ANTHROPOLOGIE • XLI/1–2 • pp. 65–69 • 2003

JANUSZ SKRZAT, HENRYK GŁĄB, KRZYSZTOF SZOSTEK, PAWEŁ BRZEGOWY, JERZY WALOCHA

RADIOGRAPHIC APPEARANCE OF THE DIPLOE OF THE SCAPHOCEPHALIC SKULL

ABSTRACT: Radiographic appearance of the diploe of the scaphocephalic skull was performed using computed tomography assisted by tonal correction of the original CT scans. We found out that the diploe of the analysed scaphocephalic skull is relatively thick, especially in the posterior aspect of the vault. It appears as highly porous structure, and tightly fills the space between tables of the compact bone. There are radiololucent areas in CT scans, which manifest rarefication of the diploe in the parietal bones. Numerous diploic channels, which communicate among themselves, were detected. The external table of the compact bone is well demarcated in contrast to the internal table of the compact bone, which seems to disappear in certain areas of the vault.

KEY WORDS: Scaphocephaly – Diploe – Trabecular bone

INTRODUCTION

Scaphocephaly refers to the condition where the head is disproportionately long and narrow. Scaphocephaly results from the premature fusion of the sagittal suture, which joins two parietal bones in the midline of the vault. Premature closure of this suture usually gives a keel-like shape of the skull and it has a profound effect of craniofacial form. Such a skull is described as having midline bony ridge over the interparietal suture region, biparietal and bitemporal narrowing and occipital prominence (Posnic *et al.* 1993, Ocampo, Persing 1994).

The bones of the cranial vault are composed in a sandwich-like fashion of an outer table of compact bone, a middle layer of spongy bone (diploe), and an inner table of compact bone. The normocephalic skull in the radiological examination shows the outer and inner cortical layers of the bone of the vault as dense areas (lines), while the diploe (cancellous bone) that lies within the mentioned layers to has an irregular pattern as a result of trabeculae producing a mottled effect.

The goal of this study was to analyse structure of the diploe of the scaphocephalic skull in the area of normally existing interparietal suture and describe its morphology in other parts of the vault. We tried to estimate if there are any significant differences in morphological appearance of the middle layer (diploe) of the bones, which form cranial roof of the scaphocephalic skull.

MATERIAL AND METHODS

Observation of the morphological appearance of the diploe was performed on the CT-scans of the dry scaphocephalic skull of the adult male individual. The investigated skull derives from craniological collection, located in the Anatomical Museum of the Chair of Anatomy, Collegium Medicum of the Jagiellonian University in Cracow.

The skull is well preserved and the bones of neurocranium and splanchnocranium are heavily mineralized and show no evidence of any perforations. Sex determination in the investigated skull was based on the sexual dimorphism observed between males and females skulls. Marked muscular attachments to the bones, strongly developed temporal lines, prominent supercilliary ridges, well-developed external occipital protuberance and the shape

TABLE 1. Craniofacial measurements (in millimetres) of the investigated scaphocephalic skull and control group.

Measurement	Scaphocephalus	Control group		
		Mean	SD	N
gl-op	201	178.3	7.29	98
ba-b	130	133.9	7.11	68
eu-eu	127	148.0	5.69	94
ft-ft	103	98.6	4.86	91
zy-zy	130	123.9	5.51	35
n-gn	113	112.1	4.60	10
n-pr	60	68.1	3.92	52

of mandible express male character of the investigated skull (*Figure 1*). Basic cranial diameters of the investigated skull are put in *Table 1.*

The scaphocephalic skull was examined using a helical computed tomography with a zoom factor which magnified images and made it easier to analyse the diploic structure and its relation to outer and inner plates of the compact bone. Radiographic studies were carried out by means of Helicat Flash scanner (Marconi) using spiral technique. The parameters of examination were: collimation 2.7 mm, pitch 1.5, exposure factors 120kV, 162 mAs. The original CT images were transformed by non-linear correction of grey scale for better visualisation the bony structures. We applied an algorithm which allowed us to determine the borders between the areas that are characterized by different levels of greyness intensity, and it is associated with changes of structural density. The intensity of grey shades of the defined regions of the cranium reflects bone tissue density and it is positively correlated with it. Darker areas of the positive CT scans correspond to higher structural density.

