Section: Anatomy

Original Research Article

A MORPHOMETRIC STUDY ON WORMIAN BONES IN SOUTHERN ODISHA POPULATION

Niharika Padhy[1], Sunita Patro[2], Vandana Maharana[3], Rajalaxmi Panda[4]

[1]*Associate Professor, Department of Anatomy, MKCG Medical College, Berhampur, Odisha, India.*
[2]*Assistant Professor, Department of Anatomy, MKCG Medical College, Berhampur, Odisha, India.*
[3]*Assistant Professor, Department of Anatomy, Dharanidhar Medical College Keonjhar, Odisha, India.*
[4]*Associate Professor, Department of Anatomy, MKCG Medical College, Berhampur, Odisha, India.*

Received *: 10/07/2025*
Received in revised form *: 26/08/2025*
Accepted *: 18/09/2025*

Corresponding Author:
Dr. Niharika Padhy,
Associate Professor, Department of Anatomy, MKCG Medical College, Berhampur, Odisha, India.
Email: niharikapadhy73@gmail.com

DOI: 10.70034/ijmedph.2025.4.1

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 1-6

ABSTRACT

Background: Wormian bones or sutural bones, are small, irregularly shaped bones most commonly found in the lambdoid suture of skull, but they may also appear in other cranial sutures. These bones develop due to multiple ossification centers within the sutures of skull during development. The knowledge of Wormian bones plays a major role for the neurosurgeons, neuro-anatomists, radiologists, forensic experts and anthropologists. Presence of few wormian bones is normal. But multiple Wormian bones need attention as it may have underlying skeletal or central nervous system pathology. **Objective:** To determine morphologic and morphometric characteristics of wormian bones in Southern Odisha population.

Materials and Methods: The study was conducted on 53 dry human skulls of unknown gender and age in the Department of Anatomy, MKCG MCH, Berhampur, Odisha. The deformed skulls and skulls of paediatric age group were excluded. The location, shape, number and side of wormian bones were determined.

Results: In the present study; wormian bones were observed in 38 (71.7%) skulls out of 53 skulls, and the total number of the observed wormian bones were 129. More than five wormian bones were found in 8 skulls (28%), four in two skulls (5.2%), three in 9 skulls (23.6%), two in 10 skulls (26.3%) and one in nine skulls (23.6%). The wormian bones were seen uniformly distributed both on right and left sides, at a rate of 44.2 %. Maximum number of bones were seen at lambdoid suture (n=78, 60.4 %); followed by lambda 11.6%, pterion 10.8 %, asterion 8.5%, parieto-mastoid suture 6.2 %, squamous suture 2.3% and occipito-mastoid suture 2.3%. The mean values of wormian bones were15.27 ± 5.99 mm vertical diameter and 18.13 ± 7.9 mm horizontal diameter. The mean cranial breadth and cranial length were found as 134.53 ± 6.38 mm and 164.81 ± 7.12 mm respectively. In terms of cephalic index values, 11.3 % were dolicocephalic, 28.3 % mesocephalic, 39.6% brachycephalic and 20.7 % were hyperbrachycephalic skulls. The most common types of skulls in the wormian bone presence group were brachycephalic.

Conclusion: Greater cephalic index, higher incidence of wormian bones, large size wormian bones in our study may indicate the influence of genetic and environmental factors over development of skull bones in Southern Odisha population.

Keywords: wormian bone, suture, interparietal bone, pterion, asterion, lamba

INTRODUCTION

Wormian bones (ossasuturalia), first described by Danish anatomist OlausWormius, are accessory, small, different-shaped bones located on cranial sutures (Creminet al., 1982).[1] They arise from additional centres of ossification and have no clinical significance. These bones may have genetic cause and their initial formation is thought to be caused by degree of dural strain and increased sutural width.

Wormian bones are considered as markers for various congenital diseases like osteogenesis imperfecta and cleidocranial dysostosis.[2]

The "Inca bone," known as the inter-parietal bone or os incae, is a sutural bone seen at lambda, where the parietal bones meet the occipital bone. It is a variation of the occipital bone, where a portion of the supraoccipital bone fails to fuse with the rest of the occipital bone, resulting in a separate piece of bone.

A study done by El-Najjar and Dawson, (1977)3focussing on the association between artificial deformation and incidence of wormian bones claimed that the incidence of wormian bones was higher in adults than in fetuses.

