SYMMETRICAL PERFORATIONS OF THE PARIETAL BONES: INCLUDING AN ACCOUNT OF A PERFORATED AND DISTORTED CRANIUM FROM THE LIVERPOOL MUSEUM.

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THE following is an account of three cases of double symmetrical perforations of the parietal bones, the most remarkable of them in a microcephalic and distorted cranium kindly sent by Dr H. O. Forbes, Director of the Liverpool Museums, to the Anatomical Department of University College for examination.

I. THE CRANIUM.

The specimen (Pl. XXXVI. and XXXVII. figs. 1–4) consists of cranium only. It is scaphocephalic and microcephalic: the sutures are obliterated, and in each parietal bone behind the vertex is a symmetrical perforation of large size.

Viewed *from above* (fig. 1) the sutures are seen to be obliterated (except the lambdoidal suture, which is faintly indicated on the left side). The parietal region is symmetrically vaulted. In each parietal bone at its posterior superior angle is a large perforation, symmetrically placed, and separated in the middle line by a bridge of bone without sutures, 20 mm. broad at the narrowest part. The *left* perforation reaches the lambdoidal suture, which is faintly marked in the surface of the skull. It is oval in outline, and measures 4·0 cm. antero-posteriorly: 3·2 cm. from side to side. The *right* perforation is smaller and more circular, and does not extend so far forwards or backwards. It measures 3·0 cm. from before backwards; 3·2 cm. from side to side. The margins of both holes are bevelled externally, and (to a less extent) internally, and the outer surface of each is marked by numerous diverging striations.

A front view of the cranium (fig. 2) shows the exaggerated vault of the frontal bone, temporal ridges well marked, and curved in such a way as to narrow the forehead to a remarkable degree (62 mm.): prominent external angular processes, and well marked but small supra-orbital arches. The frontal bone is flattened in its lowest part, and becomes vaulted above. In its centre is a prominent ridge,

running upwards as far as the bregma. The supraciliary ridges are faintly indicated. About 25 mm. from the glabella on the left side of the middle line is a small round hole communicating with the left frontal sinus. It appears to have been formed during life, as attached on each side of it is a small irregular spicule of bone.

A side view (fig. 3) shows the remarkable expansion of the parietal and occipital regions as compared with the frontal and temporal regions. The slope of the frontal bone is well marked; the temporal fossa is small and shallow, and the root of the zygoma is separated from the external angular process of the frontal bone by a distance of only 40 mm. The temporal ridge is well marked in front and behind, but is only faintly indicated in its middle third. On the right side the greater part of the great wing of the sphenoid bone is wanting. On both sides its articulations with the frontal and the squamous portion of the temporal bone are clearly indicated. It does not appear to articulate with the parietal bone. The mastoid processes are small and infantile in character; and below do not reach to the level of the occipital condyles. The digastric grooves are well marked.

From behind (fig. 4) the vaulted character of the cranium is well seen. The external occipital protuberance is prominent. The region above it is raised in an exaggerated dome-like form; the part below it is of large extent, flattened, and directed downwards and backwards. The sutures are practically obliterated, and the whole of the surface shows an erosion of the outer table of the skull, particularly over the upper portion on the left side.

The inferior surface (figs. 7 and 8) shows the remarkably short length of the basi-cranial axis of the skull, between the foramen magnum and the glabella (97 mm.) as compared with the total length of the cranium (178 mm.). Only the cranial bones are present. The area for attachment of the facial bones is extremely small, corresponding to the narrow forehead, shallow and small temporal fossæ, and infantile mastoid processes. The occipital condyles are flat, small, and asymmetrical, and their long axes are more transverse than usual. The foramen magnum is normal in size, but irregular and asymmetrical in shape. Around its margin posteriorly between each condyle is a slightly elevated ridge of bone. In front of each condyle is a similar more prominent bar of bone ending anteriorly in a free knob-like extremity, not united to the neighbouring piece. The series, together with the condyles, have a likeness to the under surface of an atlas, the anterior arches of which have not joined together.

