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GEOGRAPHICAL DISTRIBUTION OF FRONTO-ETHMOIDAL ENCEPHALOMENINGOCELE

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Congenital malformations are among the most distressing diseases that affect mankind. Attempts to reconstruct the major anomalies have only limited success. Malformations affecting the brain are usually associated with some degree of mental deficiency. The recognition of causative agents such as infection, drugs, and genetic abnormalities offers some hope toward their prevention. Unfortunately the causative mechanism has been established in only a small proportion of human congenital malformations.

Many investigations of the geographical distribution of anencephalus and defects of closure of the neural tube have been reported. Many of these reports, however, group all meningoceles of the spine and head together. The incidence of spina bifida shows a peculiar geographical pattern. The highest rates were found in Belfast (Stevenson, Johnston, Stewart, and Golding, 1966a) and Dublin (Coffey and Jessop, 1955), being 4·69 and 4·2 per 1,000 births respectively. Rates in western Europe (Böök, 1951; Hohlbein, 1959), England and Wales (Malpas, 1937; Penrose, 1957; Carter, Lawrence, and David, 1967), and the United States (Schwidde, 1952; MacMahon, Pugh, and Ingalls, 1953; Harris and Steinberg, 1954; McIntosh *et al.*, 1954) varied from 1·2 to 2·8 per 1,000 births. Lower incidences were found in eastern and southern Europe (Candido, 1951; Stevenson *et al.*, 1966a; Czeizel and Révész, 1970), South and Central America (Stevenson *et al.*, 1966a), Australia and New Zealand (Collmann and Stoller, 1962; Stevenson *et al.*, 1966a; Howie and Phillips, 1970), Africa (Simpkiss and Lowe, 1961; Khan, 1965; Stevenson *et al.*, 1966a; Gupta as quoted by Odeku, 1967), and Asia (Neel, 1958; Stevenson *et al.*, 1966a; Kolah, Master, and Sanghvi, 1967; Saifullah, Chandra, Pathak, and Dhall, 1967) with the exception of a few isolated places such as Alexandria in Egypt and perhaps Chandigarh in India.

In western countries, spinal and occipital meningoceles are common, but in Thailand we have found an exceptionally high incidence of encephalomeningocele in the anterior part of the head (see Figures 1 and 2). This fact, which suggests that meningoceles do not comprise a homogeneous group, led us to examine the geographical distribution of this group of malformations.

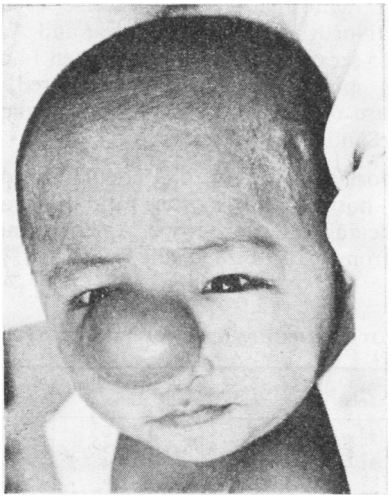

FIG. 1—A 6-month-old girl with a cystic mass on the right side of the root of the nose. The mass became tense on crying and the communication between the sac and the intracranial cavity was readily detectable.

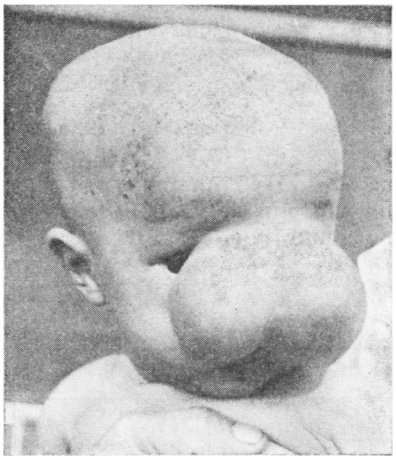

FIG. 2—A 3-month-old girl with a large mass at the glabella. It was about half this size at birth and enlarged progressively. Intracranial repair through a bifrontal craniotomy was done, to be followed by an extracranial plastic operation.

