ANATOMO-MORPHOMETRIC STUDY OF THE ANTERIOR CEREBRAL COMMISSURE IN NON-NEUROLOGICAL ADULT BRAINS

Ioana-Maria Andrioaie[1], Irina Nedelcu[2*], G. Statescu[3], M.C. Moraru[3], Simona Alice Partene-Vicoleanu[3], D.A.Chiran[3], C.I. Stan[3], A.H. Nedelcu[3]

1. University of Medicine and Pharmacy "Gr. T. Popa" Iaşi, student
2. "Sf. Spiridon" Emergency County Hospital Iaşi
3. University of Medicine and Pharmacy "Gr. T. Popa" Iaşi, Department of Morpho-Functional Sciences I

ANATOMO-MORPHOMETRIC STUDY OF THE ANTERIOR CEREBRAL COMMISSURE IN NON-NEUROLOGICAL ADULT BRAINS (Abstract): The commissural pathways of the brain have represented a point of interest for anatomists beginning with the 19th century. However, only by mid 1950s Theodor W. Blackstad achieved the experimental analysis of their functional organisation. The canal of the anterior commissure and its lateral segment were mentioned beginning with the 18th century by Vicq D'Azyr, so that in 1983 Malcolm D. Carpenter would achieve the first anatomical description of the rostral commissure. The purpose of this study is to achieve a morphometrical analysis of the mediosagittal segment of the anterior cerebral commissure, constituting an important landmark in surgical interventions at the level of the anterior wall of the third cerebral ventricle. The anatomical material is represented by 20 adult brains in the collection of "Ion Iancu" Anatomy Institute of "Gr. T. Popa" University of Medicine and Pharmacy Iaşi. The anatomical pieces were preserved through immersion into a formaldehyde solution 10% for 6 months. The images were taken with the help of a Fujifilm FinePix S3200 camera, with a resolution of 10 megapixels and processed with the ArchiCAD software. Through the measurements taken regarding the maximum and the minimum diameter, as well as through the determination of the area of the mediosagittal section, our study represents a first basis in the carrying out of an anatomical norm regarding the anterior white commissure. **Key words:** ANTERIOR COMMISSURE, THIRD CEREBRAL VENTRICLE, VICQ D'AZYR CANAL, ROSTRAL COMMISSURE

INTRODUCTION

Amongst the ones who described the main interhemispheric commissures, one can count neuroanatomists Albert von Kölliker (1896), Santiago Ramón y Cajal (1893) and Rafael Lorente de Nó (1934). The organisation of the commissural connections was not, however, analysed from an experimental point of view until mid-1950s, when Theodor W. Blackstad, a Norwegian neurologist and a pioneer in quantitative neuroanatomy, proved a complex commissural system in rats, which made the connection between most of the fields of the two parts of the hippocampus. Beginning with the year when Blackstad published the discoveries, commissural formations, especially the ones of rodents, have constituted the subject of an intense study. The commissural connections of macac monkeys have also been studies beginning with 1984 by David Amaral, professor of Psychiatry at the University of California and researcher in the field of autism and neurological development disorders. Neuroresearcher Pierre Gloor carried out in 1993 post-mortem studies on human models and wrote down similarities of their structures with the ones discovered in the case of the monkey (1).

The anterior cerebral commissure, also named rostral commissure, was emphasized in the 18th century, at which moment Vicq D'Azyr carried out the first description of its lateral canal, so that Malcolm D. Carpenter in 1983 to detail its anatomical conformation (2). Psychiatrist and neurosurgeon Jean Talairach used as references

