

FORENSIC STUDY FOR DETERMINATION OF THE INCIDENCE OF PERSISTENT METOPIC (FRONTAL) SUTURE AND ITS RELATION TO AGE AND SEX AMONG SAMPLE OF EGYPTIAN SKULLS

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ABSTRACT

Introduction: At birth the frontal bone contains two portions, separated by the metopic (frontal) suture. Metopism is the condition of having a persistent metopic suture. **Aim of the present study** was to determine the incidence of persistence of metopic suture, their shape and its relation to age and sex in Egyptian human skulls. **Material and Method:** The study was conducted on 147 human dry skulls which belong to the museum of the department of Anatomy, Faculty of Medicine, Menoufia University. The metopic sutures were classified as complete and incomplete types. Incomplete metopic sutures were divided into three groups as present in the lower part of the frontal bone, in the upper part and in the middle part. The incomplete lower metopic sutures were further subdivided into linear, 'V' shaped and 'U' shaped. **Results:** From this study, absence metopic sutures were observed in 84 (57.1%) skulls, while it was present in 63 (42.9%) ones. The complete metopic suture (metopism) was seen in 12 (8.2%) skulls and incomplete one in 51 (34.7%). Among the incomplete ones, linear, 'U' and 'V' shaped was found in 36 (24.5%), 9 (6.1%), and 6 (4.1%), respectively. All incomplete metopic sutures were found in the lower part of frontal bone, but no suture remnant was found in the upper and middle part of frontal bone. Incomplete lower V shaped metopic suture presented in all female skulls. There were statistical significant relation between absent, complete, incomplete lower linear and incomplete lower V shaped metopic suture regarding age. Also there was statistical significant relation between metopism regarding age and sex. There was sensitivity and specificity for both age and sex with metopic suture. **Conclusion and recommendation:** The incidence of metopism was 8.2% while incomplete metopic sutures were 34.7%. This incidence may be valuable information for identification of the person and for radiologists and neurosurgeons in practice to concern about metopic suture in emergency diagnosis of frontal bone fractures.

Key words: Incidence, skull, metopic suture.

INTRODUCTION

The frontal bone of the skull is divided into two halves by a fibrous metopic (frontal) suture (Vu et al., 2001). It is typically dentate suture when it is persistent and lies 2 cm anterior to the coronal suture. The posterior end of it does not meet the sagittal suture and away by 15 mm.

(Keith and Persaud, 2003; Yadav et al., 2010). The obliteration of metopic suture is controversial (Bilgin et al., 2013). It begins to unite in the second year, and completely fuses by the 8th year. The approximate closing time of the metopic suture is 2 years of age (Scheuer and Black, 2000; Bademci et al., 2007; Bajwa et al., 2013).

Partial or total failure of closure of metopic suture and its difference in shape may be present in some skulls which show racial variation (**Eroglu, 2008**). Metopism is the complete persistence of the metopic suture in adult individuals and its frequency varies between 0.0 and 13.0% (**Hanihara and Ishida, 2001**). **Faro et al., (2006)** reported that in Apert syndrome (a congenital disorder characterized by malformations of the skull, face, hands and feet) there was an impaired closure of the metopic suture. The most accepted cause is the genetic influence (**Castilho et al., 2006**). The dura mater-suture complex had a critical role in determining metopic suture patency in animal models (**Bademci et al., 2007**). **Longaker (2001)** indicated that some cytokines showed increased expression during active cranial suture fusion. Chondroid tissue is responsible for suture closure and maintenance of an open suture occurs by the process of active resorption (**Murlimanju et al., (2011)**). Persistent frontal sutures are of no clinical significance, although they can be mistaken for cranial fractures (**Weir et al., 2006**). In radiological images it can be misunderstood as fracture of frontal bone or even for the sagittal suture (**Santhosh et al., 2014**). Diagnosing the persistent suture clinically in suspected head trauma patient may be problematic as it may be considered an evidence of traumatic vertical fractures (**Aksu et al., 2014**). Multiplanar reformat 3D CT scans are helpful to demonstrate the type and extent of the suture and to verify the pathology (**Bademci et al., 2007**). Incidence of persistence of metopic suture in different races is important for paleodemography and forensic medicine (**Santhosh et al., 2014**).

Aim of The Work: to determine the incidence of persistence of metopic sutures, their shape, and the relation between metopic suture to age and sex in Egyptian human skulls.

