The Morphologic Variations of the Supramastoid Crest and Tubercles

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RÉSUMÉ

Cet article, basé sur une étude de 316 crânes de races, sexes et âges différents, décrit les variations morphologiques des tubercules et de la crête supramastoïde.

From the posterior end of the zygomatic root a bony crest extends on the temporal bone, above the external auditory meatus, to the squamous suture in the back, and thus, separates the squamous portion from the mastoid.[1] This structure was first designated by Broca in 1875 as the supramastoid crest, and was also called retro-temporal crest by dalla Rossa (Blaschy 1896) and temporal ridge by Leidy (1883). The crest could likewise be viewed as an extension of the inferior temporal line, or as the posterior root of the zygomatic process of the temporal bone.

At its posterior termination a tubercle is occasionally present, named the anterior supramastoid tubercle. At the same level but posteriorly adjacent to the parietomastoid suture the posterior supra-mastoid tubercle is sometimes found. All of these structures, if present, can be palpated in the living above the earhole.

Blaschy (1896) described a causal relationship between muscular pull of the temporalis and the squamous air cells on one hand, and the existence of the supramastoid crest on the other. Observing temporal bones of different age groups, he noted the development of the crest between 8-11 years of age, and hence, in the period of permanent dentition.

In the male the crest was more pronounced than in the female, and Blaschy recognized two male types:

[1] This is an amplified and modified version of a paper presented at the 29th annual meeting of the American Association of Physical Anthropologists, Washington, D.C., 1960.

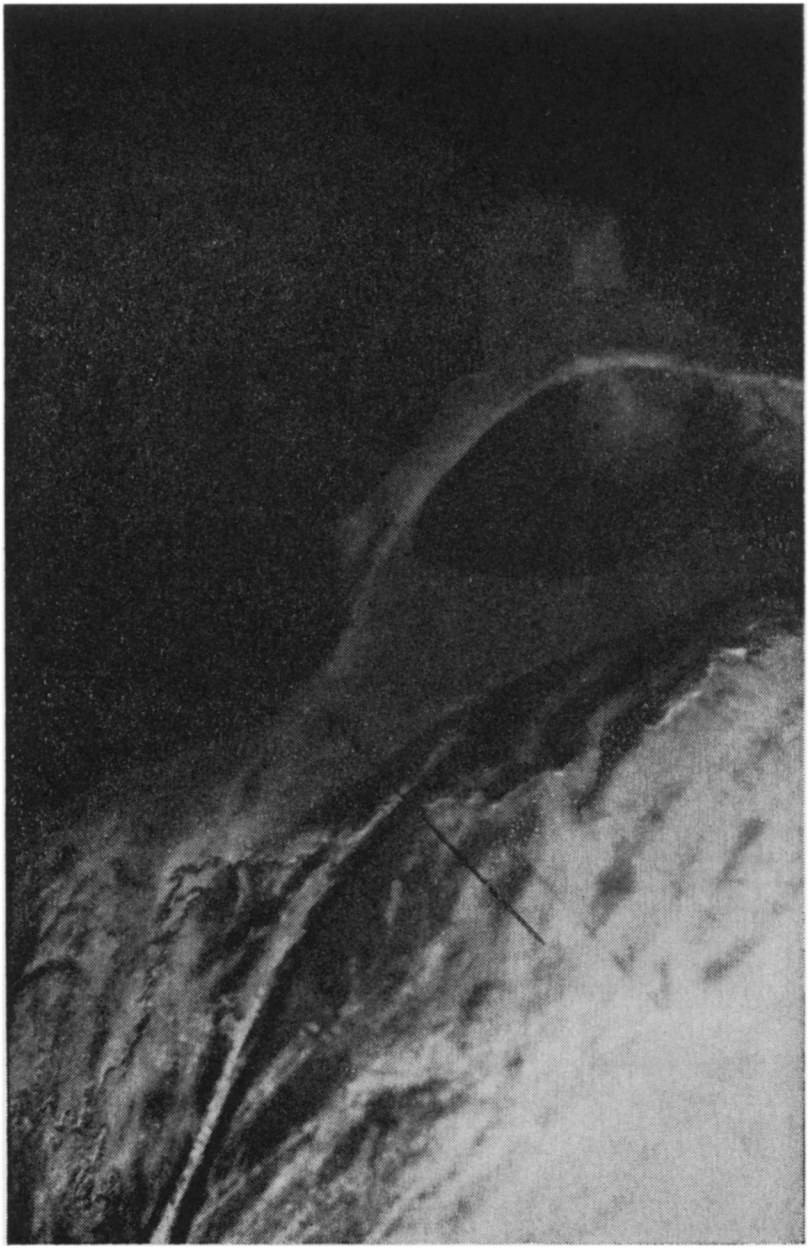

Plate I : Supramastoid crest, grade 2 (skull GM #29).