TABLE I
INCIDENCE AND SITE OF MENINGOCELE IN SERIES OF HOSPITAL BIRTHS

Country	Author	Total Births	No. of Infants with Meningocele			
			Spinal	Occipital	Sincipital	NFS
Northern Ireland	Stevenson *et al.* (1966a)	29,202	129	1	0	6
Spain	,,	20,221	12	0	0	0
Czechoslovakia	,,	20,423	18	1	0	2
Yugoslavia	,,	9,112	8	0	0	0
Yugoslavia	,,	8,583	6	0	0	0
United States	Harris and Steinberg (1954)	8,716	21	2	0	0
Australia	Stevenson *et al.* (1966a)	8,446	9	3	0	2
Australia	,,	4,055	8	0	0	0
Brazil	,,	14,849	17	1	0	0
Colombia	,,	19,142	2	1	0	0
Colombia	,,	20,854	5	0	0	0
Chile	,,	24,216	12	1	1	1
Mexico	,,	25,285	30	3	0	1
Mexico	,,	14,083	7	1	0	0
Panama	,,	16,151	14	0	0	5
Egypt	,,	10,401	20	2	0	3
Nigeria	Gupta (quoted by Odeku, 1967)	4,220	4	0	0	0
South Africa	Stevenson *et al.* (1966a)	3,134	2	0	0	1
South Africa	,,	11,427	12	0	0	1
South Africa	,,	10,425	12	0	0	0
Kenya	Khan (1965)	3,016	5	0	0	0
Uganda	Simpkiss and Lowe (1961)	5,498	2	0	0	0
Hong Kong	Stevenson *et al.* (1966a)	10,133	4	0	0	0
Philippines	,,	30,317	2	0	2	2
Malaysia	,,	16,322	4	0	0	0
Singapore	,,	40,314	7	0	1	0
India	,,	19,744	3	0	0	0
India	,,	40,493	48	2	2	0
India	Saifullah *et al.* (1967)	1,000	4	1	0	0
Thailand	Present series	42,315	5	0	7	0

NFS = site not further specified

COMMUNITY SURVEYS OF FRONTO-ETHMOIDAL ENCEPHALOMENINGOCELE IN THAILAND

We made a survey of three rural communities in Thailand—Nongree District, Kanchanaburi Province in western Thailand, and two districts in Trang Province in southern Thailand. One case of fronto-ethmoidal encephalomeningocele in each district was found among populations of 6,124, 3,500, and 7,428 respectively.

Recently, Flatz and Sukthomya (1970) made a survey of a rural community in northern Thailand and found nine persons with fronto-ethmoidal encephalomeningocele in a population of 31,582.

RELATIVE FREQUENCIES OF MENINGOCELE IN BIRTH SURVEYS

Among 42,315 live births in the maternity ward of the Chulalongkorn Hospital, Bangkok, Thailand, during a period of four and a half years from 1962 to 1966 we found seven fronto-ethmoidal encephalomeningoceles and five spinal myelomeningoceles.

The incidences of meningoceles in various parts of the body in series of hospital births are shown in Table I. Sincipital encephalomeningocele appears to be more common than the occipital lesion in Bangkok, Manila, and Singapore where seven, two, and one sincipital lesions were found without a single occipital malformation. The reverse is true for Europe, North and South America, and Australia; among 15 series of hospital births, when 14 occipital and 298 spinal lesions were encountered, only a single case of sincipital encephalomeningocele was seen (in Santiago, Chile).

In reported surveys of total populations of births and of hospital births, the ratio of cranial to spinal meningoceles in Europe, America, and Japan ranged from 1:5 to 1:28 (Table II).

TABLE II
RATIO OF CRANIAL TO SPINAL MENINGOCELES IN SURVEYS OF TOTAL POPULTATIONS OF BIRTHS (TP) AND OF HOSPITAL BIRTHS (HB)

	Author	Cranial	Spinal	Cranial/Spinal Ratio	Source
Birmingham, U.K.	Leck (1966)	143	717	1: 5·0	TP
South Sweden	Böök (1951)	2	47	1:23·5	HB
Hungary	Czeizel and Révész (1970)	21	155	1: 7·4	TP
New York, U.S.A.	Conway and Wagner (1965)	89	1,035	1:11·6	TP
Rhode Island, U.S.A.	MacMahon *et al.* (1953)	38	388	1:10·2	HB
Minnesota, U.S.A.	Harris and Steinberg (1954)	2	21	1:10·5	HB
Missouri, U.S.A.	Silberg *et al.* (1966)	25	712	1:28·5	TP
Japan	Neel (1958)	1	11	1:11·0	TP

TABLE III

PATIENTS WITH ENCEPHALOMENINGOCELE AND MYELOMENINGOCELE TREATED AT SECTION OF NEUROLOGICAL SURGERY, CHULALONGKORN HOSPITAL, BANGKOK, THAILAND IN A PERIOD OF 8½ YEARS