MATERIAL & METHODS

The study was conducted on 147 dried identified human skulls (78 males and 69 females) aged 30 - >50 years old. They were obtained from the museum of Anatomy department, Faculty of Medicine, Menoufia University. All the skulls were free from any deformities or trauma. The skulls were examined by naked eye for the presence or absence of the metopic suture. The skulls were divided into three groups as normal skulls without metopic suture, complete metopic suture (metopism) as it is found completely extended between the bregma and nasion and with incomplete metopic suture when it extends to a smaller distance either from the bregma or from the nasion (**Skrzat et al., 2004**). The incomplete metopic sutures were divided into upper, middle and lower according to their position in the frontal bone. The incomplete metopic sutures in the lower part of the frontal bone were subdivided into different shapes linear, U shaped and V shaped types (**Castilho et al., 2006**). The Data were recorded, tabulated and statistically analyzed by computer based statistical package SPSS version 16. The incidence and shape of the metopic suture were analyzed as number and percentage and Chi-square test (χ^2) was used to study association between two qualitative variables. P-value of < 0.05 was considered statistically significant. Receiver Operating Characteristic (ROC) curve was done to detect cut level of any tested variable where at this level there

is the best sensitivity and specificity. The validity of the model was measured by means of the concordance © statistic (equivalent to the area under the ROC curve). A model with a c value above 0.7 is considered useful while a c value between 0.8 and 0.9 indicated excellent

diagnostic accuracy (Elliott and Woodward, 2007). The study was carried out in an ethical manner following guidelines set by the Ethical Committee of Menoufia University.

RESULTS

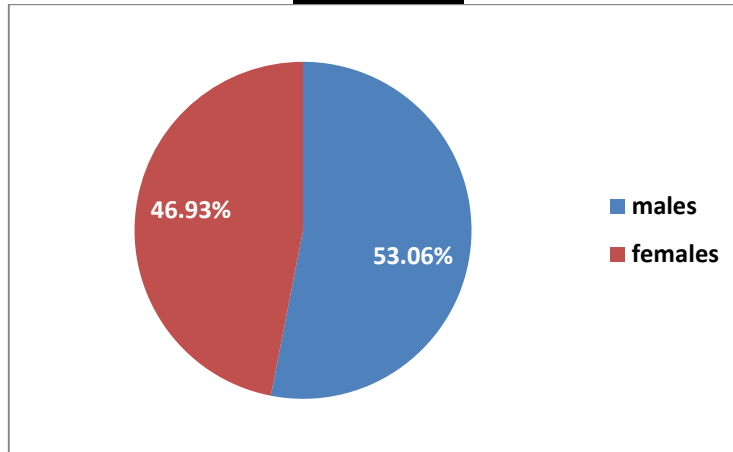


Chart (1): Percentages of Metopic Suture among Males and Females Skulls. No= 147

Table (1): Distribution of the Studied Skulls According to Age.

Age	No.	%
>30- ≤40	3	2.0
>40- ≤50	18	12.2
>50	126	85.7

No= 147

Chart and table (1): show total number of observed skulls was 147, where 78 (53.1%) skulls were males and 69 (46.9%) skulls were females. The majority of the skulls (85.7%) were

aged >50 years, while (12.2%) and (2%) of the skulls were in the age groups (>40- ≤50) and (>30- ≤40) years respectively.

Table (2): Incidence of Metopic Sutures in Males and Females Skulls.

Types of metopic suture	Sex					
	Male		Female		Total	
	No.	%	No.	%	No.	%
Absence of metopic suture	48	57.1	36	42.9	84	57.1
Complete (metopism)	6	50.0	6	50.0	12	8.2
Incomplete	24	47.1	27	52.9	51	34.7
Total	78	53.06	69	46.9	147	100.0

No=147

Table 2: shows absence of metopic suture (fig.1) was observed in 84(57.1%) skulls, more than fifty percent was males. Complete metopic suture (metopism) (fig. 2) was

presented in 12(8.2%) skulls which were equally distributed between males and females, while incomplete metopic suture was found in 51(34.7%) skulls where, 52.9% of them were females.

Table (3): Incidence of Types of Incomplete Metopic Sutures in Males and Females Skulls.

