CASE STUDY OF A HYDROCEPHALIC SKULL

STUDIUM PRZYPADKU WODOGŁOWIA

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SUMMARY

Hydrocephalus manifests itself as a permanent widening of the space in which cerebrospinal fluid accumulates. This disease is a result of disproportion in its circulation. The widening can also be brought about by cerebral atrophy. Hydrocephalus usually derives from a defect or a disease of the brain (tumors, infections). It may result in dullness, oligophrenia; however, over 50% of cases are characterized by normal or high IQ.

The paper contains a description of a case of a female juvenile individual's skull with hydrocephalus. A description and measurements of the skull had been made and the results were compared with data on skulls from the 19th century.

Key words: hydrocephalus, cerebral atrophy, central nervous system, anthropology, skull.

STRESZCZENIE

Wodogłowie przejawia się jako stałe poszerzenie przestrzeni, w której gromadzi się płyn mózgowo-rdzeniowy. Choroba ta jest wynikiem dysproporcji w obiegu. Poszerzenie może być również spowodowane przez zanik tkanki mózgowej. Wodogłowie zwykle wynika z wady lub choroby mózgu (nowotwory, infekcje).

Wodogłowie może powodować otępienie, oligofrenię, jednak ponad 50% przypadków charakteryzuje się prawidłowym lub wysokim IQ.

Praca zawiera opis przypadku czaszki osobnika młodocianego płci żeńskiej z wodogłowiem. Dokonano opisu i pomiarów czaszki, a wyniki porównano z danymi dla czaszek z XIX wieku.

Słowa kluczowe: wodogłowie, zanik tkanki mózgowej, centralny układ nerwowy, antropologia, czaszka.

INTRODUCTION

Hydrocephalus – both congenital and acquired – manifests itself as a permanent widening of the space in which cerebrospinal fluid accumulates. This disease is a result of disproportion in its circulation. The widening can also be brought about by cerebral atrophy. Hydrocephalus usually derives from a defect or a disease of the brain (tumors, infections) [1]. In accordance with M. Dokládal [2], KM. Lawrance, who, for many years, systematically studied various malformations of the central nervous system, distinguishes three fundamental causes of hydrocephalus:

1. Hyperproduction of cerebrospinal fluid (e.g. papilloma of the choroid plexus and subsequent hypertrophy of the villi).
2. Blockage of cerebrospinal fluid outflow, either from the ventricles or the subarachnoid space (e.g. the Arnold Chiari syndrome, cisternal block, inflammation, neoplasm) or caused by skull abnormalities.
3. Insufficient flow of cerebrospinal fluid (e.g. thrombosis of the venous sinuses).

Hydrocephalus may result in dullness, oligophrenia; however, over 50% of cases are characterized by normal or high IQ.

The increased pressure of the cerebrospinal fluid causes gradual growth of the skull. Usually, after the fourth year of age, diastasis of skull sutures appears, which results in formation of additional skull bones: *ossa suturarum*, *ossa fonticulorum*. The forehead is subject to significant vaulting. Further skull growth is characterized by: 1) an increased depth of the sulcal and gyral impressions; 2) erosion of the dorsum sellae and posterior clinoids; 3) enlargement of the emissary venous channels. A variable degree of sutural separation may occur in children up to the age of 10–15. Macrocephalus and hydrocephalus promote the formation of unstable skull bones as the dura mater within the sutures and fontanels is stretched, which is accompanied by separation of ossification centers [3–5]. When the ossification of the skull is finished, a compression of brain atrophy may take place – with subsequent mental consequences. The frequency of the hydrocephalus occurrence in modern-day populations has been estimated to fluctuate between 0.32 and 1.0 per 1000 born-alive babies.

Macrocephalus can be recognized by the big size of the head – when its horizontal circumference is bigger than 65 cm and brain weight is between 1600–2800 g. Despite its big size the head remains proportional which makes macrocephalus different from hydrocephalus, the former being the result of brain and bone hypertrophies; however, it can sometimes be connected with hydrocephalus. Macrocephalus occurred in some of the famous people – Dokládal quotes the examples of: Hemholtz – a physicist, Cuvier – a zoologist, Turgieniev – a writer, and politicians like Bismarck or Cromwell.

Anthropology takes interest in cases of abnormal development of the skull, such as hydrocephaly, macrocephaly, and microcephaly which provide an insight into skull morphogenesis. So far, we have presented two cases of microcephalus [6, 7]. This paper presents a case of hydrocephalus.