Sanchez-Lara et al. (2007),[4] focused on morphogenesis of wormian bonesand found higher association of wormian bones with craniosynostosis. This study reinforced the concept that mechanical forces affect wormian bone presence at high prevalence in midline with sagittal or metopic synostosis.

The incidence of wormian bones varies significantly among different populations and ethnic groups. Various studies conclude that they are more commonly observed in populations of South Asia, and parts of Africa. Whereas, lower frequencies have been reported in Central and Western Asia, and Europe. However the occurrence of wormian bones is highest along the lambdoid suturein all types of populations.

According to various anatomical studies, the prevalence of wormian bones in the general population ranges from 10% to 40%, depending on genetic and environmental influences. Some studies report that males tend to exhibit a higher incidence than females, but the difference is statistically insignificant. It may be opined that genetic factors are responsible for occurrence of wormian bones individually in different human populations.

The detailed information of precise topography, frequency, and number of wormian bones is of utmost use for

1. Surgeons performing surgery on the skull,
2. Anthropologists for identifying races, and
3. Forensic scientists for investigating child abuse cases

Aim and Objectives

1. To expound the incidence and topography of wormian bones in dry adult skulls in Southern Odisha population.
2. To measure the size, shape, location and numberof wormian bones and compare the values with available data established by other authors.

MATERIALS AND METHODS

- The study was conducted in the Department of Anatomy, MKCG Medical College and Hospital, on 53 complete adult dry skulls of unknown age and sex.
- Unbroken, clean and dry skulls of adult age group were selected for this study whereas deformed skulls and skulls without well visible sutures were excluded from the study.
- The length and breadth of skulls were measured using craniometry. Cephalic index of all skulls was determined using the formula (maximum cranial breadth/ maximumlength)×100. The skulls were classified into four groups based on cephalic index as illustrated in Table I.

Table 1: Cephalic Index classification

Shape	Dolichocephalic	Mesocephalic	Brachycephalic	Hyper-brachycephalic
Cephalic index	CI < 74.9	75<CI<79.9	80<CI<84.9	85<CI<89.9

- All the sutures in the skull were inspected for the presence of wormian bones. Distribution of the sutural bones in various types of skulls was determined. The transverse and longitudinal diameters of wormian bones were measured using thread and scale and the data was compared with the available literature.
- The descriptive statistical method analysis was used for data analysis.

RESULTS

In this study, wormian bones were observed in 38 (71.7%) skulls out of 53 skulls. More than five Wormian bones were found in 8 skulls (28%), four in two skulls (5.2%), three in 9 skulls (23.6%), two in 10 skulls (26.3%) and one in nine skulls (23.6%). The largest number of wormian bones in a single skull was 11.

When we analyse the craniometry, the mean cranial breadth and cranial length were found as 134.53 ± 6.38 mm and 164.81± 7.12mm respectively. When we analyzed the skulls in terms of cephalic index values, 11.3 % were dolicocephalic, 28.3 % were mesocephalic, 39.6% were brachycephalic and 20.7 % were hyperbrachycephalic skulls in our study. The most common types of skulls in the wormian bone presence group were brachycephalic as well as in the group that did not have wormian bone, (Table 2).

Table 2: Distribution of Wormian bones in association to cranial index. N=53

Type of cranium: no, (%)	Absent of wormian bones: no, % (15, 28.3 %)	Presentof wormian bones: no, % (38, 71.7 %)
Dolichocephalic, 6 (11.3 %)	3 (5.6%)	3 (5.6%)
Mesocephalic, 15 (28.3 %)	4 (7.5%)	11 (20.7%)
Brachycephalic, 21 (39.6 %)	5 (9.4%)	16 (30.2%)
Hyperbrachycephalic, 11(20.7 %)	3 (5.6%)	8 (15.1%)

The distribution of locations of wormian bones associated with cranial index aretabulated in Table III. Lambdoid suture is the most frequent site for occurrence of wormian bones in all types of skulls. The second frequent site is the asterion for dolicocephalic type, pterion for brachycephalic type, lambda for hyperbrachycephalic type; for mesocephaluc type the wormian bones are equally distributed in occipitomastoid suture and asterion.