Types of incomplete metopic suture	Males		Females		Total	
	No.	%	No.	%	No.	%
Linear	21	14.3	15	10.2	36	24.5
U shaped	3	2.0	6	4.1	9	6.1
V shaped	0	0.0	6	4.1	6	4.1
In lower part of frontal bone	24	16.3	27	18.4	51	34.7
In upper part of frontal bone	0	0	0	0	0	0
In middle part of frontal bone	0	0	0	0	0	0

No=147

Table (3): shows incomplete metopic sutures in the lower part of frontal bone were presented in 51 (34.7%) of skulls. Of them 18.4% were females. Linear, U and V shaped metopic sutures were observed in

24.5%, 6.1% and 4.1% skulls respectively (figs. 3, 4 and 5). Incomplete metopic sutures in upper and middle part of frontal bone didn't present in the studied skulls.

Table (4): Chi-square (X^2) Statistical Analysis of Types of Metopic Suture in Relation to Sex.

Type of metopic suture	Male		Female		Total	X2	P value
	No.	%	No.	%			
Absent	48	57.1	36	42.9	84	1.3	0.16
Complete (metopism)	6	50.0	6	50.0	12	0.049	0.5
Incomplete lower linear	21	58.3	15	41.7	36	0.53	0.29
Incomplete lower U shaped	3	33.3	6	66.7	9	1.5	0.19
Incomplete lower V shaped	0	0.0	6	100.0	6	7.07	0.009**

No=147 P>0.05 non -significant ** P<0.001 highly significant

Table (4): shows that incomplete lower V shaped metopic suture presented in all female skulls. The relation between incomplete lower V shaped metopic suture and sex was

highly statistically significant as P=0.009. There were no statistical significant differences between other types of metopic suture regarding sex.

Table (5): Chi-square (X^2) Statistical Analysis of Types of Metopic Suture in Relation to Age.

Type of metopic suture	>30-≤40 (N=3)		>40- ≤50 (N=18)		>50 (N=126)		Total No.	X2	P value
	No.	%	No.	%	No.	%			
Absent	0	0.0	6	7.1	78	92.9	84	9.3	0.009**
Complete (metopism)	3	25.0	6	50.0	3	25.0	12	54.6	0.00**
Incomplete lower linear	0	0.0	0	0.0	36	100.0	36	7.9	0.019*
Incomplete lower U shaped	0	0.0	3	33.3	6	66.7	9	4.08	0.13
Incomplete lower V shaped	0	0.0	3	50.0	3	50.0	6	8.3	0.015*

No=147 P>0.05 non -significant * P<0.05 significant ** P<0.001 highly significant

Table (5): reveals that absent metopic suture and incomplete lower linear metopic suture were 92.9% and 100% and $P=0.009$ and 0.019 respectively in age group (>50) years. Metopism presented in fifty percent of skulls in age group ($>40- \leq 50$) years. The relation between metopism and age was highly statistically significant as $P=0.00$ Incomplete lower V shaped

metopic suture was equally distributed in age groups ($>30- \leq 40$) years and (>50) years. The relation between incomplete lower V shaped metopic suture and age was statistically significant as $P=0.015$. Furthermore, there was no significant statistical relation between type of incomplete lower U shaped metopic suture and age as $P=0.13$

Table (6): Chi-square (X^2) Statistical Analysis of Types of Metopic Suture in Relation to Age and Sex.

Type of metopic suture	$>30- \leq 40$		$>40- \leq 50$		>50		Total No.	X2	P value
	Male No. %	Female No. %	Male No.%	Female No. %	Male No. %	Female No. %			
Absent	0 0.0	0 0.0	3 3.6	3 3.6	45 53.6	33 39.3	84	0.135	0.52
Complete (metopism)	3 25.0	0 0.0	3 25.0	3 25.0	0 0.0	3 25.0	12	6	0.039*
Incomplete lower linear	0 0.0	0 0.0	0 0.0	0 0.0	21 58.3	15 41.7	36	---	---
Incomplete lower U shaped	0 0.0	0 0.0	0 0.0	3 33.3	3 33.3	3 33.3	9	2.2	0.23
Incomplete lower V shaped	0 0.0	0 0.0	0 0.0	3 50.0	0 0.0	3 50.0	6	--	--

No=147 $P>0.05$ non -significant * $P<0.05$ significant

Table (6): shows that complete metopic suture (metopism) equally distributed between males and females (25%) each in age group ($>40- \leq 50$) years while it was in all males in age group ($>30- \leq 40$) years. The relation between metopism regarding age and

sex was statistical significant as $P=0.039$. On the other hand there were not significant statistical differences between other types of metopic suture regarding age and sex.