Fig. 1. The carrying out of a medio-sagittal section

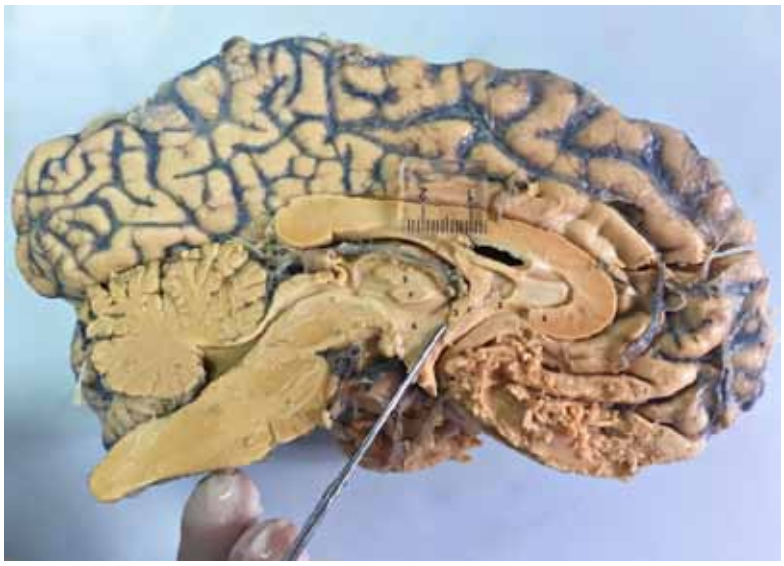

Fig. 2. Medio-sagittal section : 1.anterior white commissure ; 2-2' retro- and precomisural fibres of anterior crus of fornicis ; 3. lamina terminalis ; 4. rostrum of corpus callosum ; 5-5' thalamus and adhesio interthalamica ; 6. hypothalamus.

the anterior and the posterior cerebral commissures in order to carry out the spatial standardization of anatomical structures and their overlay with the functional ones. The coordinates system Talairach (1988) proved to be useful, especially in the case of neurosurgical interventions located paraventricularly (3).

Having an essential role in the generation of a complete sensory map of the surrounding world and facilitating the coordination of motor activities carried out simultaneously by the two parts of the body, by transmitting the acquired information between the two cerebral hemispheres, telencephalic commissures, particularly the anterior cerebral commissure, represent a subject of interest in the evolutional development of subcortical nervous structures (4,5).

The purpose of the study is to document the anatomo-macroscopic characteristics of the rostral commissure and to carry out a morphometric analysis of this structure. Through the measurements taken regarding the maximum and the minimum diameter, as well as through the determination of the area of the medio-sagittal section, our study represents a first basis in the carrying out of an anatomical norm regarding the anterior cerebral commissure.

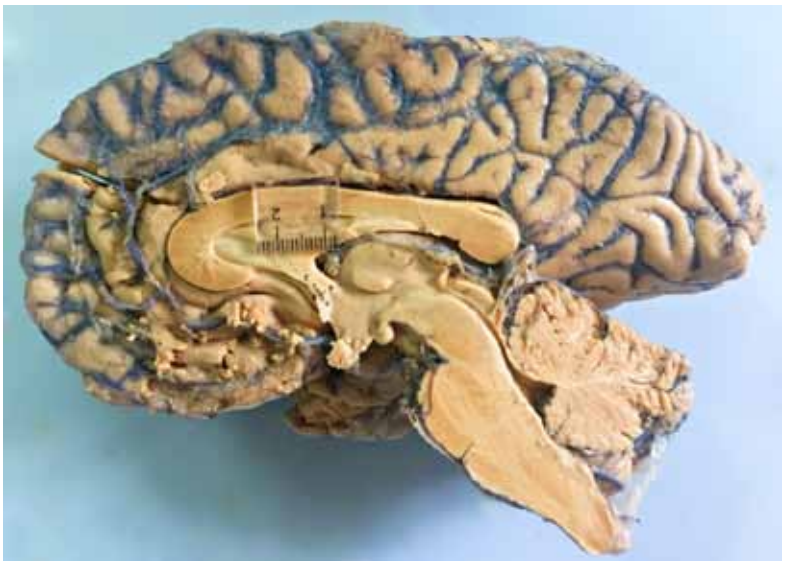

Fig. 3. Medio-sagittal section - cranio-caudal diameter (C-c) ; antero-posterior diameter (A-P)

MATERIAL AND METHOD

The anatomical material is represented by 20 adult brains in the collection of "Ion Iancu" Anatomy Institute of "Gr. T. Popa" University of Medicine and Pharmacy Iaşi. The brains were preserved through immersion into a formaldehyde solution 10% for 6 months. The anatomical pieces were processed by carrying out medio-sagittal sections (fig. 1), executed in a cranio-caudal direction through the interhemispheric fissure interesting the callosum between the Lancisi nerves and through the vertical arm of the cruciform canal of the tectal plate, technique used also for the study of the cerebral aqueduct and of the third ventricle. On the medio-sagittal section, the rostral commissure has an oval shape and has connections with the anterior pillars of the fornix, which divide into a precommissural contingent and a retrocommissural one (fig. 2).