The interior of the cranium can be examined by the light afforded by the parietal perforations. A very remarkable condition is found in the basal fossæ. The posterior fossa is large and capacious. It occupies more than two-thirds of the base of the cranium, and is covered by the greater part of the vault. The middle and anterior fossæ are very small. Both are perforated and excavated by holes and depressions of various size, and are separated by the lesser wings of the sphenoid bone, which are distorted by the formation of osseous plates erected on their upper surfaces, so

as to still further deepen and narrow the anterior fossa. The floor of this fossa is sloped towards the median line and is convex; it is remarkably deep over the cribriform plate, which is concave in the antero-posterior direction. The pituitary fossa is well marked. The anterior and middle fossæ are roofed over by the narrow, sloping frontal bone, which still more limits the capacity of this part of the cranium. All the fossæ are enlarged at the expense of the bones in the base of the skull. Both basi-sphenoid and basi-occipital bones are much thinner than usual. In the posterior fossa an abnormal arrangement of the *venous sinuses* was seen to have existed. On the left side the lateral sulcus is absent, except close to the jugular foramen. Instead, there is a well marked groove in the position of the occipital sinus, extending from the internal occipital protuberance to the foramen magnum, and along its margin to the jugular foramen of the left side. Here it is joined by a deep groove half an inch in length, corresponding to the terminal portion of the lateral sulcus. On the right side the lateral sulcus has its usual form and course.

Measurements.

The measurements were difficult to obtain, as the obliteration of sutures left the determination of the standard points doubtful.

Cranial capacity, 1225 c.c. (measured with mustard seed).

Measurements—		*Measurements*—continued.	
Maximum length	178 mm.	Breadth of foramen magnum	26 mm.
Ophryo-iniac length	149 mm.	Minimum inter-orbital breadth	16 mm.
Ophryo-occipital length	166 mm.	*Arcs*—Frontal	112 mm.
Maximum breadth	124 mm.	Parietal	80 mm.
Biasterial breadth	105 mm.	Occipital, superior	128 mm.
Minimum frontal breadth	62 mm.	Occipital, inferior	61 mm.
Bistephanic breadth	103 mm.	Horizontal circumference	456 mm.
Biauricular breadth	79 mm.		
Bizygomatic breadth	103 mm.	*Indices*—	
Basi-nasal length	80 mm.	Cephalic	= 69·66
Basi-bregmatic length	128 mm.	Vertical	= 71·91
Basion-obelion length	153 mm.	Breadth height	= 103·225
Basion-lambda length	150 mm.	Frontal	= 60·19
Basion-iniac length	66 mm.		
Basion to opisthion	33 mm.		

II. AND III. CALVARIA IN THE PATHOLOGICAL MUSEUM OF UNIVERSITY COLLEGE, LIVERPOOL.

Among the osteological series in the Pathological Museum we have found two calvaria, with symmetrical perforations of the parietal bones. There is no history attached to the specimens.

No. 306 (Pl. XXXVIII. fig. 5) is a calvarium sawn off above the lambda. The coronal suture is well marked, and there is a metopic suture. The sagittal suture is visible, except for about 25 mm. near its posterior end. In each parietal bone there is a perforation separated across the middle line by a bridge of bone 19·75 mm. in its narrowest part. The sagittal suture is obliterated in relation to this bridge of bone, which is grooved on its under surface for the superior longitudinal sinus. Across the middle line, and connecting the two perforations, is a transverse suture passing through the thickness of the bone. The perforations of the parietal bones are neither large nor equal in size. The right hole is somewhat triangular in shape, the apex pointing outwards. It measures 17 mm. transversely, and 8·5 mm. from before backwards. The left hole is smaller and rhomboidal in shape; it measures 11 mm. from side to side, and 7 mm. antero-posteriorly. The margins of both holes are bevelled, and are marked externally by faint striations. Internally, grooves for meningeal vessels can be traced to the perforations.

No. 307 (fig. 6) is a similar calvarium sawn through above the level of the lambdoidal suture. The coronal suture is well marked, and the sagittal suture is obliterated for 25 mm. in the neighbourhood of the parietal perforations.