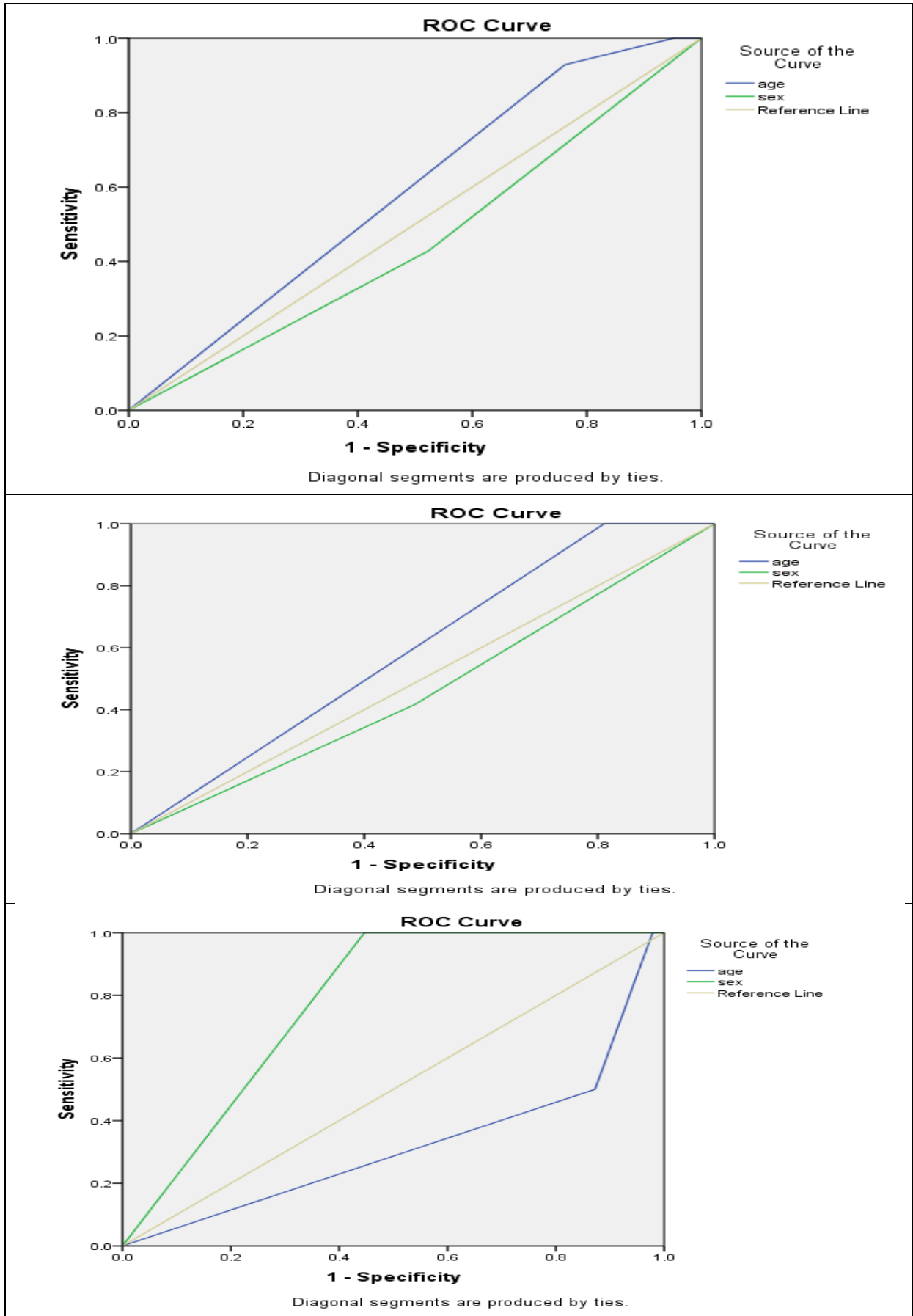


Chart (2): Receiver Operating Characteristic (ROC) curves.

Table (7): Sensitivity and Specificity of Age and Sex as Predictive Variables for Metopic Suture.