Table 3: Distribution of wormian bones (n=129) according to location and cranial index values

Type of cranium	Lambdoid suture	Occipito-mastoid suture	Asterion	Lambda	Pterion	Parieto-mastoid suture	Squamous suture
Dolichocephalic %	18.75	3.12	6.25	3.12	0	1.5	0.75
Mesocephalic %	9.37	3.12	3.12	0	1.5	0	0
Brachycephalic %	18.75	0	0	0	8.55	3.8	1.5
Hyperbrachycephalic%	15.62	0	12.5	6.25	3.8	0.75	0

The total number of the observed wormian bones were 129 and the greatest number of wormian bones were seen at lambdoid suture (n=78, 60.4 %). Wormian bones were observed at lambdoid suture 60.4%, lambda 11.6%, pterion 10.8 %, asterion8.5%, parieto-mastoid suture 6.2 %, squamous suture 2.3% and occipito-mastoid suture 2.3%. However, they were not seen at bregma, sagittal and coronal sutures. Wormian bones were seen uniformly distributed both on right and left sides, at a rate of 44.2 %. The distribution of wormian bones at different locations is illustrated in table IV.

Table 4: Location of the Wormian bones (n=129)

Location of the wormian bones	Right (n= 57, 44.2%)	Left n= 57, 44.2%)	Total (n=129)
Lambdoidsuture	40 (31 %)	38 (29.2%)	78 (60.4 %)
Pterion	7 (5.4%)	7 (5.4%)	14 (10.8 %)
Asterion	4 (3.1%)	7 (5.4%)	11 (8.5 %)
Parietomastoid suture	2 1.5%)	3 (2.3 %)	8 (6.2 %)
Occipitomastoid suture	3 (2.3%)	0 (0%)	3 (2.3 %)
Squamous suture	1 (0.7%)	2 (1.5%)	3 (2.3 %)
Lambda	15 (11.6%)		15 (11.6%)
Bregma	0 (0%)		0 (0%)
Coronal suture	0 (0%)		0 (0%)
Sagittal suture	0 (0%)		0 (0%)

Representative diagrams for locations of the wormian bones are shown in Figures 1-7.

Figure 1: Wormian bone at asterion

Figure 2: Multiple wormian bones at lambda and lambdoid suture

Figure 3: wormian bone at parieto-mastoid suture

Figure 4: wormian bone at pterion

Figure 5: wormian bone at squamous suture

Figure 6: wormian bone at occipitomastoid suture

Fig 7: large interparietal bone

The mean values of wormian bones were as follows; vertical diameter15.27 ± 5.99 mm and horizontal diameter 18.13 ± 7.9 mm. The largest wormian bone measures 105.35 mm×55.7 mm at lambda and the smallest measures 2 mm× 4.1mm.

The vertical diameter was measured as 14.27± 5.99 mm and horizontal diameter as 23.13 ± 13.9 mm on right lamdoid suture, while the mean vertical diameter and horizontal diameter on left lambdoid suture were found as 16.12± 9.73 mm and 9.38 ± 1.04 mm respectively. The mean vertical diameter at pterion was found as 18.79± 8.82mm and horizontal diameter was found as 18.79± 8.82mm on right side; for left side the vertical diameter 8± 2.5 mm, horizontal diameter was 22 ± 14.12mm. At asterion, on right side the vertical diameter was measured as 16.2 mm and horizontal diameter as16.8mm; on left side the vertical diameter was measured as 22.4 mm and horizontal diameter as 10.2mm. At parieto-mastoid suture on right side the vertical and horizontal diameters were14.5 mm and 8mm; whereas on left side these diameters were 11.8 mm and 6 mm. For occipito-mastoid suture, the mean vertical diameter was found as 7 ± 2.16 mm and horizontal diameter was found as 5.6± 1.34 mm only on right side, whereas it is absent on left side. Finally, the mean values of right vertical diameter were 13.57 ± 5.72 mm and horizontal diameter were 9.46± 7.36 mm whereas the mean values of left vertical diameter were 14.23 ± 9 mm and horizontal diameter were 9.30±8.09 mm. The mean values of vertical and horizontal diameter at lambda measured as 26.86 ± 12.12 mm. and 23.13 ± 13.34 mm respectively.

DISCUSSION

Variations in shape, number, location and incidence of wormian bones have been reported by many researchers around the world; Observations by such workers are illustrated in table V.