In this specimen the parietal holes communicate across the middle line, presenting an hour-glass form. They are symmetrical and almost circular. The narrow interval between them measures 3·75 mm. from before backwards. The lateral portions measure from before backwards 16 mm. on the right side, 17·75 mm. on the left side, and the total transverse diameter of the two holes together is (R. 21, L. 16) 37 mm. The margins of the perforations are bevelled both externally and internally. Internally grooves corresponding to meningeal vessels run to the margin of the holes. The longitudinal sulcus deviates from the middle line so as to end in front of the left perforation. It begins again in the middle line behind the perforations.

Two points of interest are noticeable in the above specimens: (1) the distortion and microcephaly of the cranium (I.), and (2) the presence of parietal perforations.

(1) The microcephalic character of the skull is not excessive, its capacity being 1225 c.c. The distortion consists in a greatly expanded vault superiorly and posteriorly, associated with arrest of development of the base of the cranium, and obliteration of the cranial sutures. The effect of closure of the sutures is apparent not only in the expansion of the vault of the cranium, but also in the forcing downwards of the base of the skull in front of the foramen magnum, and the consequent deepening of the basal fossæ. Associated characters are the imperfect condition of the foramen magnum; the infantile condition

of the mastoid processes, and the character of the occipital condyles.

In fig. 7, the contour of the cranium (*c*) is compared with the contours of the normal Irish skull (*a*) and the skull of the microcephalic idiot (*b*), as described by Cunningham and Telford Smith. The differences are seen to be due to the small size of the basi-cranial axis, and the projection of the vault of

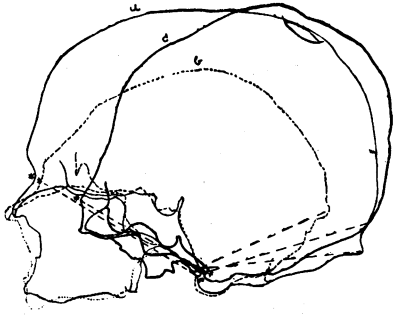

FIG. 7.—Liverpool cranium (Case I.) (*c*) compared with normal Irish cranium (*a*) and that of a microcephalic idiot (*b*), as figured by Cunningham and Telford Smith (* . . . . * = Basi-cranial Axis).

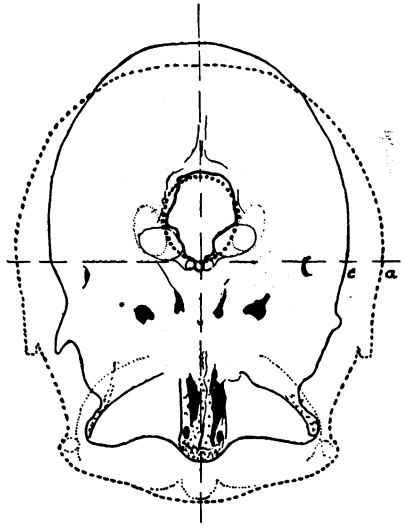

FIG. 8.—Base of Liverpool cranium (*c*) compared with the average of two normal European crania (*a*).

the cranium. In fig. 8 a similar comparison is made of the basal outline of the cranium (*c*) with the average of two normal European crania (*a*).

We have been struck with the general resemblance which this cranium in its upper part has to the Neanderthal skull, and the fragment described by Dubois from Java. If this cranium had been without its under surface, it would have been in general contour very similar to these two specimens.

(2) *Parietal Perforation.*—Humphry (6) is the first English author to refer to symmetrical perforations. He mentions a

cranium in the Cambridge Anatomical Museum, possessing parietal perforations which admitted "the end of the finger."

The first case fully described in 1865 was by Sir William Turner (2), from a specimen obtained by Dr T. J. Maclagan and illustrated by Dr Richard Caton. It was very similar to the specimens described above; there was a suture connecting the left perforation with the lambda, and the holes were filled up by cribriform membranes. They were situated at the postero-superior angles of the parietal bones, and there was an additional perforation in the median line in the supra-occipital bone. The sagittal suture was partially obliterated.

In all, ten cases of parietal perforations have been previously recorded. Besides Humphry's and Turner's examples, Wrany (3) has recorded four cases; Broca (4) is responsible for three, and D. M. Greig (7), formerly Demonstrator of Anatomy in University College, Dundee, has described one case.