1. a ridge-like bulge consisting of two slopes forming an angle, found in 50% of the cases;

2. a diffusely elevated and projecting bulge which met the temporal line at its maximum height.

There were also female types in the males, which he portrayed as a flattened bulge, the condition encountered in children at the time of puberty. Thus, until that period the structure was similar in both sexes. Henceforth, in the male it became more prominent, while in the female it retained its pedomorphic character. Blaschy concluded that until puberty its existence was due to the formation of the squamous air cells, and from then on its stronger development was attributable to the influence of the temporalis and its fascia.

Racially, it was reported that the supramastoid crest was most frequent in the Australians (72.5%) and Oceanians (40.8%), less in the American Indians (30.0%) and Asians (24.5%), and least in the Europeans (10.0%) (Martin 1928:887). Kanasugi observed its presence in 1602 of 4000 skulls (Passow 1924).

The shape of the anterior supramastoid tubercle (also called the supramastoid torus) is, according to Waldeyer (1910), either round or oblong. Passow (1924) regarded the asteriac process (named angular torus by Weidenreich, 1951) as a part of the posterior supramastoid tubercle extending into the parietal bone across the parietomastoid suture. Broek, Boeke and Barge (1942:102) reported that the posterior supramastoid tubercle was more frequent in the lower races than in the Europeans. It is likely that by lower races he meant the peripherally distributed subspecies as described by Saller (1930). Several other textbooks of anatomy do represent the supramastoid crest, but mention of both the supramastoid tubercles is rarely included.

PURPOSE, MATERIAL AND METHOD

The present paper has as its aim to find out and describe the rate of occurrence and the morphologic variations of the supramastoid crest and tubercles on both sides, in both sexes, and in different age and racial groups.