In the present study; wormian bones were observed in 38 (71.7%) skulls out of 53 skulls. This finding is almost corroborative with Murlimanju et.al,[5] and Natsis et.al.[6] However most of authors found less than 70% incidence of these bones; (Marty et.al,[7], Patel et.al,[8] Cirpanet et.al,[9] Durge et.al,[10]

Sreekanth et.al,[11] Kumar et.al,[12] Showri et.al,[13] Ghosh et.al,[14] Sah et.al,[15] Uchewa et.al,[16] Goyal et.al,[17] Padmaja et.al,[18] Kilik et.al,[19] Somani et al,[20]); whereas a high incidence (88.5%) was reported in Nepalese population by Basnet et.al.[21]

More than five wormian bones were found in 8 skulls (28%), four in two skulls (5.2%), three in 9 skulls (23.6%), two in 10 skulls (26.3%) and one in nine skulls (23.6%). The maximum number of wormian bones was 11 in a single skull. Himabindu et al,[22] found 27 wormian bones in a single skull. Cirpanet et.al,[9] observed more than 5 only in 0.7 % skulls; maximum skulls (20%) were with a single wormian bone. Ghosh et.al,[14] reported more than 10 wormian bones in 2.5%skulls. But Kilic et.al,[19] found more than five wormian bones only in one out of 12 skulls.

In our study, wormian bones were seen uniformly distributed both on right and left sides, at a rate of 44.2 %; corroborative with study of Murlimanju et.al.[5] Whereas Tallapaneni et.al,[23] Sreekanth et.al,[11] Showri et.al,[13] and Kilic et.al,[19] observed more number of wormian bones on left sides.

Maximum number of bones were seen at lambdoid suture; unanimously reported by all authors.

Lambda is the second frequent site for wormian bones in our study. Similar findings observed by Cirpanet et.al,[9] Sreekanth et.al,[11] Kumar et.al,[12] Ghosh et.al,[14] and Jyothi et.al.[24] However according to Uchewa et.al,[16] and Li et.al,[25] pterion is the second highest site for wormian bones. In our study only 10.8% skulls had wormian bones at pterion. Asterion is reported as the second higest frequent site for wormian bones as reported by Murlimanju et.al,[5] Patel et.al,[8] Kumar et al,[12] Showri et al,[13] Sah et.al,[15] and Kilic et.al.[19] We also found wormian bones at parietomastoid and occipitomastoid sutres.

The wormian bones were absent at sagittal and coronal sutures. However wormian bones were reported at these sites by Murlimanju et.al,[5] Patel et.al,[8] Sreekanth et.al,[11] Sah et.al,[15] Basnet et.al,[21] Padmaja et.al,[18] Natsis et.al,[6] Somani et.al,[20] Jyothiet.al,[24] and Li et.al.[25] A large number of wormian bones were observed at coronal suture in greek population by Natsis et. Al,[6] and at sagittal suture by Somani et al.[20]

Table 5: Comparison of prevalence of wormian bones at different sites by different authors

Authors	Total	Coronal Suture	Sagittal suture	Lambdoid suture	Bregma	Lambda	Occipitomastoid suture	Parietomastoiduture	Asterion	Pterion
Murlimanju[5], 2011	73.1	1.3	1.3	56.4	--	--	--	--	17.9	11.5
Patel[8]. 2015	44.4	0.03	--	48.14	--	--	0.03	0.07	18.5	0.03
Cirpan[9], 2015	59.3	--	--	40.7	--	--	1.3	--	--	--
Sreekanth[11], 2016	59/1	--	0.9	53.15	0.9	8.1	0.9	4.5	2.7	1.8
Kumar[12], 2016	11	--	--	44	--	6	6	--	6	2
Showri[13], 2016	--	0	0	57.14	0	9.37	9.37	0	18.76	9.37
Ghosh, 2017	42.8	--	--	53.33	0.61	21.21	--	--	--	--
Sah[15], 2017	6	--	3.63	63.63	--	--	--	--	20	12.72
Basnet[21], 2018	45	4.28	7.14	61.43	--	11.43	27.14	41.43	24.29	25.71
Uchewa[16] 2018	55/8	--	--	36.36	--	--	--	--	--	9.09
Goyal[17]2019	0	--	--	23.8M,1	--	--	--	--	--	--
Padmaja[18],2019	88.5	10.6	--	1.5 F	--	--	--	--	--	--
Natsis[6] 2019	45.4	39.8	--	61.2	--	--	--	15.1	21	--
Kilic[19] 2020	6	0	0	44.6	0	9.37	9.37	0	18.76 -	0
Somani[20] 2021	35.3	1.06	10.77	57.14	--	--	--	--	-	--
Jyothi[25], 2022	19	--	0.7	21.28	--	5.4	--	--	--	--
Li[25], 2023	74.7	--	4.95	12.5	--	8.24	--	--	12.09	34.62
Present study	42	0	0	78.57	0	11.6	2.3	6.2	8.5	10.8
	56/1			60.4						
	88									
	13.2									
	63.8									
	6									
	71.7									