Test Variable(s)	Result	AUC	Sensitivity	Specificity	Cut off points	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
							Lower Bound	Upper Bound
Age	Absent metopic suture	58.5	92.9	23.5	52.3	.078	.490	.680
	Lower linear incomplete	59.5	100	22.5	55.6	.089	.497	.693
Sex	Lower V. Shaped incomplete	77.7	100	56.3	2	.022	.660	.893

Receiver operating characteristic (ROC) curve analysis AUC= area under the curve. The cut off point for age = 52.3 and 55.6. The cut off point for sex = 2

Chart (2) and table (7): show Receiver Operating Characteristic (ROC) curve to differentiate absent metopic suture, lower linear incomplete metopic suture

and lower V shaped incomplete metopic suture as regarding age and sex. It was obtained a sensitivity of 92.9%, a specificity of 23.5% and cut off point 52.3, sensitivity of 100%, a specificity of 22.5% and cut off point 55.6 and sensitivity of 100%, a specificity of 56.3% and cut off point 2 respectively.

**Figure (1):** Showing absence of metopic suture (Arrow).

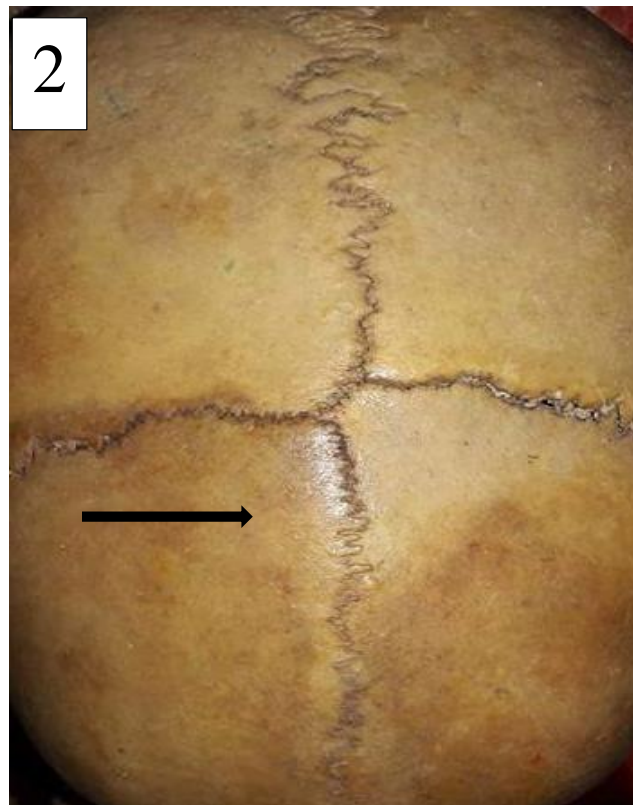


Figure (2): Showing Complete metopic suture (Arrow).



Figure (3): Showing linear lower metopic suture (incomplete) (Arrow).

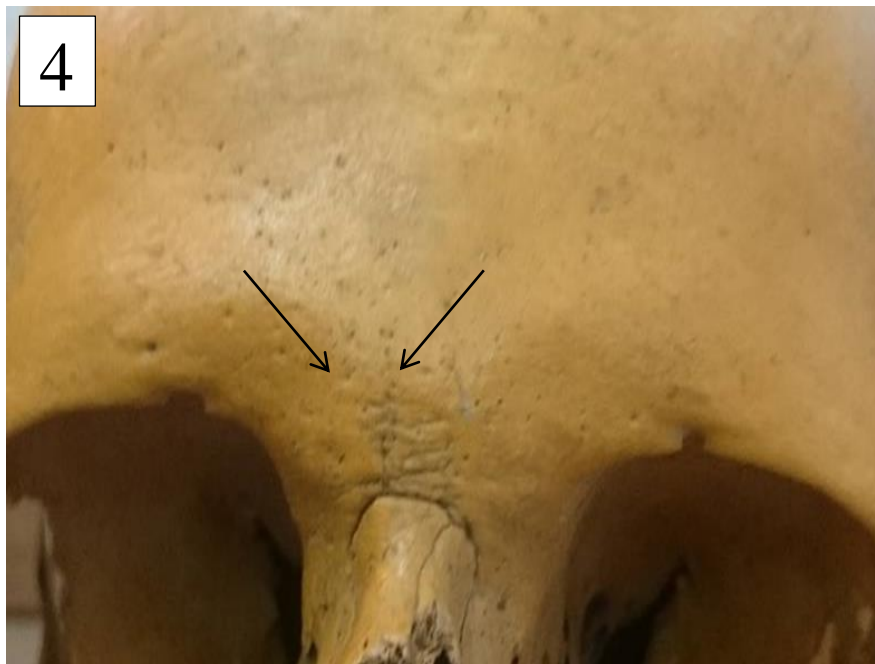


Figure 4: Showing U shaped lower metopic suture (incomplete) (Arrows).