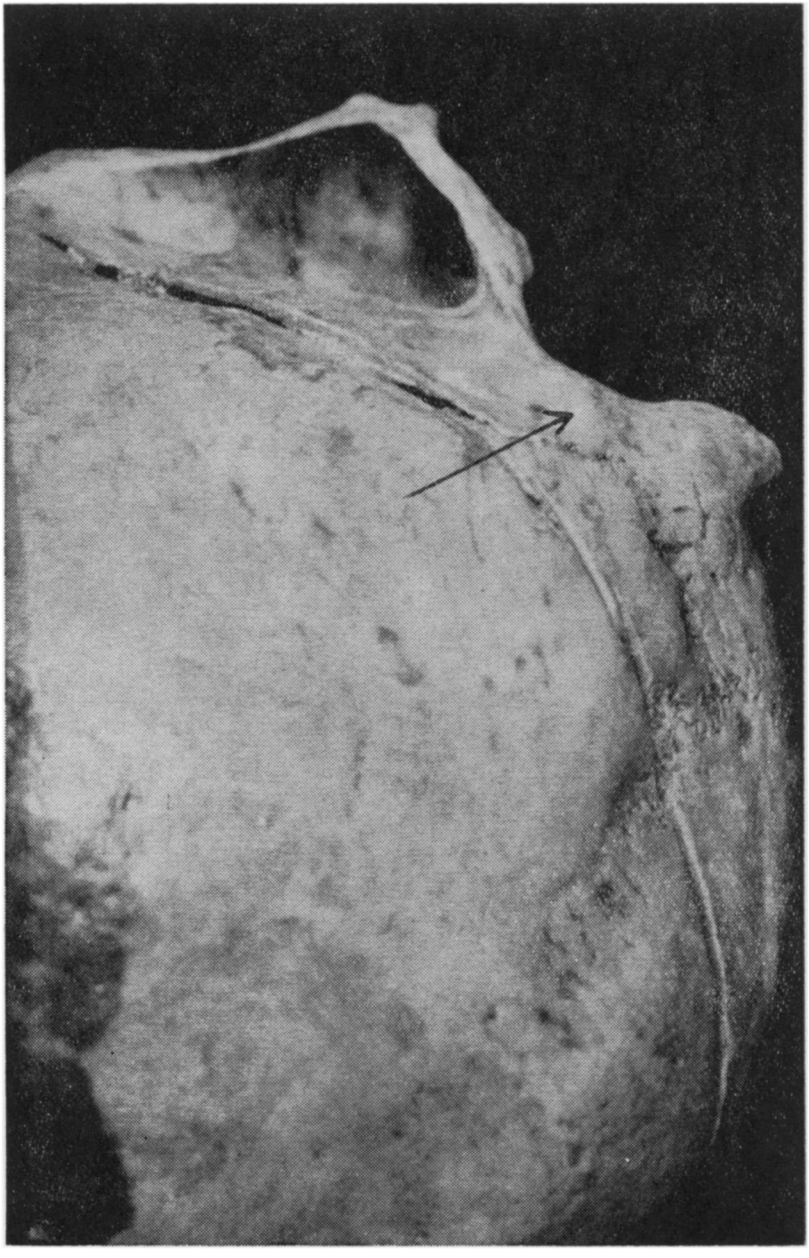

Plate II : Anterior supramastoid tubercle, grade 2 (skull GM #179).

As material, 316 skulls are used consisting of:

a) 85 American Negro skulls from the collection of the Department of Anatomy, Howard University College of Medicine, Washington, D.C.;

b) 96 Alaskan Eskimo skulls;

c) 35 Central European skulls, both groups from the Department of Physical Anthropology, U.S. National Museum, Washington, D.C.;

d) 100 Indonesian (Central Javanese) skulls from the collection of the Department of Anatomy, Gadjah Mada University College of Medicine, Jogjakarta.

Only those skulls which had been sexed and aged in groups *b* and *c* are used for study of respectively sex and age differences. The recording of age in group *d* has been reported in our earlier paper (Jacob 1965).

In observing the structures we employ the following classification (see Plates):

grade 0. The structure is absent as determined by inspection and palpation.

grade 1. It is slightly distinct, and a line is palpable.

grade 2. It is distinct: a slight, gradual elevation is present.

grade 3. It is very distinct, and a projecting crest or tubercle is observable.

The percentage of occurrence of each grade is calculated, and also of the total of the positive grades. The weighted index of expression of the trait is determined by multiplying the percentages of occurrence of grades 0, 1, 2 and 3 respectively by 0, 1, 2 and 3, and dividing the result by 3, a method utilized by Oschinsky and East (1964). Statistical significance is confirmed by X^2 determinations.

Bilateral symmetry is investigated only in Indonesian skulls. For the study of age difference the skulls of the four racial groups are pooled together, and divided into those under and over 40 years of age.