Basic anthropological measurements were also performed on the investigated scaphocephalic skull to present its size in comparison to the normatives of the adult male skulls. Craniofacial measurements of the control group were taken from literature (Kaczanowski 1965). Craniofacial measurements were taken with an appropriate instrument (sliding calliper, spreading calliper), respectively to the methodology (Martin, Knussmann 1988).

RESULTS

We noted that entire diploe is well mineralized and seems to be of a heterogeneous structure if its density is considered. In the analysed scaphocephalic skull both the compact tables and the diploe vary conspicuously in different parts of the vault. The outer table of the compact bone is much better demarcated from diploe than the inner table of the compact bone (*Figure 2*). In the frontal part of the vault the diploe is more compact and there are clumps of thicker trabeculae, which normally are not observed in non-scaphocephalic skulls (*Figure 3*). The diploe of the scaphocephalic skull seems to be more porous in the posterior aspect of the vault than in the anterior, which might be a result of extreme cranial elongation. We found out also that the diploe of the investigated scaphocephalic skull is not a cohesive structure in respect to trabecular organization and venous channels. There are specific radiololucent areas in CT scans, which manifest rarefication of the diploe, especially in the parietal bones. Analysis of the CT scans revealed numerous diploic channels running horizontally and transversely to the section. The channels are observed in the frontal, parietal and occipital bones. They vary in their magnitude and orientation (*Figures 3, 4*).

A remarkable condensation of the diploe was observed on the CT scans in the midline. Probably these are the remnants of the ossified interparietal suture. It resembles elongated cluster of dense bony trabeculae, orientated sagittaly *(Figure 5)*. Initially, in CT scans this stripe of darker area was well visible, but lower sections within parietal bones did not show similar condensation of bony tissue in the diploe. Hereby, we want to emphasise that external surface of the vault did not show any trace of the obliterated interparietal suture.

DISCUSSION

Scaphocephaly as a result of premature obliteration of the interparietal suture is a vivid example of the cranial deformation. We hypothesise that the middle layer of the bone (diploe) is basically responsible for maintaining sutural contact between bones, while outer and inner plates reinforce suture area. If there is a rapid fusion of bony margins and premature obliteration of the suture, one may conclude that diploe should also undergo metamorphosis, whose traits might be recorded by computed tomography.

Because there is lack of the interparietal suture, which normally serves as a place of transverse cranial growth, the parietal bones have to enlarge their diameters in a way of compensatory growth, which might occur within other sutures of the vault (Person 1995). Thus these disturbances may implicate changes of bone vascularization resulting in increased number of diploic channels with blood vessels (Cooper 1961). In the studied case parietal bones are extremely elongated, so one may presume that extensive growth of these bones required abundant vascularization (Silau *et al.* 1995).

Visible morphological differences can be due to involution processes related to rapid changes of trabecular density in the diploe accompanied with the fluctuations of the mineral components. The assessment of the morphological variation in the diploic structure of the scaphocephalic skull seems to be significant in comparison with normally developed cranium; it comprises two distinct parietal bones joined by the non-ossified suture. Deformation affecting the neurocranium shows that structure of the diploe can be involved in this pathological process.

Our study was concentrated on observation of diploe in the axial CT scans, as they present in antero-posterior

FIGURE 1. Image of the investigated scaphocephalic skull; anterior and lateral view.

