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# The Sequence in Appearance and Disappearance of Impressiones Gyrorum Cerebri and Cerebelli

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## ABSTRACT

*We investigated the sequence and the intensity in the appearance and the disappearance of the impressiones gyrorum cerebri and cerebelli, of juga cerebralialia and cerebellaria and of juga cerebellaria interlobularia in the collection of 34 macerated and disarticulated skull bones from the newborn to 30 years of age (68 specimens / halves of skulls) and 19 skulls in the period from 30 to 80 years of age (38 specimens). Juga cerebralialia on the squama of the temporal bone and cerebral lamina of the frontal bone appeared already in the course of the first year of life, much earlier than cited in the literature. The intensity of the development of juga cerebralialia increased to the third decade. After that age, the intensity decreased gradually, and the juga cerebralialia disappeared completely in parietal bones, in the cerebral fossae of the occipital bones and finally in most cases also on the cerebral lamina of the frontal bones. Juga cerebellaria and impressiones gyrorum cerebelli appeared in the middle of the second year of age and persisted to the ten years of age, which coincides with the closure of the fissures among the parts of the occipital bone. Jugum cerebellare intersemilunare appeared in the first year of life and persisted in its complete length, or interrupted in different sections of its course, during the whole life. The intensity in appearance of juga is partly influenced by the increasing thickness of the diploe.*

**Key words:** impressiones gyrorum cerebri and cerebelli, frontal bone, occipital bone, temporal bone

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## Introduction

We used our collection of disarticulated skull bones and skull bases in the life

period from newborn to adults to investigate the sequence in appearance and the

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pattern of imprints of the cerebral and of the cerebellar surface on the skull bones.

The appearance of juga cerebrialia has been discussed in many publications, but the data of the first appearance of juga cerebrialia and impresiones gyrorum, as well as of juga cerebellaria and impresiones gyrorum cerebelli, vary from author to author. Our aim was to determine the exact time of appearance and the life-long fate of juga cerebrialia and cerebellaria, impresiones gyrorum cerebri and cerebelli, and impresiones lobulorum cerebelli.

The publications of Schwalbe<sup>1,2</sup> and Lang<sup>3-5</sup> yield precise relations of the cerebral surface to the outer surface of the

skull bones in shape of »protuberances«. Schwalbe<sup>1</sup> studies also the appearance of the juga cerebrialia on 59 skulls in the period from the newborn to 16 years of age (Table 1). Besides the juga cerebrialia Schwalbe describes, followed by Lang the elevations, the »protuberances« on the outer surface of the skull bones produced by the gyrus inferior, gyrus temporalis superior and medius and very rarely also by the gyrus temporalis inferior. Lang studies the protuberances on 62 skulls of children and ranges them in 4 groups following the systematisation of Schwalbe. The protuberances start to develop in the first year of life in degree I, rarely in degree II. In the period from 6 to 7 years of age appear besides the degree I most fre-

**TABLE 1**  
THE APPEARANCE OF THE JUGA CEREBRIALIA, BY DIFFERENT AUTHORS

Time of appearance	Our findings	Schwalbe, Lang	Burghardt
First year of life	temporal bone, lamina cerebralis of the frontal bone, parietal bone, fossa occipitalis cerebralis	parietal bone, fossa occipitalis cerebralis	
Second year	ala major ossis sphenoidalis, squama frontalis	ala major ossis sphenoidalis, squama frontalis	first appearance of juga cerebrialia
End of second year	squama temporalis	pars orbitalis ossis frontalis, squama temporalis	
4–5 Years of age			most intensive imprints
10 Years of age			the pattern remains constant
30 years	increase in intensity		
After 30 years	gradual disappearance especially in the parietal bone, fossa occipitalis cerebralis		

quently also protuberances of degree II. In 16 to 17 years of age appear also the degrees III and IV of protuberances. The most constant protuberances (missing only in 16.6% of cases) in the period from 16 to 17 years of age belong to the gyrus frontalis inferior.

The findings of Schwalbe are slightly but not essentially different what concerns the time of appearance and the degree of development from the findings of Lang.