Of Wrany's four cases (3) one appears to be an example of mere enlargement of the normal parietal foramen, the left being the larger of the two perforations and big enough to admit a raven's quill. Of Broca's cases, one, a negro cranium (5), is also an example of an enlarged parietal foramen. Greig's case is particularly interesting from the fact that the subject is a soldier who was alive at the beginning of the year (8). The condition in this case is known to be congenital. The pulsation of the brain can be felt beneath the perforations, and the scalp is freely movable over them.

With the three examples described above, we are acquainted altogether with eleven certain, and thirteen possible examples of double parietal perforations. They present, taken together, three points more or less in common: (1) the position of the perforations in the position of the normal parietal foramen at the postero-superior angles of the parietal bones; (2) the microcephalic character of the cranium, referred to in four cases—Turner's, one of Broca's (Baron Larrey's case), Greig's case, and the cranium from the Liverpool Museum; and (3) the partial or complete obliteration of sutures referred to in five cases—three Liverpool cases, Turner's, and one of Wrany's cases.

The differences among the several cases are mainly differences in size, the holes varying from mere enlargement of the parietal

foramen to perforations measuring, as in one of our cases, 4·0 by 3·2 and 3·2 by 3 cm.

Possibility of Trephining.—We should not enter into the question of the possibility of trephining having occurred in one of our specimens, had not the cranium been figured in Dr Robert Munro's *Prehistoric Problems*, 1897 (13), and cited as the solitary example of double trepanning known in an English skull. The "trepanned apertures show clean cut and slightly round edges . . . , the production of which seems to me to have entailed the use of surgical instruments of a higher order than were to be had either in the Bronze or Stone Age." As the deformity of the skull "was probably due to pathological causes, it is interesting to note that the operation (of trepanning) had been resorted to as a means of treatment."

Broca, who was among the first anthropologists who investigated the occurrence of artificial perforations of the cranium, clearly recognises the difference between such holes and the congenital symmetrical double perforations of the parietal bones, of which the cranium in question is in our opinion an undoubted example. The cranium was found in the churchyard at Eastry, near Sandwich, and the inference is that it is at any rate not prehistoric. There is no evidence of inflammatory change in the neighbourhood of the perforations; in short, the position, and the symmetrical nature of the foramina, associated with other similar instances, one diagnosed during life and known to be congenital, along with the evidence (positive and negative) derived from an examination of the perforations themselves, compel us to dismiss at once the view of their formation suggested by Dr Munro, and to place the perforations in this cranium among those of congenital origin.

Relation to Parietal Depressions.—It does not appear as if parietal perforations were related in any way to the symmetrical parietal depressions recorded by Humphry (6), Shepherd (9), and others (10). The latter appear to be congenital depressions in some cases, though they are regarded by Shepherd as due frequently to senile changes in the temporal artery. They are due to a deficiency in the outer table; and the inner table is not affected. The normal parietal foramina may be present along with them, and the examples recorded do not agree in

position with the situation of parietal perforations, being situated further forward on the bones.

Relation to the Parietal Foramina.—The situation of parietal perforations in relation to that of the normal parietal foramina has led to the very natural suggestion by Turner, Humphry, and others, that the perforation is due to an alteration in vascular conditions, an enlargement in size of meningeal vessels, or an increase in the number of vessels in the position of the parietal foramina.

Broca (4) indeed regards the parietal foramina themselves as abnormal. While they are not an essential characteristic of the mammalian parietal bone as a rule—we have only found them in a bear, an ox, and a leopard among the skulls in our possession—there can be no doubt that they are a normal occurrence in the human parietal bone. Out of 204 adult parietal bones examined, we have found the foramina present in 66 per cent., absent in 33 per cent., and present as a single median hole in 1 per cent.

At the same time it is difficult to understand how even a considerable vascular disturbance, such as a blood island or a circulus venosus, much less a mere emissary vein or meningeal artery, could account for perforations of the size of those recorded.

With the object of ascertaining if the arrangement of the diploic veins in normal crania would throw any light on the conditions, we have filed off the outer table of the skull from five crania. In the cases examined the arrangement was fairly regular throughout. A large posterior temporal vein collects from the upper part of the parietal bone, and communicates in some cases with the occipital vein. In one case a 'circulus venosus' was present (but not in the position of the perforations), but the bone was as well ossified within the circle as elsewhere.