MATERIAL AND METHOD

The skull in question belonged to a female who died in her juvenile age in the first half of the 20th century (phot. 1). All the measurements were made in compliance with modern anthropometric standards [8]. The control group were a set of 64 19th century female skulls from the collection of the 'Department of Anthropology of the University of Łódź' (phot. 2).

In order to assess the degree and trend of deviations in the size of the examined skull, compared with the values for the normal skulls, the measurements were normalized:

$$Z = (Xa - X) : SD$$

The general value of deviations was calculated:

$$M = \Sigma Z : K,$$

where: K – number of features

And Perkal's natural conditions:

$$W = Z - M.$$

RESULTS

Description of the skull's surfaces

The superior surface, *norma verticalis*, is of rhomboides verus shape. One can see the not very complex sutura coronalis and its simple layout, the slightly dislocated Bregma point and, to the back of this point, the *os suturarum*. The right frontal tuber (*tuber frontale*) and the left parietal tuber (*tuber parientale*) are a little more marked.

On the surface, one can see the non-ossified s*ynchondrosis spheno-occipitalis*. The foramen magnum in the *ossis occipitalis* is of oval shape. The condyloid processes (*processus condylaris*), similarly to the alveolar processes (*processus alveolaris*) within the range of the molars, have porous structure, which points to erosion of the compact substance. On the surface of *norma basilaris* interna one can see deepened grooves (*sulci venosi*), erosions of the dorsum (*dorsum sellae*) and the clinoid processes, widening of the vena emissaria canal. The axes of petrous pyramids intersect at an angle of 95, which points to the dolichocranus skull type.

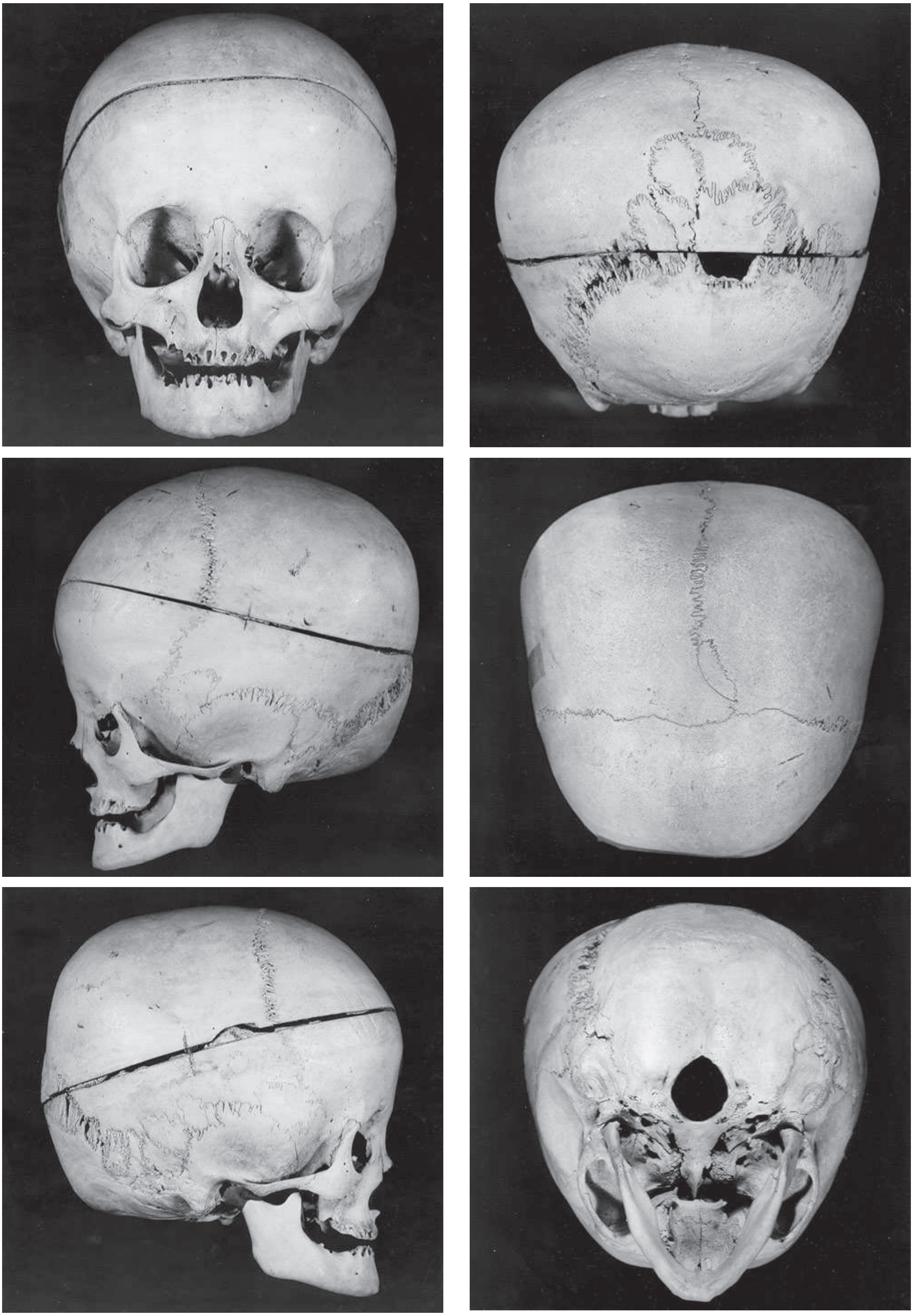
The occipital surface has the neurocranium of the *spheroides* verus type. One can distinguish a very complicated and highly serrate lamboid suture of the os *incae multipartitum* – 5 bonelets. On the right side of the lamboid suture there are 15 suture bonelets and on the left side there are numerous small bones. There are os astericae at both ends of the sutures. The nuchal lines and the exterior occipital protuberance are not visible.

