

# THE OCCURRENCE OF METOPISM IN OUR PRESENT POPULATION AND ITS RELATIONSHIP TO SINUS FRONTALIS

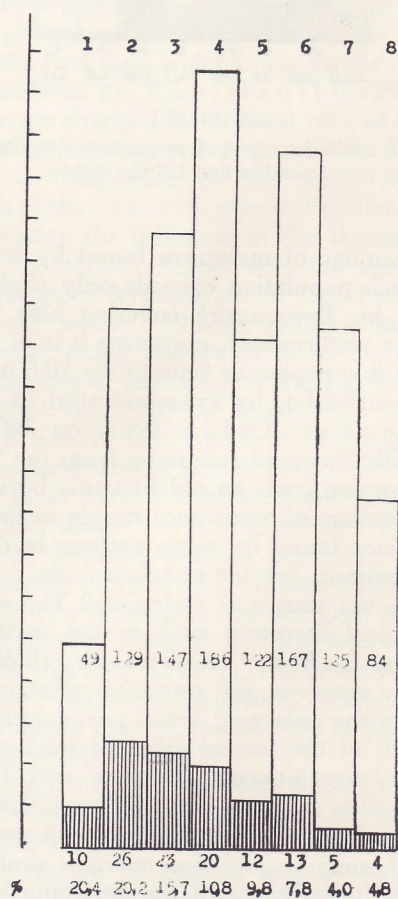
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The frontal suture obliterates in man normally by the end of the second year of life. If obliteration does not take place at this time, one speaks of metopism, sutura metopica, or also of sutura frontalis persistens. Regarding metopism, its causes, as well as the relationship of metopism to the development of sinus frontalis, the relevant literature gives us various, disputable, and often even contradictory data.

In order to observe a wider framework of examining the morphogenetic effect of intensive physical stress upon the human organism, we have also paid attention to skull roentgenograms of boxers who astounded us with a considerable occurrence of metopism, viz. in 21 per cent of cases. This finding of ours was already published some time ago (Linc, Fleischmann, 1966). We have tried to compare the high percentage of the occurrence of metopism in boxers with the means value of its occurrence in our present population. We have found, however, that the data in the relevant literature differ considerably. There are the data of B o r o v a n s k ý (1932) on the one hand, who, on the basis of a study of one thousand skulls coming from three localities in southern Bohemia, found the occurrence of metopism to make 8.2 per cent, and the report of M a t e r n a (1936) on the other hand, proceeding from an analysis of sections of 3,000 persons from northern Moravia and Silesia, according to which the occurrence of metopism makes only 2 per cent. That is why we decided to investigate the occurrence of metopism in the present Czech population ourselves, and that on the basis of interpreting the roentgenograms of skulls of persons with known personal data, so that we were able to follow exactly the occurrence of metopism not merely by sex, but also its distribution in the individual age categories from childhood till high age. For the relevant studies we availed ourselves of the roentgenograms of persons examined runningly at the Prague Clinic of Prof. Š v á b in the years 1960 and 1961 (We express our thanks to Prof. Š v á b and Ass. Prof. K o l á ř for kindly making available the necessary roentgenograms for our studies).

Figs 1, 2, 3 illustrate the frequencies of occurrence of metopism in the individual decennaries of life,

both totally (Fig. 1) and separately according to sex (Figs 2 and 3). Out of a total of 1,009 examined photographs of skulls we have found metopism in 113 cases, i.e., in 11 per cent, this proportion holding both for the male and female parts of the population. Out of 599 males, 68 cases were metopic, while 45 females out of the number of 400. The largest

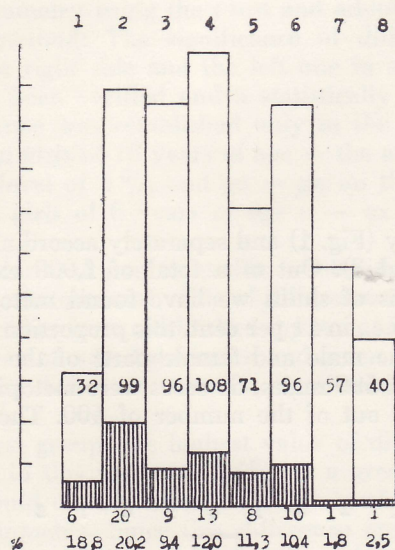


GRAPH 1

Occurrence of metopism in the respective life decennaries from the first till the eighth. The columns give the total number of examined persons pertaining to the respective decennary, the stripy columns contain the number of metopic skulls. The figures below the columns denote the percentage of occurrence in the respective decennaries.



occurrence is in the first two decennaries, whereupon it diminishes gradually, but metopism can still be encountered in a high number in advanced age: there is a 10 per cent occurrence in the fifth, and a 7.7 per cent occurrence in the sixth decennary. Metopism has also been found in some 80-year-old persons. Thus we can see that, in metopic skulls, suture frontalis may persist even till an age at which the other sutures have long become obliterated.