The images were taken within the laboratories of "Ion Iancu" Anatomy Institute of "Gr. T Popa" University of Medicine and Pharmacy Iaşi using a Fujifilm FinePix S3200 camera, with a resolution of 10 megapixels. The processing of the images was carried out by reporting to a millimetre scale using ArchiCAD, software for outline, visualisation, measurement and storage developed by Graphisoft. Measurements of the maximum diameter corresponding to the large axis of the commissure with an oblique cranio-caudal tendency (written down by us C-c), as well as of the minimum diameters with an antero-posterior orientation (marked by us A-P) were carried out (fig. 3).

RESULTS AND DISCUSSIONS

The morphometric data obtained were transposed in the form of a table highlighting the antero-posterior (A-P) and cranio-caudal (C-c) diameters of the anterior white commissure for the 20 cases. We carried out, using the same software, the calculation of the area of the section, expressed in square millimeters (mm^2).

The variation intervals are between a minimum value of 1.30 mm in case no. 19 and a maximum value of 2.35 mm in case no. 16 for diameter A-P, respectively a minimum value of 2.55 mm in case no. 19 and a maximum value of 4.47 mm in case no. 16 for diameter C-c. The average value of the 20 anterior-posterior A-P diameters measured is of 1.88 mm, while the average value of vertical C-c diameters measured is of 3.49 mm. The analysis of the value highlights that the vertical diameter (C-c) of the rostral commissure is significantly higher than the antero-posterior one (A-P) in all cases, with the exception of cases 2, 4, 10 and 17 where the difference between the two axes is significantly lower, the antero-posterior diameter being approximately 65% of the vertical diameter (fig. 4). The particularity of case 10 is that the minimum diameter is approximately 77% of the maximum one, being the only case where the sizes of the two diameters are so close in value (the minimum diameter being of 2.15 mm and the maximum one of 2.76 mm).

TABLE 1
Antero-posterior (A-P) and cranio-caudal (C-c) diameters, as well as the area of the anterior white commissure

No. piece	A-P diameter (mm)	C-c diameter (mm)	Area (mm^2)
1	2.30	4.29	7.75
2	1.59	2.40	2.99
3	2.25	4.31	7.61
4	1.79	2.70	3.79
5	1.43	2.78	3.12
6	2.32	4.44	8.08
7	1.85	4.25	6.17
8	2.28	4.27	7.64
9	2.23	4.29	7.5
10	2.15	2.76	4.65
11	1.33	2.58	2.69
12	1.45	2.80	3.18
13	1.83	4.23	6.07
14	1.31	2.56	2.63
15	2.21	4.27	7.40
16	2.35	4.47	8.24
17	1.82	2.73	3.90
18	1.62	2.95	5.44
19	1.30	2.55	2.60
20	2.26	4.32	7.66

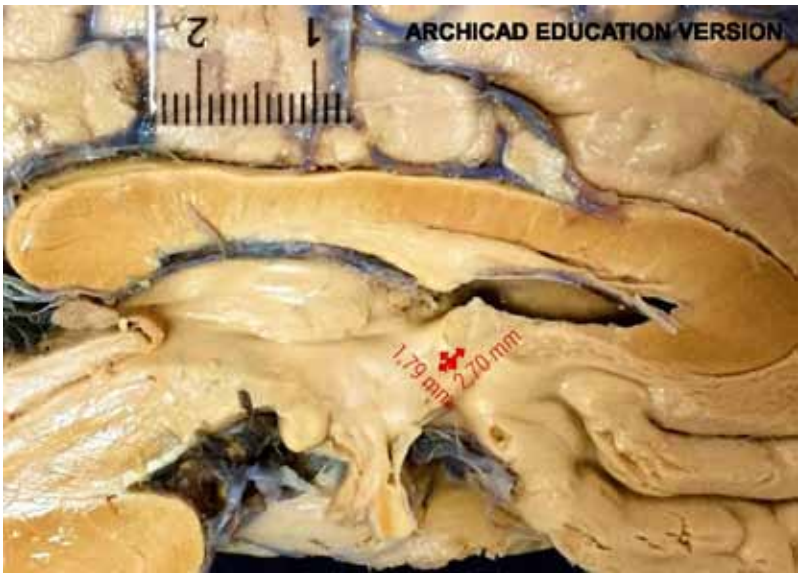

Fig. 4. Sample no. 4

The average A-P diameter is 53.8% of the average C-c diameter so we conclude that anterior cerebral commissure widens cranio-caudally.