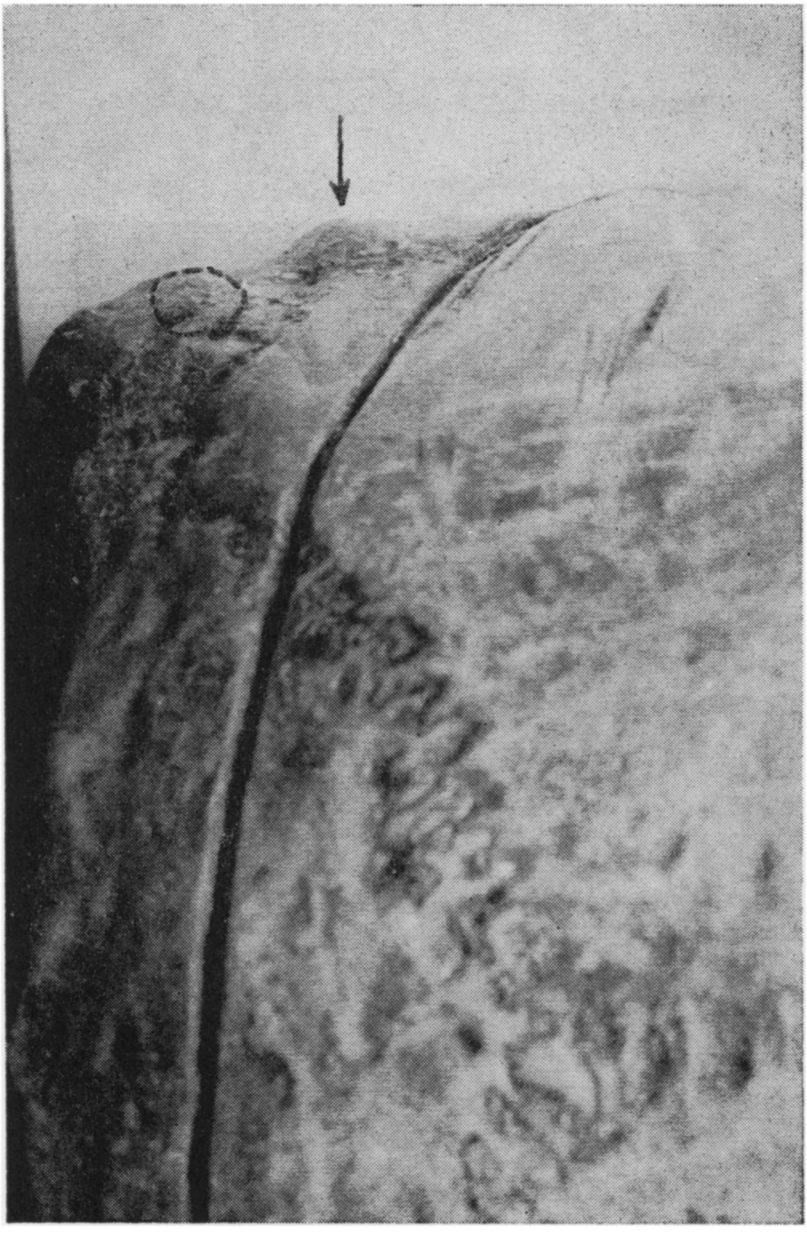

Plate III : Anterior supramastoid tubercle (arrow), grade 3, and posterior supramastoid tubercle (encircled), grade 1 (skull GM #312).

RESULTS AND DISCUSSION

As is the case with most bony structures, there is no significant bilateral asymmetry as proved by the study in Indonesian crania (Table 1). The rate of occurrence is the highest for the anterior supramastoid tubercle, and the lowest for the posterior supramastoid tubercle. It is significant that most anatomy textbooks do not describe the anterior tubercle, which is certainly not a rare variation.

TABLE 1

Old age does not change the weighted index of expression significantly, except for the posterior supramastoid tubercle (Table 2). It seems that irregular bony outgrowth affecting the aged does influence this part of the temporal bone.

TABLE 2

Blaschy observed sex difference in the prominence of the supramastoid crest. In this study, however, sex difference is expressed only in the Eskimo posterior supramastoid tubercle to a very significant degree. Although Eskimo females are known to utilize their chewing apparatus intensively, the males in our sample still show a higher index of the tubercle. Sex difference in the supramastoid crest in the Eskimo is probably significant, while in the Negro the discrepancy in both sexes is moderately significant both for the supramastoid crest and the posterior supramastoid tubercle (Table 3).

TABLE 3

The prominence of the three structures differs in different races. The supramastoid crest is expressed to the highest degree in the Europeans, Eskimos and Negroes, while in the Indonesians it is present in approximately half of the cases and as less distinct types.

On the other hand, the anterior supramastoid tubercle is least likely to occur in the Negroes, whereas in the three other groups its incidence is about equally high. The posterior tubercle is very rare in the Indonesians; in the Eskimos, however, the structure exhibits the highest index and percentage.

In other words, in the Europeans, Eskimos and Negroes the crest is the most often occurring supramastoid structure; in the

TABLE 1. — VARIATION OF THE SUPRAMASTOID CREST AND TUBERCLES ON BOTH SIDES IN INDONESIAN SKULLS

Side	N	n / %					Index	P
		3	2	1	T	0		
				Supramastoid Crest				
L	100	2	19	30	51	49	24.7	<0.8
R	100	2	18	20	44	56	22	>0.75
				Anterior Supramastoid Tubercle				
L	100	17	43	19	79	21	52	<0.7
R	100	22	43	19	71	29	46	>0.5
				Posterior Supramastoid Tubercle				
L	100	0	0	3	3	97	1	No difference
R	100	0	1	2	3	97	1.3	

