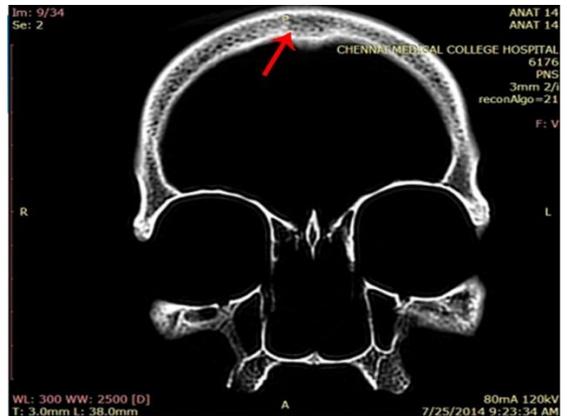


Fig. 4: Coronal CT of incomplete metopic skull showing bilateral absence of frontal sinuses

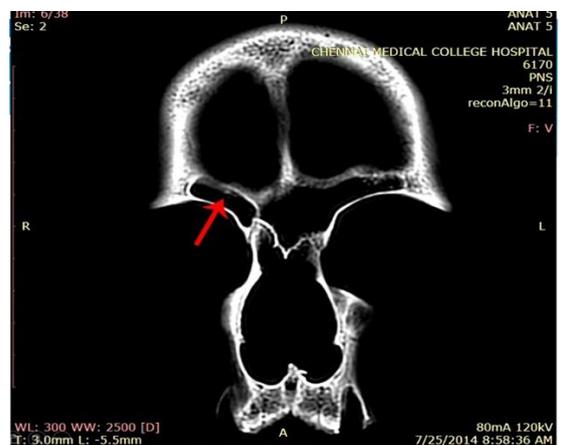


Fig. 5: Coronal CT of incomplete metopic skull showing asymmetrical frontal sinuses with small right sinus

Discussion

Anatomia Capitis Humani by Johannes Dryander in 1536 exhibited the first illustration of metopic suture.³⁰ Since then, many illustrations and descriptions about this inter-frontal suture had been put forth with its classification and incidence among different ethnicities.¹⁻²⁵ Similarly, from the times of Galen (130-201AD) the query about the presence of sinuses and their exact function continues on till today with varied explanations.³¹

The reported incidence of metopism was noticed to be higher in European's in comparison to Australian and African populations, while the Asians occupy the mid-range.^{6,10-25} The present study also observed incidence of metopism equivalent to the literature reporting on Asian ethnicity. Differing views had been proposed as the probable etiology for this persistence. The causes may be either active resorption of chondroid tissue of suture, role of dura mater in keeping the suture patent, altered expression of active cranial suture fusion cytokines, increased osteoclastic resorption maintaining open suture.³²⁻³⁵

The association between persistent inter-frontal suture and developmental variation in frontal sinus had been analysed and reported by few studies with contradicting claims.^{26,28,29,36} These studies had shown spectrum of findings ranging from total absence^{26,28} to presence of fully formed frontal sinuses³⁶ in skulls with complete metopism. In cases with incomplete type also, previous literature exhibits varying reports of existence of well-formed frontal sinuses to marked asymmetrical sinuses.^{26,27} One study reported no correlation between existence of metopic suture and absence of frontal sinuses.²⁹

In midst of this contradictions, the current study has observed absence of frontal sinuses in both morphological types. Where in, total absence of frontal sinuses was noticed to be proportionately more in complete metopism when compared to incomplete type. More over the present study also found incomplete type to be associated closely with asymmetrical frontal sinuses in majority of the incomplete skulls studied with a marked right side ill formed sinuses.

The reason for this association had been forwarded by a couple of studies by reviewing the development of the frontal region.³⁷⁻³⁹ Among them a study regarded metopism as a normal evolutionary progressive phenomenon rather than atavistic feature by rejecting theories of compensatory development, weakened extra cranial muscular pressure and endocrine pathology.