On the lateral surface one can see a strongly convex-overhang (forward-pushed) forehead; parietal bones equally flattened and raised, a rounded occiput; the mastoid process – very small and blunt. In regio pterica one can distinguish the *os epiptericum*. On both sides of the squamous suture on the left side of the skull, are small *ossa suturae squamosum* and *os postsquamosum*; whereas on the right side of the skull, in the back section of the suture, there are three bigger bonelets, of which the last one is an equivalent of the *os postsquamosum*. Flat glabella, the cheek bone without a marginal tuber, small nasal spine, mesognathous jaw (*mesognathia alveolaris*).

On the front surface one can notice a total lack of superciliary arches, a sharp edge of the upper rim of orbit; the orbits – very big and round. Narrow, convex, trapezoid nasal bones with foramens at 1/3 of its height. Nasal foramen (*apertura piriformis*) of piriform- droplet shape with a sharp lower part of the rim. Shallow canine fossa and extremely shallow maxillary incisure.

The figures characterizing the size of the skull and indices are shown in table 1, whereas table 2 presents a comparison of the values with those of the control group. The skull in question is most different from the normal ones with respect to: neurocranium's breadth features (co-co, en-en, ast-ast), length (g-op) and skull height (ba-b). The measurements of the facial part of the skull approximate the range of values for normal skulls.

Phot 1. The skull of an adolescent female specimen with hydrocephalus



Phot. 2. Skulls from the collection of the Departament of Anthropology, University of Łódź

Table 1. Measurement (mm) of the hydrocephalic skull

Dimensions											
A. Chords						B. Archs			C. Mandible		
1.	eu-eu	211	20.	enm-enm	33	1.	g-b	170	1.	go-go	84
2.	ba-b	182	21.	ekm-ekm	52	2.	n-b	183	2.	kdl-kdl	109
3.	po-b	155	22.	ol-sta	39	3.	g-l	380	3.	gn-id	28
4.	g-op	230	23.	ba-o	37	4.	n-l	393	4.	go-gn	74
5.	g-b	109	24.	ba-l	152	5.	g-i	646	5.	enm-enm	43
6.	n-b	101	25.	ba-n	101	6.	n-i	659	6.	ekm-ekm	62
7.	g-l	225	26.	ba-pr	88	7.	l-b	207	E. Indices		
8.	n-l	225	27.	ba-gn	98	8.	l-i	90	1.	bread–lenght 1:4	91.7
9.	g-i	203	28.	n-gn	98	9.	l-o	150	2.	height–lenght (ba) 2:1	79.1
10.	n-i	198	29.	n-pr	68	10.	i-o	115	3.	height–leng (po) 3:4	67.4
11.	l-b	171	30.	n-ns	52	11.	Median – sapit aren of the voult	550	4.	height–bread (ba) 2:1	86.3
12.	l-i	102	31.	mean orbital height	36	12.	po-b (left)	225	5.	height–bread (po) 3:1	73.5
13.	l-o	135	32.	ft-ft	109	13.	po-b (right)	261	6.	height–med (p-o)	82.5
14.	i-o	62	33.	zy-zy	131	14.	po-b-po	486	7.	height–med	70.3
15.	co-co	185	34.	ek-ek	102	15.	Horizontal circumference	720	8.	upper face 29:33	51.9
16.	ast-ast	156	35.	zm-zm	90				9.	morph. face 28:33	74.8
17.	mst-mst	117	36.	mf-ek	44				10.	nasal 38:30	44.2
18.	au-au	122	37.	mf-mf	27				11.	orbital 31:36	81.8
19.	breadth of foramen magn.	30	38.	apt-apt							