Figure (5): Showing V shaped lower metopic suture (incomplete) (Arrows).

DISCUSSION

Metopic suture is a kind of dentate suture extending from the nasion to the bregma. Its timing of closure is still controversial. The etiology of persistent metopic suture is unclear. **Skrzat et al., (2004)** reported that, it is difficult to find difference between shapes of skulls with or without metopic sutures

as there is a lack of suitable data. According to **Del Sol et al., (1989)** metopism can be due to abnormal

growth of cranial bones, growth retardation, heredity, atavism, hydrocephalus, sexual influence, mechanical causes and hormonal dysfunction.

This study aimed to determine incidence, shape and extent of metopism in Egyptian population skulls sample. The metopic sutures in the present study were observed in 42.9% of the skulls. Among them 78 (53.1%) were seen in males and 69 (46.9%) in

females. Similar male preponderance of metopic sutures was observed earlier by **Baaten et al., (2003)** in Labanise, **Murlmanju et al., (2011)** in Indian and **Khamanarong et al., (2015)** in Thai skulls. Maximum incidence of metopic suture was reported by **Murlmanju et al., (2011)**, as 64.1% in Indian skulls.

In the present study complete metopic suture (metopism) was determined as 8.2% and equally distributed between male and female skulls. This result was similar to earlier study carried by **Skrzat et al., (2004)** in Europeans as 7-10% but it was higher than the incidence reported by other workers. **Castilho et al., (2006)** observed the occurrence of metopism in 7.04% of the Brazilian skulls, of which 80% were female and 20% male. **Santhosh et al., (2014)** reported that the incidence of metopism in south Indian was found to be 6%. **Murlmanju et al., (2011)** reported that the incidence of metopism in Indian was determined as 1.2%. The highest incidence of metopism was reported in Alpine skulls as 63.2% (**Castilho et al., 2006**). According to **Baaten et al., (2003)**, the incidence of metopism was 0.82% in the Lebanese population.

In the present study, the incidence of incomplete metopic suture was found to be 34.7% where, 18.4% of them were females. This coincides to the study conducted by **Chakravarthi and Venumadhav (2012)** (38.75%) and **ShantaChandrasekaran and DeeptiShastri (2011)** (40%). But it is in contrast to the study conducted by **Yadav et al (2010)** (14.6%) and **Santhosh et al. (2014)** (7%). **Khamanarong et al., (2015)** reported that the incidence of incomplete metopic suture of Thais was higher than that of the complete metopic suture with

respect to sex, the metopic suture in both types is found to be higher in males than in females.

All skulls of incomplete metopic suture type (34.7%) were observed in the lower part of frontal bone, whereas none of the incomplete metopic suture was observed in the upper and middle part of frontal bone. This is in agreement with previous study by **Santhosh et al., (2014)** reported incomplete metopic suture in the lower part of frontal bone, whereas none of the incomplete metopic suture was observed in the upper and middle part of frontal bone. On contrast **Yadav et al., (2010)** reported metopic suture in lower part in 14.02% skulls, in upper part in 0.39% and in middle parts in 0.19% cases. In this study we found linear incomplete metopic suture in 24.5% of the skulls, 'U' shaped and 'V' shaped in 6.1% and 4.1% skulls respectively which is similar to the study conducted by **Santhosh et al., (2014)** but is in contrast to the study conducted by **ShantaChandrasekaran and DeeptiShastri (2011)** and **Chakravarthi and Venumadhav (2012)**. Also in the present study, there was found that V shaped metopic suture presented in all female skulls. This is different from the study carried by **Murlmanju et al., (2011)** who observed that males were higher incidence than females.

In this study there was significant statistical relation between metopism regarding age and sex. Complete metopic suture (metopism) equally distributed between males and females in age group (>40- ≤50) years but, it presented in all males in age group (>30-≤ 40) years. This is different from others studies, **Santhosh et al., (2014)** found that the incidence of metopism was slightly higher in the female

population and **Khamanarong et al., (2015)** found that this incidence was higher in males than in females.