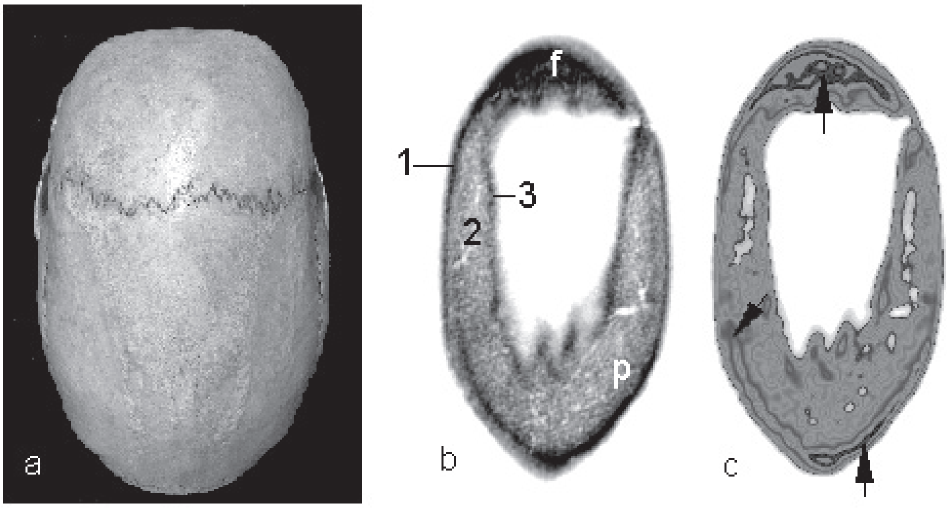

FIGURE 2. Image of the investigated cranial vault (a) and axial CT scan (b – original, c – modified); f – frontal bone, p – parietal bone; 1 – outer table of compact bone, 2 – middle layer of spongy bone (diploe), 3 – inner table of compact bone. The arrows indicate areas of the higher density.

direction, which corresponds with direction of cranial elongation during growth. Moreover, the axial scans deliver simultaneous insight into the diploe of frontal and parietal bones on the same level. The squama of the occipital bone is relatively short in comparison with cranial height, so its diploe was visible only on the inferior sections, if referred to the vertex of the skull.

Performed computed assisted tomography analysis of the diploe of the scaphocephalic skull gives the background for further study, which should also focus on the morphological analysis of the frontal and sagittal CT scans of the skull. Then the three-dimensional image of the diploe and its relation to the outer and inner table of the compact bone may be used.

We are aware of the fact that noticed peculiar features of the diploe of the scaphocephalic skull could be regarded as normal individual variation, but we are not able to verify this view, as there is not enough evidence on this topic in

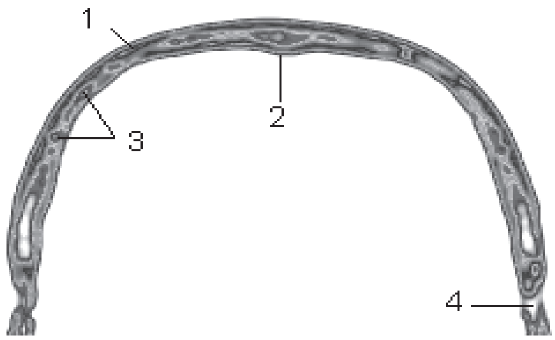

FIGURE 3. Axial CT scan of the frontal bone – visible diploic channels. 1 – outer table of compact bone, 2 – inner table of compact bone, 3 – diploic channels, 4 – coronary suture.