GRAPH 2

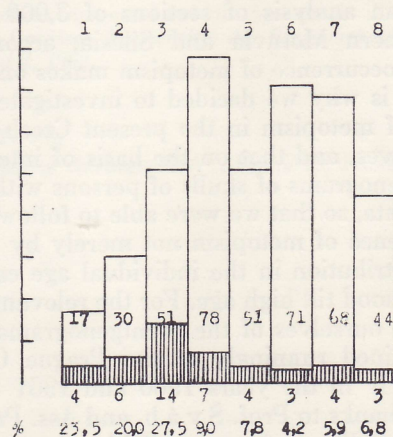
Occurrence of metopism in the respective life decennaries in men from the first till the eighth.

The percentage of metopism found by us in the present Czech population exceeds only slightly the data given by Borovanský covering also persons living in the past century, moreover it is of interest to note that it corresponds even to the 10.5 per cent-occurrence established by Vyhnánek et al. (Vyhnánek, Stloukal, Kolář, 1967) on 306 skulls found at Mikulčice and stemming from the 9<sup>th</sup> century, i.e., coming from an old Slavonic burialplace.

Our percentage of occurrence ranges in the upper limit of values found by more authors in different European nations. See the attached table.

What are the causes of metopism? The standard anthropological literature such as the textbook of anthropology by Martin-Saller (1959) gives, without any reserves, the causative relationship of metopism to the enlarging brain, particularly to the development of the frontal lobes of telencephalon. However, a longer time ago Bryce and Young (1916) as well as Essen-Moeller (1928) showed that there is no significant difference between the capacity of metopic and non-metopic skulls. This view about the influence of the enlarging brain on metopism was also rejected by Bolk (1911, 1917, 1920), who pointed to the fact that, according to what has been said, metopism would have to be constant in every hydrocephalic skull, which is far from the truth. Searching for the causes of metopism Bolk started from an attempt to analyse the

mechanical forces affecting the skull. Having performed an analysis of the arrangement of the masticatory musculature and one of the shape of the frontal bone in semi-apes, apes, and in man parallel to the occurrence of metopism in them, he found that, while in semi-apes (where the frontal suture persists in the adult age) the muscle temporalis does not originate from the frontal bone, in apes (where the frontal suture obliterates usually in the adult age) the proportion of insertion into the frontal bone is markedly represented and, contrary to this, a gradual regression of this onset is observable in man (where metopism is relatively rare). By an analysis of the arrangement of the orbits, especially of the configuration of their lateral walls, and by comparing the extent and the shape of the insertion surface of the temporal muscle, Bolk points to the possibility of changes in the pressure effect of this muscle upon the frontal bone and also to the possibility of rebuilding trajectories inside the frontal bone. This change decides whether the frontal suture occludes or whether it persists. Since in man the frontal bone is much broader than in apes, and contrary to this, the insertion surface of the temporal muscle thereupon is much smaller, a considerable pressure cannot be extended on the bone by the muscle. Thus Bolk closes his conclusions in saying that the occurrence of metopism depends upon a reduction of the pressure caused by the tension of the temporal muscles on the frontal bone. Bolk also denies the causal relationship between metopism and brachy-crania. A u g i e r (1931) argues with Bolk regarding the reduced pressure of the temporal muscles and its influence on the genesis of metopism, or still whether such a reduced pressure really occurs; he suggested, as a test for either confirming or refuting Bolk's view, a comparison of sizes of the insertion surface of the temporal muscle on the frontal bone in metopic and non-metopic skulls. This test was carried out by Borovanský who recorded the insertion surfaces with the aid of a dioptograph and found the total insertion surfaces of the temporal muscles to be the same in both kinds of skulls, but when comparing the ratio of insertion in the frontal and