TABLE 2. VARIATION OF THE SUPRAMASTOID CREST AND TUBERCLES IN DIFFERENT AGE GROUPS

Age	N	n					%					Index	P
		3	2	1	T	0	3	2	1	T	0		
						Supramastoid Crest							
<40	196	9	76	52	140	56	4.6	38.8	26.5	71.4	28.6	39.3	<0.1
>40	246	18	129	46	193	53	7.3	52.4	18.7	78.5	21.5	48.5	>0.05
						Anterior Supramastoid Tubercle							
<40	196	17	24	30	121	75	8.7	37.8	15.3	61.7	38.3	39.0	<0.02
>40	246	26	83	14	123	123	10.6	33.7	5.7	50	50	35.0	>0.01
						Posterior Supramastoid Tubercle							
<40	196	0	26	12	38	158	0.	13.3	6.1	19.4	80.6	10.9	<0.001
>40	246	3	64	20	87	159	1.2	26.0	10.2	35.4	64.6	21.9	

TABLE 3. — VARIATION OF THE SUPRAMASTOID CREST AND TUBERCLES IN DIFFERENT RACES AND BOTH SEXES

Race	Sex	N	n					%					Index	P
			3	2	1	T	0	3	2	1	T	0		
Supramastoid Crest														
Ne	F	50	0	23	17	40	10	0	46	34	80	20	42	<0.005
	M	120	5	88	20	113	7	4.2	73.3	16.7	94.2	5.8	58.6	>0.001
Es	F	106	2	60	28	90	16	1.9	56.6	26.4	84.9	15.1	48.4	<0.01
	M	86	18	57	8	83	3	20.9	66.3	9.3	96.5	3.5	68.2	>0.005
Eu	F	24	0	15	6	21	3	0	62.5	25	87.5	12.5	50.0	<0.2
	M	46	0	40	6	46	0	0	87.0	13.0	100	0	62.3	>0.1
In	F	68	0	12	19	31	37	0	17.6	27.9	45.6	54.4	21.0	<0.7
	M	132	4	25	35	64	68	3.0	18.9	26.5	48.5	51.5	24.4	>0.5
Anterior Supramastoid Tubercle														
Ne	F	50	0	4	1	5	45	0	8	2	10	90	6	<0.8
	M	120	0	14	0	14	106	0	11.6	0	11.6	88.4	7.7	>0.75
Es	F	106	8	41	15	64	42	7.6	38.7	14.2	60.4	39.6	38.1	<0.8
	M	86	11	30	6	47	39	12.8	35.0	7	54.7	45.3	38.5	>0.75
Eu	F	24	0	15	2	17	7	0	62.5	8.3	70.8	29.2	44.4	<0.7
	M	46	6	26	3	35	11	13	56.5	6.5	76.1	23.9	52.8	>0.5
In	F	68	5	24	16	45	23	7.4	35.2	23.5	66.2	33.8	38.7	<0.05
	M	132	24	62	19	105	27	18	47.0	14.4	79.5	20.5	54.1	>0.025
Posterior Supramastoid Tubercle														
Ne	F	50	0	5	3	8	42	0	10	6	16	84	8.7	<0.005
	M	120	0	40	8	48	72	0	33.3	6.7	40	60	24.4	>0.001
Es	F	106	0	18	9	27	79	0	17.0	8.5	25.5	74.5	14.2	<0.001
	M	86	3	46	11	60	26	3.5	53.5	12.8	69.8	30.2	43.4	
Eu	F	24	0	0	1	1	23	0	0	4.2	4.2	95.8	1.4	<0.05
	M	46	2	6	4	12	34	4.3	13	8.6	26.1	73.9	15.8	>0.025
In	F	68	0	0	0	0	68	0	0	0	0	100	0	<0.1
	M	132	0	1	5	6	126	0	0.8	3.8	4.5	95.5	1.8	>0.05

ABBREVIATIONS

L = left
N = number of temporal bones observed
n = frequency of grade, 3, 2, 1, 0 respectively
% = percentage of grade, 3, 2, 1, 0 respectively
Index = weighted index of expression
Ne = Negro
Eu = European
F = female
R = right
n/T = frequency of occurrence (3 + 2 + 1)
%/T = total percentage of occurrence
P = probability
Es = Eskimo
In = Indonesian
M = Male

Indonesians this position is occupied by the anterior tubercle. This elevation is the least frequent in the Negroes, while in the other racial groups the posterior tubercle has the lowest incidence.