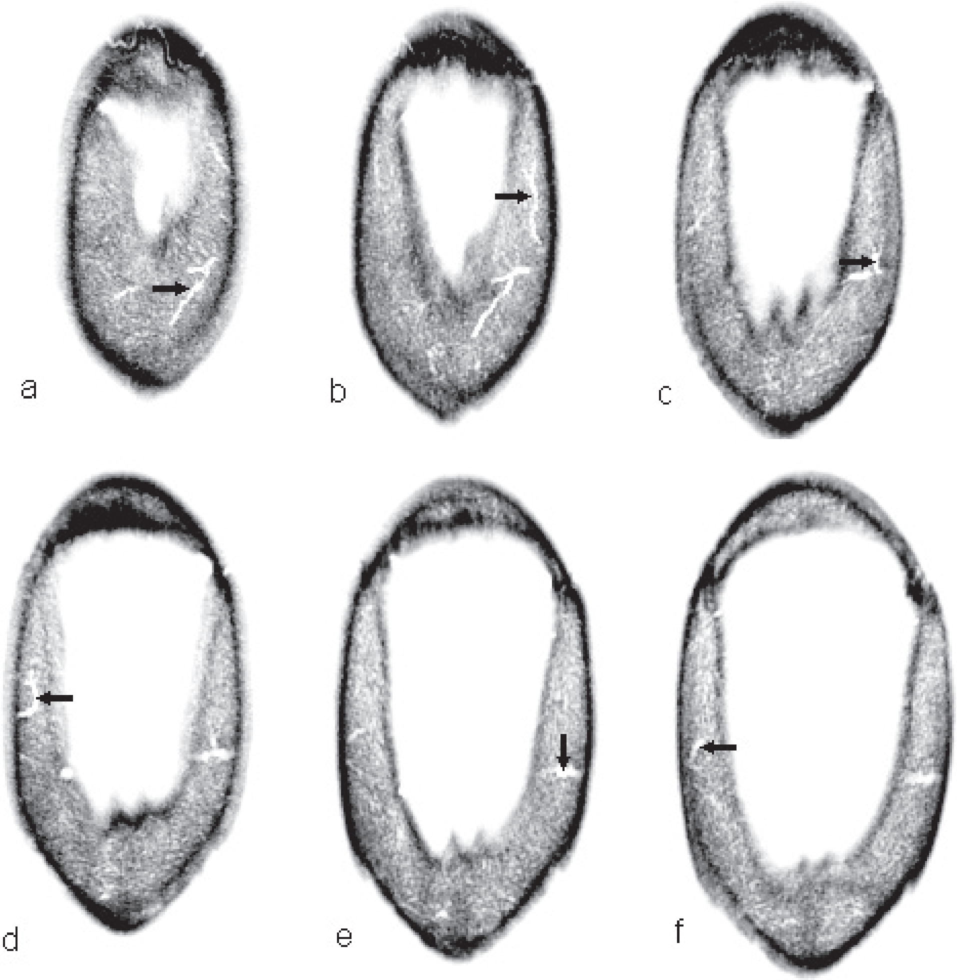

FIGURE 4. Serial, axial CT scans of the scaphocephalic skull (initial steps). Note the higher condensation of diploe in the frontal bone and posterior aspect of the skull (parietal bones) and visible diploic channels.

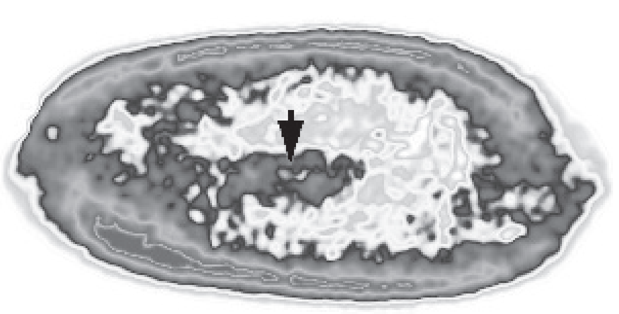

FIGURE 5. Presumably visualised remnants of the interparietal suture (indicated by arrow).

the literature. Results of comparative studies of the radiographic appearance of the diploe of the scaphocephalic and normal skulls performed on large cranial series would be necessary to confirm or deny our observations. From our study we inclined to suggest that the diploe of the scaphocephalic skull vary from the diploe of the normal skull.

To conclude, we found out that the diploe encapsulated by the compact bone of the analysed scaphocephalic is relatively thick, especially in the posterior aspect of the vault. It appears as highly porous structure, and tightly fills the space between plates of the compact bone. There are numerous diploic channels present, which communicate among themselves. The external plate of the compact bone is well demarcated in contrast to the internal plate of the compact bone, which seems to disappear in certain areas of the vault.

REFERENCES

COOPER E. R., 1961: Cranial diploic channels and their communications. *Acta Anatomica* 47: 345–362.

KACZANOWSKI K., 1965: Czaszki przy kościele Mariackim w Krakowie (XV-XVIII w.). *Materiały i Prace Antropologiczne* 71: 57–112.

MARTIN R, KNUSSMANN R., 1988: *Anthropologie Handbuch der vergleichenden Biologie des Menschen. Band I, Wesen und Methoden der Anthropologie*. Gustav Fischer Verlag, Stuttgart, New York.

OCAMPO R.V, PERSING J. A., 1994: Sagittal synostosis. *Clinical Plastic Surgery* 21: 563–574.
PERSSON M., 1995: The role of sutures in normal and abnormal craniofacial growth. *Acta Odontologica Scandinavia* 53: 152–161.
POSNIK J. C., LIN K. Y., CHEN P., ARMSTRONG D., 1993: Sagittal synostosis: quantitative assessment of presenting deformity and surgical results based on CT scans. *Plastic Reconstructive Surgery* 92: 1015–1024.
SILAU A. M., FISCHER H. B., KJAER I., 1995: Normal prenatal development of the human parietal bone and interparietal suture. *J of Craniofacial Genetics and Developmental Biology* 15: 81–86.

Janusz Skrzat
Paweł Brzegowy
Jerzy Walocha
Department of Anatomy CMUJ
ul. Kopernika 12
31-034 Kraków, Poland
E-mail: jskrzat@poczta.onet.pl

Henryk Głąb
Krzysztof Szostek
Department of Anthropology
Institute of Zoology
Jagiellonian University
Kraków, Poland