Ossification of the Parietal Bones.—The examination of ossifying parietal bones throws some light upon the formation of foramina, depressions, and perforations. In all our specimens of fœtal parietal bones, there was only one example of apparent ossification from more than one centre. In a three months' embryo the bone formation is occurring in two separate areas which are joined together, however, along a line which passes

vertically down the centre of the bone. The examination of eighty-five parietal bones in nine months' fœtuses shows the existence of a very constant cleft in the upper border of the bone, in the position of the parietal foramen, formed by a vessel which produces a rounded or oval notch (fig. 10) at the outer angle of the cleft. This cleft is present in seventy specimens. In fifteen cases it is absent or indistinguishable from the numerous small serrations along the upper border of the bone.

The presence of this emissary vessel is thus able to retard the bone formation in the situation of the parietal foramen. In six cases out of the eighty-five, there were remarkable thinnings, even (in two cases) perforations in the parietal bones, placed symmetrically in one or more situations (Pl. XXXIX. figs. 9, 10, 11). When present, these perforations are oval in form, are due to excessive thinning of the bone, are symmetrically placed, and not always in the same position. They may be present along with thinnings of the bones, and along with the clefts representing parietal foramina. They do not occur in the exact situation of the parietal foramen. When the bone is thinner than usual, it has a cribriform character.

Both thinnings and perforations in the fœtal bones look exactly as if, owing to inequality of growth in the cranium and cerebrum, pressure had been exerted upon the ossifying parietal bones by the subjacent cerebral convolutions. But the usual parietal perforations occur in the situation of the normal parietal foramina. It has been shown that the existence of the usual vessel or vessels in the ordinary course of events retards the bone formation. It is conceivable that in certain cases, it may be along with larger or more numerous vessels, the same inequality of growth and consequent pressure of the cerebral convolutions may keep open and enlarge this embryonic cleft, and so give rise to the large perforations present in some few cases. In one of our cases there is coalescence of the perforations across the middle line; and in another a suture connects them together. The idea of such a cause being responsible is supported by the fact that in several of the examples recorded the cranium has a microcephalic character, or there is partial or complete obliteration of the cranial sutures.

One is inclined, therefore, to causally associate the general con-

Professor PATERSON on Symmetrical Perforations of the Parietal Bones.

FIG. 1.

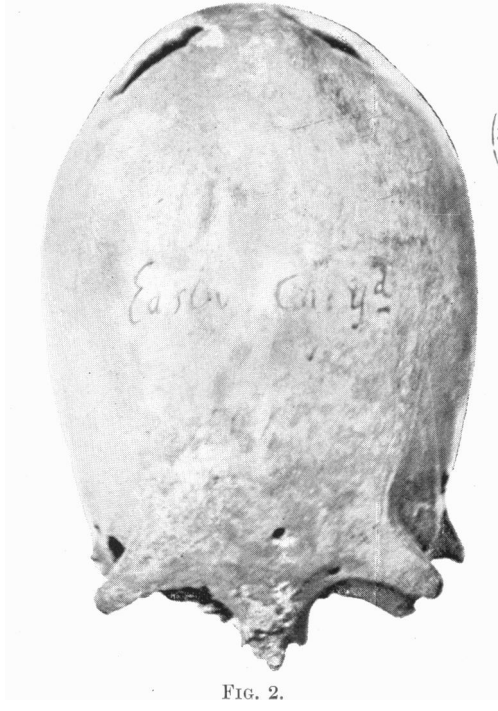

FIG. 2.

FIG. 3.

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FIG. 4.

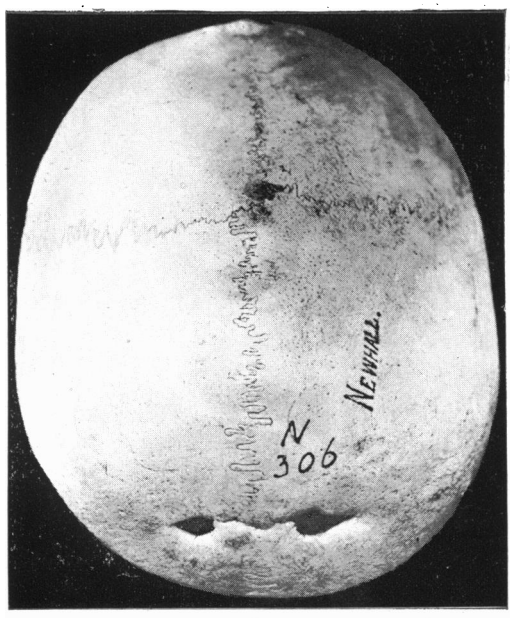

FIG. 5.