According to Burkhardt<sup>6</sup>, *juga cerebellaria* appear between the 12<sup>th</sup> and 24<sup>th</sup> month of life. Their development is most intensive between 4 and 5 years of age and from the 10<sup>th</sup> year they remain constant (Table 1).

The thickness of the skull bones depends upon the relation in the thickness of *tabula externa*, *diploe* and *tabula interna*. According to Dietrich<sup>7</sup>, the relation of these structures in young individuals is 1:2:1, in older men 1:3:2 and in women 1:2:2. After 60 years of age the relation is 1:3:1. The thickness of the *diploe* increases to 40 years of age at the expenses of the *lamina interna*, and from 50 years of age at the expenses of the of *lamina externa*<sup>3,8,9</sup>

Data concerning the impressions of gyri cerebellares are contradictory. Most of the authors<sup>10,11</sup> consider the cerebellar fossae as smooth. Some of them<sup>12</sup> describe erroneously »digital impressions« which do not exist in the cerebellar fossae<sup>13</sup>.

Eida<sup>14</sup> describes »*jugum cerebellare intersemilunare*« as *crista tonsillobiventerica*. According to his illustration, this ridge does not separate *tonsilla* and *lobulus biventer* but the two *semilunar lobuli*. His description of different shapes of »*crista tonsillobiventerica*« corresponds to our description of different shapes of *jugum cerebellare intersemilunare*. 22 years after our publication about *jugum cerebellare intersemilunare*, Schafer<sup>15</sup>

describes this ridge as »*jugum cerebellare terminale*« which is in our opinion an inadequate name. This *jugum* is the part of the horizontal fissure of the cerebellum dividing the two *semilunar lobuli*. Our name »*jugum cerebellare intersemilunare*« corresponds exactly to the position of the ridge.

## Materials and methods

We examined skulls from 34 individuals (68 sides) from our collection of macerated disarticulated skull bones in the life period from the newborn to 30 years of age and 19 skulls (38 sides) of the skull bones in the life period from 31 to 80 years of age. To determine the intensity of development of *gyral* and of the *fissural* imprints we used the three degrees classification instead of four-degree classification used by Schwalbe and Lang<sup>1,2,3-5</sup> for the so called protuberances on the outer side of the skull bones. In our classification the degree I concerned the cases where the surface of the bone displayed only shallow deepenings surrounded by rounded scarcely visible ridges. The degree II concerned the cases with deepenings surrounded by ridges not exceeding 1 mm in height and the degree III the deepenings surrounded by sharp ridges of more than 1 millimeter in height. We measured also whenever it was possible the greatest depth of the *gyral* impressions between the two neighbouring *juga* on the cerebral lamina of the frontal bone, temporal squama and in the impression of the *lobulus semilunaris superior*. The depth was measured in the deepest place between the two ridges. We examined a special group of specimens what concerned the fossae *occipitales cerebellares*. Since the *juga cerebellaria* appeared only in the period from one and a half to ten years of age we examined 37 specimens belonging to this special group.

**Results**

The juga cerebralialia and cerebellaria and the impressiones gyrorum cerebri and cerebelli were examined in the anterior, middle and posterior cranial fossae. The juga cerebralialia and the impressiones gyrorum cerebri were found already in the newborn, in the cerebral lamina of the frontal bone (Figure 1), in the parietal bone, squama of the temporal bone, and cerebral fossae of the occipital bone. In this life period the development of juga was most intensive in the cerebral fossae of the occipital bone (Figure 2). The juga on the cerebral lamina of the frontal bone appeared much earlier than stated in the literature. The first appearance of the juga cerebralialia on the orbital part of the frontal bone occurs according to Schwalbe<sup>1,2</sup> at the end of the second year of age

simultaneously with the appearance of the juga in squama temporalis. In the the second year of age the juga appeared in the ala major of the sphenoid bone and squama of the frontal bone (Table 1). The appearance of the juga and their missing was related to the side of the examined bones (Table 2). The degree of development of the juga was also related to age (Table 3, Figure 3). If the juga were present in old age they displayed in general the degree I or II while the degree III was an exception.