Persistence of normally closing sutures form particular significance in descriptive and experimental studies rather than in clinical studies where they are mere insignificant rarities. Still the persistent inter frontal suture holds varied prominence in forensic, neurosurgical and radiological differentiation from vertical frontal fractures and during performing pterional or supraorbital craniotomy.⁴⁰⁻⁴³

This significant proportion of absence of frontal sinus in cases of metopism in Indian ethnicity observed in present study induced the authors to put forth a hypothesis of possible associated developmental defect of midline structures which needs further detailed elucidation in larger population. The author also opine that the impact of frontal sinus asymmetry as seen in incomplete type warrants detailed clinical study.

Conclusion

The incidence of 3.88% complete and 46.66% incomplete inter frontal suture with a strong association between absence and asymmetry of frontal sinuses respectively was noticed in this study. This frequent occurrence of metopism and its association with either absence or asymmetry of frontal sinuses in Indian ethnicity in this study serves as an alert to clinicians to the fact that this is not a simple anatomical anomaly but a significant differential diagnosis in frontal trauma and imaging.

References

1. Ajmani ML, Mittal RK, Jain SP. Incidence of the metopic suture in adult Nigerian Skulls. *J. Anat.* 1983;137(1):177-83.
2. Hamilton WJ. Text book of Anatomy, 2nd ed. London: Macmillan and Co; 1976:60.
3. Torgersen JH. Hereditary factors in the sutural pattern of the skull. *Acta Radiol.* 195;136:374-382.
4. Keith A. Human embryology and morphology, 6th ed. London: Edward Arnold; 1948.
5. Piersol GA. Human Anatomy, 5th ed. Philadelphia: Lippincott; 1916.
6. Romanes GJ. Cunningham's text book of Anatomy, 11th ed, London: Oxford university press; 1972:133.
7. Torgerson J. Developmental, genetic evolutionary meaning of metopic suture. *American Journal of Physical Anthropology.* 1951;9:193-210.
8. Warwick R and Williams PL. Gray's Anatomy, 36th ed. London: Longmans; 1980:334.
9. Basmajian JV. Grant's method of Anatomy, 9th Ed. New Delhi: S Chand and Co. Ltd: Baltimore: Williams and Wilkins, Co; 1975:451-604.
10. Bryce TH. Osteology and Arthrology. In Quain's elements of Anatomy. 11th ed, London, Longmans Green; 1915:177.
11. Berry AC. Factors affecting the incidence of non-metrical skeletal variants. *J Anat.* 1975;120(3):519-535.
12. Rau R.K. Skull showing absence of Coronal suture. *J. Anat., London* 1934;69:109-112.
13. Jit I, Shah MA. Incidence of frontal or metopic suture amongst Punjabi adults. *Indian Medical Gazette* 1948;83:507.
14. Fakhruddin S, Bhalerao UK. Interparietal Bone in Three Pieces-A case report. *J. Anat. Soc. India.* 1967;16:146-147.
15. Dixit CS, Shukla PL. Metopic sutures in human crania. *J. Anat. Soc. India* 1968;17:47.
16. Das AC, Saxena RC, Deo MAQ. Incidence of metopic suture in U.P. subjects. *J. Anat. Soc. India.* 1973;22:140.
17. Agarwal SK, Malhotra VK, Tewari SP. Incidence of the metopic suture in adult Indian crania. *Acta anatomica.* 1979;105:469-474.
18. Bilodi AK, Agrawal BK, Mane S, Kumar A. A study of metopic sutures in human skulls. *Kathmandu Univ Med J.* 2004;2(2):96-9.
19. Yadav A, Kumar V, Srivastava RK. Study of metopic suture in adult human skulls of north India. *J. Anat. Soc. India* 2010;59(2) 232-236.
20. Honnunar RS, Hallikeri VR. Incidence of metopism in skulls of adult people from Belgaum, Karnataka Medico-Legal Update - An International Journal. 2011;11(1):81-82.
21. Chandrasekaran S, Shastri D. A study of metopic suture in adult south Indian skulls. *IJBMS.* 2011;1(7):379-382.
22. Nelluri V. Morphological study of Metopic suture in adult South Indian skulls. *Int J Med Health Sci.* 2012;1(2):23-28.
23. Rakesh G, Nema U, Zaidi SH. A Study of Metopic Suture in Adult North Indian Skulls. *NJIRM.* 2012;3(1):82-74.
24. Kapadia D, Rathva A, Kubavat DM, Nagar SK. Study of Sutures: Anatomical Variations in the Fusion of Sutures. *International Journal of Recent Trends in Science and Technology.* 2013;8(2):94-99.
25. Gugapriya TS, Vinay Kumar N, Nalinakumari SD. A Morphological Study of Wormian Bones and Palate in Metopic Skulls. *World J. Biol. Med. Science.* 2015;2(2):25-34.