In our study the mean size of wormian bones was measured as 15.27± 5.99mm vertical diameter and as 18.13 ± 7.9 mm horizontal diameter; which is larger in comparison to findings of Showriet.al,[13] (12.29 ± 4.48mm × 10.93 ± 4.39 mm) and Kilic et.al,[19] (12.29 ± 4.48 mm × 10.93 ± 4.39 mm)

When we analyse the craniometry, the mean cranial breadth and cranial length were found as 134.53 ± 6.38 mm and 164.81± 7.12 mm respectively; which is greater than the findings by Kilic et.al (128.06 11.92 mm and 166.12 5.47mm respectively)

In our study, the most common types of skulls in the wormian bone presence group were brachycephalic as well as in the group that did not have wormian bone; corroborative with findings of Gümüsburun et.al.[26] Whereas Showri et. Al,[13] Basnet et.al,[21] and Kilic et.al,[19] found most of the skulls in dolicocephalic group with and without wormian bones. This indicates presence of larger cephalic

index in the present study; though the literature for this work is limited.

CONCLUSION

Although there were many variations on prevalence rate, location, number size and shape of wormian bones in different races; our study results were similar with the data in other population with regards to the location of highest number of wormian bones at lambdoidsuture. We found higher incidence of wormian bones at pterion and lamda in comparision to other workers. In our study; majority of the skulls belong to Brachycephalic type. Greater cephalic index, higherincidence of wormian bones, large size wormian bones may indicate the influence of genetic and environmental factors over development of skull bones in southern Odisha.

In conclusion, it is considered that the results of this study are crucial for anthropologists, anatomists, radiologists, forensic experts, and make a contribution to literature data. Presence of few bones are normal. But multiple wormian bones need attention as it may have underlying skeletal or CNS pathology. Due to the fact that wormian bones may give rise to mistakes in determining fractures, these data will also be helpful for diagnosis and treatment of skull pathologies for clinicians and neurosurgeons as wormian bone at pterion may produce complications in neurosurgical procedures like burr holes.

Acknowledgement

We would like to thank whole heartedly tothe Institutional Ethical Committee without whom the study would not have been possible.