The depth of the impressions in the anterior cranial fossa, i.e. in the cerebral lamina of the frontal bone, was in average 1.15 mm in cases of degree II and 1.47 mm of degree III. The depth of the impressiones gyrorum in the squama of the temporal bone was 1.0 mm in cases of de-

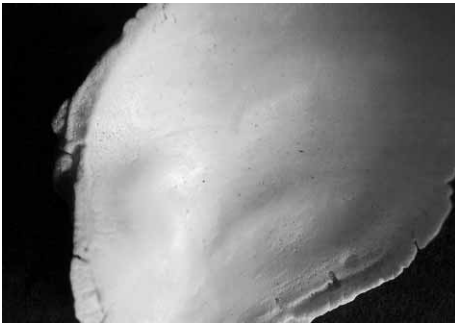


Fig. 1. Frontal bone of a 48 days old skulling. First appearance of juga cerebralialia.

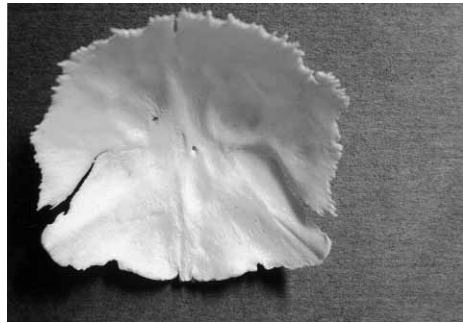


Fig. 2. Occipital bone of a newborn. First appearance of juga cerebralialia in the fossae occipitales cerebrales.

**TABLE 2**  
NUMBER OF SPECIMENS ACCORDING TO THE DEGREE OF DEVELOPMENT

Degree	Frontal bone		Temporal bone		Sphenoidal bone		Parietal bone		Occipital bone		Cerebellar fossa	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
I	16	10	15	17	10	10	7	6	16	19	26	25
II	13	20	10	5	9	8	0	1	14	15	–	–
III	27	12	27	31	8	7	2	2	14	16	32	31
Missing	5	8	8	7	33	35	0	0	16	10	2	4

**TABLE 3**  
DEGREE OF DEVELOPMENT RELATED TO AGE

Specimen (N)	Age (years)	Frontal bone				Temporal bone				Sphenoidal bone				Fossa cerebrealis			
		Degree				Degree				Degree				Degree			
		I	II	III	0	I	II	III	0	I	II	III	0	I	II	III	0
68	0–20	27	16	21	4	39	11	14	4	12	16	13	2	29	18	17	4
16	21–30	10	5	1	–	7	7	2	–	3	8	3	2	6	6	3	1
22	31–80	5	4	6	7	11	7	4	–	1	1	2	–	3	6	3	10

gree I, 1.56 mm of degree II and 2.15 mm of degree III.

The pattern of the ridges (juga) in the cerebellar fossae of the occipital bone were of different shape and appeared at different time (Figure 4 and 5). The jugum separating the impressions of lobuli semilunares, (jugum cerebellare intersemilunare) appeared in the middle of the first year of life, most frequently as a continuous ridge. From the middle of the second to the end of the 10<sup>th</sup> year of age, this ridge was accompanied by ridges corresponding to the sulci between the cerebellar gyri, as well as between the other lobuli of the cerebellum (i.e. between lobulus semilunaris inferior and lobulus gracilis and between lobulus gracilis and lobulus biventer, juga interlobularia). We called the ridges separating the cerebellar gyri juga cerebellaria. We found the impres-

sions of the cerebellar gyri in the group of 37 specimens in 12 specimens. Jugum ce-

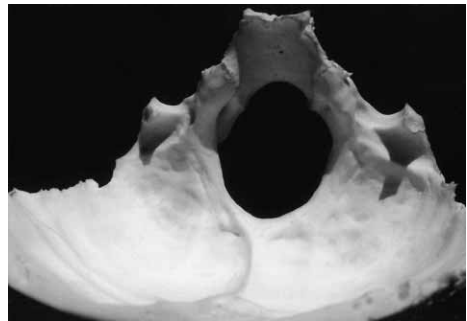


Fig. 4. Juga cerebellaria and impressiones gyrorum cerebelli in a 6 years old child.



Fig. 3. Complete disappearance of juga cerebellaria in a 56 years old male.