The present study showed ROC curve differentiate absent metopic suture and lower linear incomplete metopic suture regarding age and lower V shaped incomplete metopic suture regarding sex. **Perkins and Schisterman (2006)** and **Akobeng (2007)** stated that there are several advantages by using ROC curve. The diagnostic accuracy from this analysis is based on sensitivity and specificity which can easily obtained by visualizing the curve (**Greiner et al., 2000; Morton et al., 2001**)

Conclusion and recommendations

The present study has shown the incidence of metopic suture in Egyptian skulls as 42.9% and metopism as 8.2%. The most common incomplete metopic suture was linear type in the lower part of the frontal bone. The relation between incomplete lower V shaped metopic suture and sex was highly statistically significant as it presented in females skulls. There were highly significant relation between absent metopic suture and metopism regarding age. There was significant statistical relation between metopism regarding age and sex where, it presented in all males in age group (>30-≤ 40) years. There was sensitivity and specificity for both age and sex with absent metopic suture, lower liner incomplete and lower V-shaped metopic suture respectively. So the study would be a useful guide for forensic medicine experts in the identification of a person. Due to lake of the availability of the skulls, a lesser number of sample sizes were taken in this study. Larger sample size can be done for better analysis and helpful constructive data.

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دراسة شرعية لتحديد مدى وجود الدرز الجبهي وعلاقته بالنوع و العمر في عينة من جماجم المصريين

عزة وجيه زناتي

قسم الطب الشرعي والسموم الإكلينيكية كلية الطب – جامعة المنوفية

المقدمة: تحتوي عظمة الجبهة علي جزئين منفصلين بواسطة الدرز الجبهي عند الولادة . ويسمي وجود الدرز الجبهي ببقاء الدرز الجبهي.

الهدف من الدراسة: تحديد مدى وجود الدرز الجبهي و أشكاله وعلاقته بكل من الجنس و العمر.
المادة والطريقة: أجريت هذه الدراسة علي ١٤٧ جمجمة من متحف قسم التشريح كلية الطب جامعة المنوفية. تم تقسيم الدرز الجبهي إلى نوعين كامل وغير كامل، تم تقسيم الدرز الجبهي الغير كامل الي ثلاثة أنواع من حيث وجوده إما في الجزء السفلي من عظم الجبهة ، في الجزء العلوي ، أو في المنتصف. وبعد ذلك تم تقسيم الدرز الجبهي السفلي الغير كامل حسب الشكل إلي خطي، أو علي شكل حرف U أو، V.

النتائج: اتضح من هذه الدراسة عدم وجود الدرز الجبهي في ٨٤ (٥٧،١%) جمجمة، بينما وجد في ٦٣ (٤٢،٩%) جمجمة. لوحظ بقاء الدرز الجبهي كاملاً في ١٢ (٨،٢%) جمجمة و غير كامل في ٥١ (٣٤،٧%) جمجمة . وجد أن اشكال الدرز الجبهي الغير كامل هي الخطية، U، و V ٣٦ (٢٤،٥%)، ٩ (٦،١%)، و ٦ (٤،١%) علي التوالي. لوحظ الدرز الجبهي الغير كامل في الجزء السفلي من عظم الجبهة وعدم وجوده سواء في الجزء العلوي أو الأوسط. وجد أن الدرز الجبهي الغير كامل وعلي شكل V في عينات الإناث. واتضح أن هناك علاقة ذو دلالة احصائية بين أنواع الدرز الجبهي (الغير موجود، الكامل و الغير كامل في الجزء السفلي وعلي شكل خطي و شكل V) والعمر. كما أنه هناك علاقة ذو دلالة احصائية بين الدرز الجبهي الكامل بالنسبة للجنس و العمر. واتضح ايضا ان هناك حساسية وتحديد بين العمر والنوع و الدرز الجبهي.

الخلاصة و التوصية: مدى بقاء الدرز الجبهي ٨،٢% بينما وجد الدرز الجبهي الغير كامل ٣٤،٧%. يعتبر هذا المدى ذو قيمة للاستعراف علي الشخص كما أنه ذو أهمية من الناحية العملية لأطباء الأشعة وجراحي المخ والأعصاب بالأخذ في الاعتبار في تشخيص كسور العظم الجبهي.