GRAPH 3

Occurrence of metopism in the respective life decennaries in women from the first till the eighth



occipital bones, he found an increased ratio of insertion in the frontal bones of metopic skulls. Thus his discovery stands in rigid contrast to what was to issue from Bolk's hypothesis. While Bolk had also proceeded from the assumption that the temporal muscles compressed the skull during their contraction, Borovanský noted that, as a result of the spatial distribution of the temporalis muscle in regard to the skull, and particularly to the frontal bone, it was rather necessary to take into consideration the tendency to lateral traction of the muscle towards squama frontalis. Though the influence of the masticatory muscles upon the shape of the skull is obvious — recent research has yielded evidence for this in an extensive study by Dokládal (1964) done on rats — all considerations led in this direction have not resulted in a solution of the causes of metopism. By the way, Nikitjuk (1959) found that removal of the temporal muscles in a dog prevents obliteration of the sagittal and lambdoid sutures, but does not affect the occlusion of the frontal suture in any way.

Followers of the opinion of progressivity of metopism give as evidence its marked occurrence in European nations: out of 33,442 European skulls 8.3 per cent were metopic, out of 2,721 Mongolian skulls only 6.5 per cent, and of 1,630 Melanesian skulls only two per cent were found to be metopic (Ashley-Montagu, 1937). If we leave aside the basic objection, i.e. whether it is possible at all to speak of a progressivity in the somatic and psychological development of European nations as compared with the Mongolian ones, it is found that in many primitively living tribes, e.g. some Red Indians in Bolivia, the occurrence of metopism is much higher than anywhere else in Europe.

There are authors who contrary to the preceding view consider metopism to be a characteristic of atavism (Canestrini, 1867). Schwalbe (1904) formulated this view when saying "... Als primitiver Zustand hat man anzunehmen, dass die beiden Frontalia auch beim Ausgewachsenen getrennt bleiben." Due to this view, metopism would have to increase in the phylogenetically younger representatives of man, or in his predecessors. Metopism occurs also in Neanderthal skulls. Vlček (1967) found it in 3 cases out of 8 examined skulls of infants between the age of 2.5 and 5 years. The number of examined Neanderthal skulls as well as the age of infants is too low to allow some deduction of conclusions on a primitive characteristic. When reference is made to the high occurrence of metopism in certain ancient cultures, for example, in Etruscans where it makes as much as 37.5 per cent (Cipriani, 1926), then his findings in representatives of other ancient cultures, such as in the Greeks (10.4 per cent; Koumaris, 1918) or the Romans (10.7 per cent; Schmidt), or the Egyptians (3.2 per cent; Schwalbe, 1904) do not correspond to the former. Metopism is exceptional in anthropoid apes, and world literature gives only one description of it in gorillas (Schultz, 1956).

The view according to which metopism represents criminal stigmatization (Benedikt, 1888) has

been completely abandoned today and in its time it can be considered a tribute to Lombroso. The percentage of metopism in criminals (10.1 per cent) given by Le Double (1903) exceeds only slightly the means number of the remaining Italian population.

Literature has repeatedly reported the dependence of metopism on the occurrence of mental defects. Topinard (1885) found metopism in asylum inmates, Mingazzini (1893) in 12 per cent, and in epileptics even in 18 per cent. Of course, this is difficult to bring into harmony with the finding made by Materna, who in lunatic asylum inmates found metopism only in 2.37 per cent — an occurrence which does not differ essentially from that in a check series of persons with sound minds.

Metopism as a characteristic of total somatic stigmatization is studied by Hess (1945), who even suggests to speak about a so-called metopic syndrome characterized by syndactylia, cleft palate, and other malformations.

A compensatory development of the frontal bone due to pathologically premature concretion of bones pertaining to the cranial base as the cause of metopism was considered by Virchow (1875) — this presumption represents, however, merely a variation of the hypothesis about the significance of intracranial hypertension.

For the first time endocrinous causes of metopism are considered by Papillault (1928), who after many years changed his original view of the progressivity of metopism, and emphasizes a defect of the process of ossification on account of the impaired function of the endocrine glands. Papillault takes into consideration the influence of the thymus upon the origin of metopism. Augier does the same rather for the influence of hypophysis. As far as the thymus is concerned, to-day's studies indicate its altogether different meaning and point to its central position in the genesis of immunobiological processes (Miller, 1966). As far as the hypophysis is concerned, Augier is right in that, e.g., there is a frequent sutura frontalis persistens in acromegalic skulls. Naturally, for the most part, a retarded concretion of sutures and so also that of the frontal suture occur in severe congenital hypothyrosis, in cretenism. It appears that virtually certain endocrinous diseases are accompanied by metopism, and one may even suppose such diseases to promote the development of metopism. By this fact, however, the prevailing majority of metopic skulls is inexplicable, while it is known that metopism may be found even in persons otherwise completely sound.