Lesion	No. of Patients
Fronto-ethmoidal	105
Cranial vault	5
Interfrontal	1*
Interparietal	3
Temporal	1
Occipital	11
Basal	1
Craniofacial cleft with meningocele	2
Spinal	35

* One patient had a combination of interfrontal and lumbosacral lesions

CASES SEEN IN NEUROSURGICAL UNITS

The numbers of patients treated for encephalomeningocele or myelomeningocele at the Section of Neurological Surgery, Chulalongkorn Hospital, Bangkok, Thailand, over a period of eight and a half years are shown in Table III. The fronto-ethmoidal encephalomeningocele was more than nine times commoner than the occipital lesion.

Table IV compares the ratios of cranial to spinal meningoceles as reported from various centres. In Europe, the United States, and Australia, the ratio ranged from 1:5·2 to 1:22. In Nigeria, Odeku (1967) found the ratio to be 1:1·9, but in Thailand a reversed ratio was encountered, 3·5:1.

The ratios of sincipital to occipital encephalomeningoceles are shown in Table V. In most series the sincipital lesion was less frequent than the occipital one. The large series reported by Matson (1969) showed 196 occipital lesions in contrast to 31 sincipital, a ratio of 6·3:1. In most series in the United States the ratio was above 5:1. In Europe the ratio seemed to change gradually from west to east, 15:1 and 3:1 in England, and 2:1 in Germany, Switzerland and Sweden. In Russia, the sincipital lesion was apparently the more frequent the ratio

TABLE IV

RATIO OF CRANIAL TO SPINAL MENINGOCELES TREATED IN NEUROSURGICAL UNITS

	Author	Cranial	Spinal	Cranial/Spinal Ratio
Sheffield, U.K.	Lorber (1961)	16	156	1:9·8
Germany	Gerlach and Jensen (1960)	115	946	1:8·2
Massachusetts, U.S.A.	Ingraham and Matson (1943)	79	462	1:5·8
,, U.S.A.	Matson (1969)	265	1,390	1:5·2
Minnesota, U.S.A.	Fisher *et al.* (1952)	63	468	1:7·4
Indiana, U.S.A.	Mealey *et al.* (1970)	65	563	1:8·7
Iowa, U.S.A.	Kolodny (1933)	3	66	1:22·0
,, U.S.A.	Schwidde (1952)	26	199	1:7·7
Australia	Barrow and Simpson (1966)	14	140	1:10·0
Nigeria	Odeku (1967)	36	69	1:1·9
Thailand	Present series	124	35	3·5:1·0

TABLE V

RATIO OF OCCIPITAL TO SINCIPITAL ENCEPHALOMENINGOCELES IN PATIENT SERIES

	Author	Occipital	Sincipital	Occipital/Sincipital Ratio
England	Lorber (1961)	15	1	15·0:1
,,	Lawrence (1856)*	53	17	3·1:1
France	Houel (1859)*	68	16	4·3:1
,,	Larger (1883)	41	41	1·0:1
,,	Piquet and Tramblin (1926)	3	1	3·0:1
Germany	Wallmann (1863)*	24	20	1·2:1
,,	Gerlach and Jensen (1960)	79	36	2·2:1
Sweden	Lindfors (1894)*	24	11	2·2:1
Switzerland	Reali (1874)*	86	33	2·6:1
Russia	Miller (1886)	8	34	1·0:4·2
,,	Sokolow (1939)*	20	119	1·0:6·0
U.S.A.	Ingraham and Matson (1943)	63	6	10·5:1
,,	Matson (1969)	196	31	6·3:1
,,	Schwidde (1952)	19	7	2·7:1
,,	Fisher *et al.* (1952)	45	8	5·6:1
,,	Mealey *et al.* (1970)	55	8	6·9:1
Chile	Poblete (1961)	15	6	2·5:1
Australia	Barrow and Simpson (1966)	11	2	5·5:1
Morocco	Acquaviva *et al.* (1966)	59	37	1·6:1
Nigeria	Odeku (1967)	29	7	4·1:1
,,	Odeku *et al.* (1967)			
South Africa	Lipschitz *et al.* (1969)	17	15	1·1:1
India	Tandon (1970)	24	11	2·2:1
Thailand	Present series	11	105	1·0:9·5

* Quoted by Mustakallio (1946)

being reversed (1:4 and 1:6). In an orphanage in Moscow, Miller (1886) found 34 sincipital and 8 occipital encephalomeningoceles. In another series in Russia, Sokolow (1939, quoted by Mustakallio, 1946) found 119 sincipital and 20 occipital lesions. More recently, Vetebskii (1958) reported 64 sincipital lesions seen over a period of eight years; the number of occipital lesions was unknown in this last series.