26. Baaten PJJ, Haddad M, Abi-Nader K, Abi-Ghosn A, Al-Kutoubi A, Jurjus AR. Incidence of metopism in the Lebanese population. *Clin Anat.* 2003;16:148–151.
27. Das S, Suri R, Kapur V. Anatomical observations on osinca and associated cranial deformities. *Folia Morphol.* 2005;64(2):118–121.
28. Schuller, A. A note on the identification of skull X-Ray pictures of the frontal sinus. *Med. J. Aust.,* 1943;25(1):554-6.
29. Ponde JM, Andrade RN, Via JM, Metzger P, Teles AC. Anatomical variations of the frontal sinus. *International Journal of Morphology.* 2008;26(4):803-9.
30. Dryander J, Marburg A. In Heirs of Hippocrates. The Development of Medicine in a Catalogue of Historic Books in the Health Sciences Library. Friends of the University of Iowa Libraries, The University of Iowa, Iowa City, 1980.
31. Patricia BL, Biggs NL. Eighteen hundred years of controversy-the paranasal sinuses. *American Journal of Anatomy.* 1969;124:135-48.
32. Levine J, Bradley J, Roth D, McCarthy J, Longaker M. Studies in cranial suture biology: Regional dura mater determines overlying suture biology. *Plast Reconstr Surg* 1998;101:1441-1447.
33. Longaker MT. Role of TGF-beta signaling in the regulation of programmed cranial suture fusion. *J Craniofac Surg* 2001;12:389-390.
34. Manzaranes MC, Goret-Nicaise M, Dhem A. Metopic sutural closure in the human skull. *J Anat* 1998;161:203-215.
35. Most D, Levine J, Chang J, Sung J, McCarthy J, Schendel S, Longaker M. Studies in cranial suture biology: Up-regulation of transforming growth factor B1 and basic fibroblastic growth factor mRNA correlates with posterior frontal cranial suture fusion in the rat. *Plast Reconstr. Surg* 1998;101:1431-1440.
36. Hunt DR, Everest K. Frontal sinus size: Sex, population and metopism affinities. Abstracts of AAPA poster and podium presentations. *American Journal of Physical Anthropology.* 2001;114(32):67-84.
37. Marciniak R, Nizankowski C. Metopism and its correlation with the development of the frontal sinuses: a roentgen-anatomic study *Acta Radiol.* 1959;51(5):343-52.
38. Samuel Salinger MD. The Paranasal Sinuses: summaries of the Bibliographic Material Available for 1958-1959. *Arch Otolaryngol.* 1961;73(2):196-243.
39. Buckland JC, Wright. A Radiographic Examination of Frontal Sinuses in early British Populations. *Man New Series, Published by: Royal Anthropological Institute of Great Britain and Ireland.* 1970;5(3):512-517.
40. Harris AM, Wood RE, Nortje CJ, Thomas CJ. The frontal sinus: forensic fingerprint? A pilot study. *J Forensic Odontostomatol.* 1987;5:9-15.
41. Bademci G, Kendi T, Agalar F. Persistent metopicsuture can mimis de skull fractures in the emergency setting? *Neurocirugia.* 2007;18:238-240.
42. Vikram S, Padubidri JR, Dutt AR. A rare case of persistent metopic suture in an elderly individual: Incidental autopsy finding with clinical implications. *Arch Med Health Sci* 2014;2:61-3.
43. Ozgursoy OB, Comert A, Yorulmaz I, Tekdemir I, Elhan A, Kucuk B. Hidden unilateral agenesis of the frontal sinus: human cadaver study of a potential surgical pitfall. *Am J Otolaryngol.* 2010;31(4):231-4.