REFERENCES

1. Cremin, B.; Goodman, H.; Spranger, J. &Beighton, P. Wormian bones in osteogenesisimperfecta and other disorders. Skeletal Radiol., 8(1):35-8, 1982
2. Susan Standring:Greys anatomy 42nd edition, 2021; pg 560.
3. El-Najjar, M. & Dawson, G. L. The effect of artificial cranial deformation on the incidence of Wormian bones in the lambdoidal suture. Am. J.Phys. Anthropol., 46(1):155-60, 1977.
4. Sanchez-Lara, P. A.; Graham, J. M. Jr.; Hing, A. V.; Lee, J. & Cunningham, M. The morphogenesis of wormian bones: a study of craniosynostosis and purposeful cranial deformation. Am. J. Med. Genet. A, 143A(24):3243-51, 2007.
5. Murlimanju, BV. Et al.: Morphological and topographical study of Wormian bones in cadaver dry skulls J. Morphol. Sci., 2011, vol. 28, no. 3, p. 176-179
6. Natsis K, Piagkou M, Lazaridis N, Anastasopoulos N, Nousios G, Piagkos G, et al. Incidence, number and topography of Wormian bones in Greek adult dry skulls. Folia morphologica. 2019;78(2):359
7. Marti B, Sirinelli D, Maurin L, Carpentier E. Wormian bones in a general pediatric population. DiagnInterv Imaging. 2013 Apr 1;94(4):428-32.
8. Patel D, Chauhan K, Patil D. Morphological study of wormian bones in dried human skulls. NJMR. 2015 Sep 30;5(03):222-5.
9. Cirpan, S.; Aksu, F. & Mas, N. The incidence and topographic distribution of sutures including wormian bones in human skulls. J. Craniofac. Surg., 26(5):1687-90, 2015.
10. Durge SV. Study of Wormian Bones on Dry human skull and its sexual dimorphism in the region of Andhra Pradesh. Asterion. 2016;2(3):79-82
11. Sreekanth, T. &Samala, N. Morphological study of wormian bones in dried adult human skulls in Telangana. Int. J. Anat. Res., 4(4):3157-62, 2016.
12. Kumar, T. M. V.; Kumar, V. &Yadav, N. The occurrence of wormian bones within the cranial sutures and their clinical significance. Int. J. Anat. Res., 4(4):3082-6, 2016.
13. Showri, R. & Suma, M. P. Study of wormian bones in adult human skulls. IOSR J. Dent. Med. Sci., 15(12):54-60, 2016.
14. Ghosh SK, Biswas S, Sharma S, Chakraborty S. An anatomical study of wormian bones from the eastern part of India: is genetic influence a primary determinant of their morphogenesis? AnatSci Int. 2017 Jun; 92:373-82.
15. Sah SK, Chaudhary D, Pandey N. Study of Metopism and Wormian Bones in Dry Skulls of Human Cadavers in Nepal. Int J Anat Res. 2017; 5(1):3443-3446.
16. Uchewa OO, Egwu OA, Egwu AJ, Nwajagu GI. Incidence of wormian bones in the dried skull of Nigerian males. Int J Anat Var. 2018 Mar;11(1):32-4.
17. Goyal N, Garg A, Kumar Y. Incidence and medicolegal significance of wormian bones in human skulls in North India Region. Int J App Basic Med Res. 2019; 9:165-8.
18. Padmaja S, Thenmozhi MS, Lakshmanan G. Prevalence of wormian bones in dried adult human skulls of South Indian population-An osteomorphometric study. Drug Invention Today. 2019 Apr 15;12(4).
19. KiliçSafak, N.; Taskin, R. G. &Yücel, A. H. Morphologic and morphometric evaluation of the wormian bones. Int. J. Morphol., 38(1):69-73, 2020.
20. Somani M, Yadav SS, Kumar S, Kumar V. Study of Incidence of Wormian Bones in Eastern Haryana - A Prospective Observational Study. Sch J App Med Sci. 2021 Aug 9(8): 1256-1259. DOI: 10.36347/ sjams. 2021.v09i08.003
21. Basnet L M,ShresthaS,Sapkota S: Prevalence of wormian bones in dried adult human skulls: an osteo-morphometric study in Nepal. Anatomical Science Internationalhttps://doi.org/10.1007/s12565-018-0454-x
22. Himabindu A, Rao BN. An Insight into Wormian Bones. IJSRES. 2(6), June 2015.ISSN: 2349-8862.Jyothi C N, Muraleedharan A, J.P G, Devi. Morphometric Analysis of Accessory Sutural Bones Association with Parietal Emissary Foramina. Anatomical Sciences Journal. 2022; 19(1):33-38.
23. Tallapaneni, S.; Namrata, C.; Veliginti, S.; Mogili, A.; Zaman, S. &Hashmi, F. A. Fourteen wormian bones in an adult Indian skull – A rare case report. Med. Sci., 1(3):55-9, 2013.
24. Jyothi C N, Muraleedharan A, J.P G, Devi. Morphometric Analysis of Accessory Sutural Bones Association with Parietal Emissary Foramina. Anatomical Sciences Journal. 2022; 19(1):33-38.
25. Li JH, Chen ZJ, Zhong WX, Yang H, Liu D, Li YK. Anatomical characteristics and significance of the metopism and Wormian bones in dry adult- Chinese skulls. Folia Morphol (Warsz). 2023;82(1):166-175. doi: 10.5603/FMa2022.0006. Epub 2022 Jan 31. PMID: 35099043
26. Gümüsburun, E.; Sevim, A.; Katkici, U.; Adigüzel, E. & Güleç, E. A study of sutural bones in Anatolian-Ottoman skulls. Int. J. Anthropol., 12(2):43-8, 1997.