In Tandon's first report from India in 1966, including cases from Lucknow and Delhi, 15 occipital and 10 sincipital lesions (1·5:1) were encountered. In his second report in 1970 from Delhi, the ratio was 2·2:1. Odeku (1967) from Ibadan, Nigeria reported a series of 29 occipital and 7 sincipital lesions (4:1); Lipschitz, Beck and Froman (1969) from Johannesburg, South Africa, found 17 occipital and 15 sincipital lesions (1·1:1); and Acquaviva *et al.* (1966) from Morocco reported 59 occipital and 37 sincipital lesions (1·6:1). In Thailand we found 11 occipital and 105 sincipital lesions (1:9·5), which is the most extreme ratio yet reported.

Discussion

We are well aware of the limitations of these findings. The sources of error are great considering the selective bias of hospital births and are even greater for the cases seen in neurosurgical units. We feel nevertheless that the differences are real. The main purpose of this communication is to draw attention to the variation within the group of neural tube defects.

Sincipital encephalomeningocele is rare in western Europe and America. This is true also in Japan (Sano, Handa, and Suzuki, personal communications 1968), Hong Kong (Wu, personal communication 1968), and southern India (Mathai and Wadia, personal communication, 1967). On the other hand, it is commonly found in Thailand, Russia (Miller, 1886; Sokolow, 1939, quoted by Mustakallio, 1946; Vetebskii, 1958), Malaysia (Selby, personal communication, 1969), Indonesia (Gass, personal communication, 1967), and Burma (Gillingham, personal communication, 1971). An intermediate frequency is probable in Africa.

In previous reports (Suwanwela and Hongsaprabhas, 1966; Suwanwela, Sukabote, and Suwanwela, 1971) we have probed superficially into the aetiology of the sincipital encephalomeningocele. The lack of familial incidence, a negative chromosome study, and the discordant affection in a pair of identical twins does not suggest a genetic mechanism as a primary cause. More detailed investigations, however, are needed. We found a significant difference in incidence among the various ethnic groups in Thailand. More patients came from the Thai natives than from Chinese or Indian immigrants. In Kuala Lumpur, Selby (personal communication 1969), however, saw no difference between the Malay, Chinese, or Indian subjects.

Environmental agents are known to produce congenital malformations including encephalomeningocele in experimental animals as well as in man. The high incidence of sincipital encephalomeningocele in a rather localized south-east Asian region of the world suggests the possibility of a common aetiology. The differences in geological and geographical characteristics in various parts of south-east Asia are great, and it seems improbable that geological or geographical factors play any important role in the genesis of this lesion. A more severe protein-calorie deficiency is seen more frequently in India and Africa than in south-east Asia and is, therefore, not a likely cause. A considerable amount of evidence from animal experiments suggests that vitamin deficiencies play a role in the pathogenesis of cranial soft tissue and bone defects (Evans, Nelson, and Asling, 1951; Warkany, 1954). In Thailand vitamin B deficiencies are widespread. If they are major or essential causes of fronto-ethmoidal encephalomeningocele, the incidence of this malformation should be much higher than was actually observed. Vitamin B deficiency is therefore unlikely to be responsible. The observed age distribution in patients with fronto-ethmoidal encephalomeningocele, ranging even to age 70 years, shows that this type of lesion is not new in this population, and therefore drugs or chemicals introduced during the past 20 years are very unlikely to contribute to its formation. A study of custom, food, or other materials used in common by the Thai, Malay, Indonesian, and Burmese peoples and not by the Chinese, Japanese, or Indians might be worthwhile.

Summary

In Thailand fronto-ethmoidal encephalomeningocele is relatively common; it was present in seven newborn infants among 42,315 live births at the Chulalongkorn Hospital in Bangkok, and 105 patients were treated for this condition in the neurosurgical unit of the same hospital over a period of eight and a half years. In surveys of rural communities in Thailand, the frequency in the population varies between 1 in 3,500 and 1 in 7,500.

The incidence in the series of hospital births and the frequency found in the neurosurgical unit were compared with those reported from other parts of the world. The fronto-ethmoidal encephalomeningocele appears to be common in south-east Asia and in Russia. In these regions the sincipital lesion

is more common than the occipital encephalomeningocele.

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