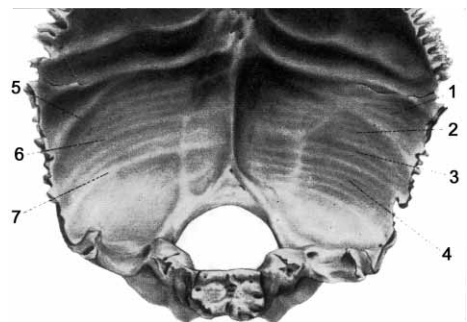


Fig. 5. Extremely good developed juga cerebellaria in 6 years old child. 1. impressio lobuli semilunaris superioris, 2. impressio lobuli semilunaris inferioris, 3. impressio lobuli gracilis, 4. impressio lobuli biventeris, 5. jugum cerebellare intersemilunare, 6. jugum between lobulus gracilis and lobulus biventer.

rebelle intersemilunare was developed completely or partially in 80% of cases and remained in complete length or interrupted in its course during the whole life. The depth of the impression of the lobulus semilunaris superior was 0,95 mm in degree I and 1,7 mm in degree II.

## Discussion

The juga cerebralia and impressiones gyrorum were examined on the bones of the anterior, middle and posterior cranial fossa. The time of appearance of juga in these regions for the lamina cerebralis of the of the frontal bone was different in comparison to the data in the literature. Other places where juga were found in the first year of life were the parietal bone, squama of the temporal bone and cerebral fossae of the occipital bone. The degree of development varied according to the investigated side (Table 2) as well as according to the age of the investigated specimens (Table 3). The degree of development was more intensive on the right

side of the frontal and on the left side of the temporal bone. The intensity of development increased to the third decade. After that age the intensity in development decreased gradually to disappear finally in some cases completely.

Juga cerebellaria and impressiones gyrorum cerebelli appeared in a strictly determined period from the middle of the second year to the end of the 10<sup>th</sup> year of age. This period coincided with the time of closure of the fissures among the constituent parts of the occipital bone and loss of compliance of the bone to the pressure of the growing brain<sup>16–18</sup>.

Jugum cerebellare intersemilunare separating the two semilunar lobuli appeared in the first year of life and persisted in it is segments or in its entire length during the whole life.

The existence of juga cerebralia and cerebellaria yields us the exact relation of the cerebral and cerebellar parts of the brain to the surrounding skull bones, and it can serve as the orientation in surgical interventions and radiological imaging.

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## **REDOSLIJED U POJAVLJIVANJU I NESTAJANJU IMPRESSIONES GYRORUM CEREBRI I CEREBELLI TIJEKOM ŽIVOTA**

### **S A Ž E T A K**

Ovim istraživanjem pokazali smo da je redoslijed, te izražajnost u pojavljivanju, te nestajanju udubina i brazda na kostima lubanje: impressiones gyrorum et juga cerebrialia, impressiones gyrorum cerebelli i juga cerebellaria i juga cerebellaris interlobularia povezana sa životnom dobi čovjeka. Uzorak je obuhvaćao 34 kosti lubanje od novorođenačke dobi do 30 godina starosti (68 uzoraka) i 19 lubanja u dobi od 30 do 80 godina starosti (38 uzoraka ili strana). Pokazali smo da su juga cerebrialia na ljusci sljepoočne kosti prisutna već u prvoj godini života, te joj se izražajnost povećava do 30 godine života. Porastom životne dobi ona potpuno nestaju u području parijetalne, okcipitalne, te cerebralne lamine frontalne kosti. Juga cerebellaria i impresije cerebelarnih vijuga pojavljuju se u drugoj godini života, te ostaju prisutne do 10 godine života. Jugum cerebellare intersemilunare pojavljuje se u prvoj godini života, te ostaje prisutan (u cijeloj svojoj dužini ili prekinutog toka u različitim dijelovima svoga puta) tijekom cijeloga života. Postojanje navedenih brazda i impresija ukazuje na povezanost pojedinih dijelova mozga s kostima lubanje što može poslužiti kao dobra orijentacija tijekom kirurških zahvata, te radioloških prikaza.