Nižankowski considers the possibility of an early traumatization of the skull in the origin of metopism. He proceeds from a high occurrence of metopic skulls in boxers, and of their repeated knockouts. We have searched for this event in boxers' history cases, and even though many of them do admit knockout, we still suppose that it is impossible to speak of a causal connection, for such skulls are held to be metopic, where sutura frontalis has not become obliterated in a child as early as between the second and the third year of life, that



is, in a time when no sporting activity or skull traumatization can be taken into account at all. Sooner there is the explanation, whether a definite mental specification, a certain set of psychic qualities is not required for boxing, and it cannot be excluded that such factors, when influenced by endocrinous regulation, may come into play in the selection of persons for this sport.

In view of the fact that none of the causes given could provide us with a satisfactory explanation of how metopism originates, we have again turned our attention not only to man, but to the other primates and mammals in general. We have studied skulls from the collections of the Natural Science Faculty, Charles University, and from the collections of the National Museum, and have ascertained that the frontal suture persists until mature age in skulls of various mammals, no matter of what configuration they may be, further that the suture is particularly preserved even in all of the prosimians examined pertaining to lemur and lorid families. Contrary to that, the suture was obliterated in skulls of adult representatives of pongine primates. Special attention in this respect deserves metopism in monkeys of *Colobus* genus (Gueréza), of the Cercopithecidae family. The genera *Colobus abyssinicus*, *C. ellioti*, *C. ruwenzori*, *C. palliatus* exhibit no metopism, but contrary to this it occurs from 62 to 77 per cent in the species *Colobus kirki*. This species is known to live in complete isolation on the island of Zanzibar without any possibility of interbreeding with the other related population. We have found a similar conspicuous difference as to occurrence of metopism even in Sullivan's reports (Sullivan, 1922) coming from craniological studies made in tribes of Bolivian Red Indians, where one locality may reach even a 26 percent occurrence, while another one displays no occurrence at all. Even here holds good that tribes of these Red Indians live in strict isolation and that no tribal interbreeding occurs there. By the way, the case is similar in tribes living on the islands of New Caledonia where for one island metopism in 12.5 per cent was found, but for the other none at all (Ashley-Montagu, 1937).

On the base of these finds, literature analysis, and analysis of our material, we have arrived at the conclusion that metopism is primarily a matter of genetics. Our assumption was confirmed when we got acquainted in greater detail with the relevant literature not only of an anatomical and anthropological but also of a roentgenologically-clinical character where we discovered several data about the familiar occurrence of metopism; and when we re-collect the old reports of Welcker (1862) or Lesgaff (1927), who described metopism in brothers and sisters of one family, or also in mother and son, we may place them together with Torgersen's report (Torgersen, 1951), who had found metopism twice in father and sons, or also in both parents and two sons and one daughter.

That is why we suggest that the explanation concerning the dependence of metopism on the development of the frontal lobes of the encephalon, which has been adhered so stubbornly should be replaced

by the view of primary and secondary metopism. Secondary metopism is of an endocrinous character, in the first place due to dysfunction of the thyroidea, primary metopism occurring in sound persons is conditioned by genetic factors, whereby the metopic geneas is also evident from our material — is not bound upon sex, and therefore its occurrence is the same in men as in women.

In the other part of our report we want to deal with the relation of metopism to frequency and development of sinus frontalis. Sinus frontalis belongs to paranasal cavities where we find a considerable variability, both generic and individual. In the genesis of paranasal cavities we can follow a phylogenetic and, parallelly with this, also an ontogenetic sequence. The oldest from the viewpoint of revo-