The highest rate of occurrence of the posterior supramastoid tubercle is in the Eskimo males (69.8%); in other groups it is less than 50%.

Compared with the data presented by Martin (1928), the rate of occurrence of the supramastoid crest in our series, except the Indonesians, is higher than the highest rate in his series. The discrepancy is probably due to the difference in the technique of observation, for example concerning the slightly distinct types. His data on the other Mongoloids are more comparable to the Indonesians.

If the supramastoid tubercles are caused by pneumatization, then the races having extensive air cells in the mastoid region would certainly show a higher index of expression of the traits. It has been reported by Mudd (1907-08), Callfas (1912) and Law (1929:6) that mastoid air cells might invade adjacent structures and bones. According to Turner and Porter (1922) cellular mastoids are more frequent in non-Europeans, especially Indians, Eskimos, Papuans, Melanesians and Polynesians. It is true that in this study the posterior supramastoid tubercle is more often found in the Eskimos than the Europeans, but the Negroes have a lower index of anterior tubercle, and the Indonesians have a lower index of posterior tubercle than the Europeans.

It appears to us that, as maintained by Blaschy, the presence of the supramastoid crest is accounted by both muscular traction and pneumatization. Well-developed temporal muscles and air cells would result in the presence of the supramastoid crest and the anterior tubercle. In case of less developed muscles and cellular mastoid regions, only the anterior supramastoid tubercle would be found as in the Indonesians. Insofar as the posterior tubercle is concerned, it seems that muscular pull plays a more important part. Its sex difference is more markedly expressed than in the other two structures, and its age difference is likewise of high statistical significance.

Phylogenetically, the supramastoid crest is a part of a cranial superstructure which is continuous with the nuchal crest in the lower primates (Robinson 1958). Disintegration of the crest occurs with the decrease in masticatory and nuchal musculatures. The supramastoid crest is well developed in Zinjanthropus and other Australopithecines. An anterior tubercle is also apparent in photographs of Zinjanthropus (Coon 1962). In *Pithecanthropus erectus* the crest is pronounced as reflected by skull II and V (Jacob, in preparation). *P. pekinensis* also possesses massive supramastoid crests. In all the afore-mentioned hominids the direction of the crest is more obliquely upward and backward, and consequently it forms a more acute angle with the zygomatic arch. In *Homo soloensis* the crest is likewise strongly developed and meets the squamous suture at an angle of 60° (Weidenreich 1951). Furthermore, the structure is also present in *H. rhodesiensis*, whereas in the Neanderthals, Krapina and Combe-Capelle it is steeper than in modern man, too (Martin 1928:887; Groth 1937).

SUMMARY AND CONCLUSIONS

1. 632 temporal bones are studied in 85 American Negro, 96 Alaskan Eskimo, 35 Central European and 100 Indonesian skulls to find out the incidence and degrees of prominence of the supramastoid crest and tubercles.

2. No significant difference is observed in the rate of occurrence and index of expression of the structures on both sides in Indonesian skulls.

3. Old age affects only the posterior supramastoid tubercle to a significant degree, probably attributable to irregular bony outgrowth.

4. Sex difference is highly significant for the posterior supramastoid tubercle in Eskimos. It seems that this structure owes its presence more to muscular traction rather than to pneumatization. Moderate sex difference is reflected in the supramastoid crest in the Negroes.

5. The most frequent supramastoid structure is the supramastoid crest, and the least the posterior tubercle. The anterior tubercle ranges from 10% to 77.5%, an incidence high enough to claim for description in anatomy textbooks. The absence of sex difference in this tubercle suggests that it is accountable to pneumatization.

6. The supramastoid crest has a low index of expression in Indonesian skulls, which is only 21-24.4. The rate of occurrence is as low as 45.6%, while the corresponding figure for European males is 100%. It is our opinion that the presence of the crest is due both to air cells and muscular pull.

7. The Negroes have the least frequent anterior supramastoid tubercle (10%), whereas the Indonesians have the least frequent posterior tubercle. This latter structure is generally rare except in the Eskimos.

8. Finally, the course of the supramastoid crest is less oblique in modern man than in prehistoric hominids. Extensive development of the crest in early man might obscure the presence of the supramastoid tubercles.

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