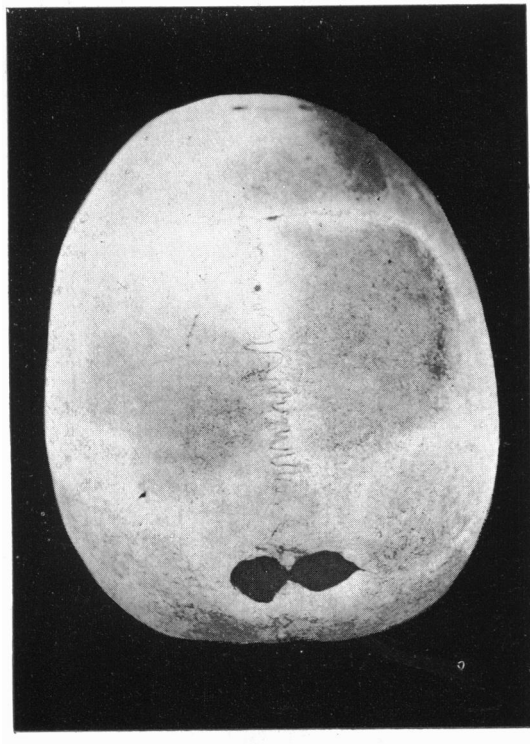

FIG. 6.

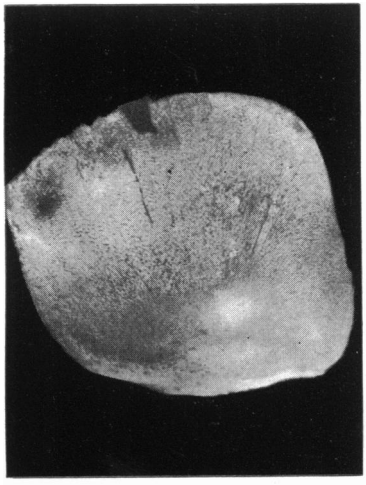

FIG. 9.

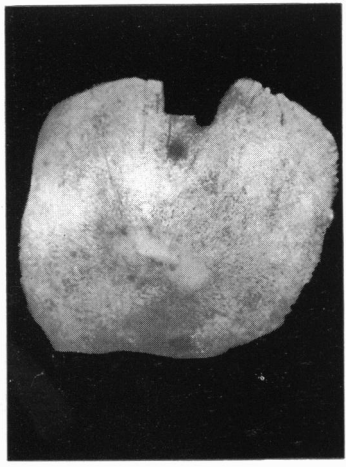

FIG. 10.

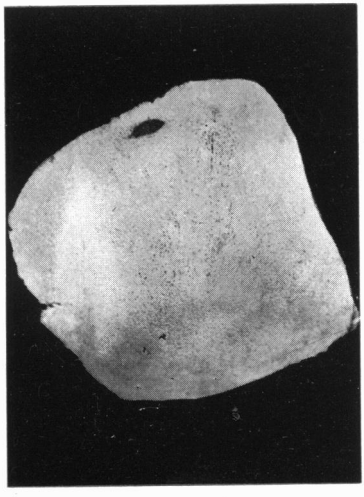

FIG. 11.

dition of the cranium described, arrest of development of the base, closure of sutures, and microcephalic character, with the existence of these enormous perforations of the parietal bones.

EXPLANATION OF PLATES XXXVI.-XXXIX.

Figs. 1–4. Superior, anterior, lateral, and posterior views of the cranium (Case I.).

Figs. 5, 6. Calvaria from Pathological Museum (Cases II. and III.).

Figs. 9, 10, 11. Parietal bones of nine months' fœtuses—perforated and thinned.

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