Metopism Occurrence in Some Populations

Nationality	Number of skulls examined	Number of metopic skulls found	Percent of occurrence	Author
Australians	226	0	0	Ashley-Montagu
Aines	60	0	0	Tarenetzky
Eskimos	102	0	0	Sullivan
Peruvians	458	5	1.1	Russell
Negroes (Congo)	93	1	1.1	Bartels
Negroes	959	12	1.2	Anučin
Malayans	422	12	1.2	Anučin
Silesians (Opava region)	3.000	61	2.0	Materna
Egyptians (ancient times)	154	5	3.2	Schwalbe
Melanesians	698	24	3.4	Anučin
Peruvians	565	20	3.4	Anučin
Papuans	209	9	4.3	Regalia
Mongols	621	32	5.1	Anučin
Japanese	585	35	6.0	Suzuki
Germans (Bavaria)	144	9	6.3	Ried
Russians	1.093	70	6.4	Welcker
Egyptians (ancient times)	250	18	7.2	Berry-Berry
Germans (Bavaria)	2.535	191	7.5	Ranke
Czechs (southern Bohemia)	1.000	82	8.2	Borovanský
Chinese	400	26	8.7	Anučin
Tyrolese	827	73	8.8	Frizzi
Englishmen	497	45	9.0	Anučin
Italians	1.777	161	9.1	Anučin
Swedes	1.150	111	9.6	Essen-Moeller
Scots	570	55	9.6	Bryce-Young
Frenchmen (catacombs)	10.000	990	9.9	Topinard
Italians (criminals)	1.519	154	10.1	Le Double
Frenchmen	1.336	140	10.4	Papillault
Greeks (ancient times)	581	61	10.4	Loumaris
Slavs (Mikulčice) 9th century)	306	32	10.5	Vyhnálek
Pompeians	93	10	10.7	Schmidt
Czechs	1.009	113	11.0	Linc
Germans (Saxony)e	567	70	12.3	Welcker
Italians (14th century)	41	6	14.6	Ashley-Montagu
Carinthians	421	63	15.0	Shapiro
Red Indians (Bolivia)	876	155	20.2	Sullivan



lution is the sinus sphenoidalis demonstrable as early as in a 20-mm-long embryo. Almost simultaneously with the latter appears also the base of sinus maxillaris (i.e. until the end of the second month of intrauterine life), later small cavities in the ethmoid bone are apparent, sinus ethmoidales. Opposed to these paracavities, which originate as early as in the course of intrauterine life, stands sinus frontalis which forms as late as the end of the first year of life as a derivative of the most rostral part of the ethmoid cavities. Until the 7<sup>th</sup> year of life sinus frontalis enlarges only very slowly, and only after the 12<sup>th</sup> year there is a more marked acceleration of growth. It is, however, not before about the 20<sup>th</sup> year of life that it attains its definitive shape and size.

There is a discussion going on in professional roentgenological literature about coincidence, or about a causal relationship of metopism and the development of sinus frontalis. On the one hand, there are authors who, from their assumption about metopism being characterized by infantile characters ("foetalization" of a metopic skull), infer that metopic skulls are characterized by a low degree of pneumatization of the cranial bones, and, first of all, by a low degree of development of sinus frontalis. Rochlin and Rubashev (1934), Murczynski (1957), Welin (1952), and Hodgson (1957) are the principal advocates of this idea.

There are authors, on the other hand, who, on the basis of an analysis of the studied skulls, contest such a causal relationship between metopism and hypoplasia of sinus frontalis. To these authors belong in the first place Marciniak and Niżankowski (1959), who found a fully developed sinus frontalis in 92 per cent cases, the total of skulls being 252. Besides, even Rochlin found developed sinus frontalis only in 31 cases of the total number of 110 metopic skulls, so that his find was positive in 72 per cent. In our material we have found that in 113 metopic skulls sinus frontalis was hypoplastic only in 13 cases, i.e. that there was coincidence between metopism and sinus frontalis in 88.5 per cent. Thus it does not correspond to reality that hypoplasia of sinus frontalis should be characteristic of metopic skulls. From our analysis it also follows that it is not only impossible to speak about infantilism in metopic skulls, but, on the contrary, that many male metopic skulls exhibit marked signs of robusticity and are also characterized by hyperostosis of the cranial vault.

#### SUMMARY

In 1,009 examined skull roentgenograms of persons of known age and sex the occurrence of metopism was studied, which was demonstrated in 11 per cent of cases, both in males and in females. The graphs illustrate the distribution according to the individual decennaries of life — metopism was found even in persons of the advanced age of 80 years.

According to the causes, primary metopism conditioned by genetic factors, and secondary metopism due to hormonal defects, were distinguished.

As far as the relationship of metopism to sinus frontalis is concerned, it was found that in 88.5 per cent of cases sinus frontalis is fully developed in metopic skulls. Thus the argument does not hold that sinus frontalis hypoplasia is characteristic of metopism.

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