D. Measurements of the cranial cavity (cavum cranii):
1. Lengh of anterior cranial (fossa crani anterior) – 93
2. Maximum breadth of anterior cranial (fossa crani anterior) – 168
3. Length of the lateral part of middle cranial (fossa crani madia) – 96
4. Lateral breadth of middle cranial fossa at the level of sella (fossa crani media) – 77
5. Lateral breadth of middle cranial fossa at the level of sella's dorum (tuberculum sellae) – 81
6. Length of posterior cranial (dorsum sellae) – 144
7. Maximum breadth of posterior cranial fossa (fossa crani posterior) – 147
8. Angle of convergence of the axes of temporal bones' ppyramids – 95

Sella – deep
8. The value of the angle falls within the range of doliochocephalus.

Table 2. Statistical characteristics of the hydrocephalic skull – as compared with the controls

	Measurement	64 female skulls from XIX c.		Hydrocephalic skull percentage relation (normal = 100%)			
		$\bar{X}$	SD	$\bar{X}$ a	%	$(\bar{X}a - \bar{X}) : S$ Z	W
	1	2	3	4	5	6	7
1.	g-op	173	5.9	23	132.9	+9.66	+6.34
2.	eu-eu	135	6.8	211	156.3	+11.18	+7.86
3.	ba-b	127	5.0	182	143.3	+11.00	+7.65
4.	co-co	112	5.7	185	165.2	+12.81	+9.49
5.	ast-ast	104	4.7	156	150.0	+11.06	+7.74
6.	mst-mst	98	5.2	117	119.4	+3.65	+0.33
7.	au-au	110	5.2	122	110.0	+2.31	–1.01
8.	enm-enm	37	2.8	33	89.2	1.43	–4.75
9.	ekm-ekm	57	3.9	52	91.2	1.28	–4.60
10.	ol-sta	42	3.2	39	92.8	0.94	–4.26
11.	ba-l	113	6.8	152	134.5	+5.74	+2.42

12.	ba-n	97	3.8	101	104.1	+1.05	–2.27
13.	ba-pr	93	5.1	88	94.6	0.98	–4.30
14.	n-pr	66	4,2	68	103.0	+0.42	–2.90
15.	n-ns	49	3.2	52	106.1	+0.94	–2.38
16.	Orbital height	35	2.3	36	102.8	+0.43	–2.89
17.	ft-ft	93	4.2	109	117.2	+3.81	+0.49
18.	zy-zy	123	5.0	131	106.5	+1.60	–1.72
19.	ek-ek	94	3.1	102	108.5	+2.58	–0.74
20.	zm-zm	89	4.3	90	101.1	+0.23	–3.09
21.	mf-ek	41	2.1	44	107.3	+1.43	–1.89
22.	mf-mf	21	2.8	27	128.5	+2.14	–1.18
23.	apt-apt	25	2.0	23	92.0	1.00	–4.32

$\bar{X}$ – arithmetical mean of the female skulls from Poland; $\bar{X}a$ – measurements of the hydrocephalic skull; Z – normalised values of the measured features; W – Perkal's natural indices; m – general value.

One can also see that hydrocephalus also results here in ultrabrachycrania, caused by stronger broadening rather than lengthening of the neurocranium. G.W. Richards and S.C. Anton have described compensation skull changes caused by hydrocephalus and found the most significant broadening in the case of neurocranium, forehead and even the distance between the angles of the mandible (go-go). They have found narrowing of the jaws and the nose (apt-apt) [9]. Their findings are confirmed by the measurement values of the skull presented in this paper. Besides, our skull deserves attention because of its considerable size.

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