In cases 7 and 13 studied, a major difference is noticed between the 2 distances (in both cases it being of 2.40 mm) and in cases 5, 9, 11, 12, 14, 15, 19 the minimum diameter is approximately half the maximum one. In case no. 19 we have the particularity of its sizes, being significantly inferior in comparison with the other anatomical parts, both regarding the antero-posterior diameter and the cranio-caudal one (1.30 mm, respectively 2.55 mm). The sample no. 16 stands out due to his significantly superior diameters in comparison with the other anatomical pieces, aspect noticed both in the sizes of the minimum diameter and of the maximum one (2.35 mm, respectively 4.47 mm).

Regarding the area of the medio-sagittal aspect of anterior cerebral commissure, it varies

Fig. 5. Sample no. 2

between a minimum value of 2.60 mm^2, in case of piece 19 and a maximum value of 8.24 mm^2, in case of piece 16. Thus, a major difference between the two anatomical pieces studied is found, a difference over three times higher. The average value of the 20 areas calculated is of 5.45 mm^2. Moreover, symmetry of the areas is noticed in comparison with the average mean, ten samples, meaning half of the ones studied, with a value above the average, and ten under average.

Therefore, the lowest values of the area of the rostral commissure are noticed in the cases of parts 14 and 19, and the highest values in cases 6 and 16. Sample no. 6 presents a value approximately equal to the maximum one, only 0.16 mm^2 lower, and case no. 1 presents a difference of only 0.49 mm^2, in comparison with maximal case no. 16. Samples 2, 11, 14, 19 (fig. 5) have an area lower than 3 mm^2, followed by sample number 5, which slightly exceeds the threshold of 3 mm^2, by only 0.12 mm^2. Regarding cases 1, 3, 8, 9, 15 and 20, these have an area higher than 7 mm^2, followed by cases number 7 and 13, whose areas are close to 6 mm^2. The values of the areas in the remaining cases are placed around the average mean, cases with particular sizes of the surface not being met.

Few ventricular structures like the pillars of fornix, anterior and posterior cerebral commissure, hypothalamic sulcus and interthalamic adhesion have landmark value for radiologists and neurosurgeons. The anterior commissure stands out because of his central position in the anterior wall of the third ventricle. His position, shape or dimensional alteration on CT or especially IRM could have a pathological significance due to a nearby tumor process or vascular malformation. Moreover, the anterior commissure is one of the first landmarks seen during the neuroendoscopy of the third ventricle, as the minimally invasive approach for paraventricular tumor and intraventricular cavernoma (2,6).

CONCLUSIONS

Our study constitutes an anatomo-macroscopic analysis of the anterior cerebral commissure, offering quantitative data regarding the maximum diameter, the minimum one, as well as the area of the medio-sagittal section, through the comparative examination of the anatomical pieces coming from the dissection of adult brains. This represents a first basis in the carrying out of an anatomical norm regarding the anterior cerebral commissure, taking into account its morphological variability. Moreover, we demonstrate that rostral commissure extends cranio-caudally with the antero-posterior diameter being about half of the cranio-caudal diameter for majority of the cases. By setting down certain concrete sizes of this anatomical structure, inflammatory or traumatic or tumor process can be revealed and localized with a higher degree of accuracy in the area of the anterior white commissure.

BIBLIOGRAFY

1. Mai JK, Paxinos G. *The Human Nervous System* (Third Edition). London, Waltham, San Diego : Elsevier, 2012.
2. Nedelcu AH, Tepordei R, Perianu Lacramioara, Moraru M, Mocanu Nicoleta Andreea, Taranu T. An original regionalization of the anterior cerebral comissure in adult brains. *Revista Romana de Anatomie functionala si clinica, macro- si microscopica si de antropologie*, 2014, 13(1) : 21-24 ISSN 1583-4026.
3. Laureys S, Gosseries O, Tononi G. *The Neurology of Consciousness* (Second Edition). London, Waltham, San Diego : Elsevier, 2016.
4. Ashwell KWS. Anterior commissure versus corpus callosum : A quantitative comparison across mammals. *Zoology* (Jena). 2016 Apr ; 119(2) : 126-136. doi : 10.1016/j.zool.2016.02.004. Epub 2016 Feb 24.
5. Lavrador JP, Ferreira V, Lourenço M, Alexandre I, Rocha M, Oliveira E, Kailaya-Vasan A, Neto L. White-matter commissures : a clinically focused anatomical review. *Surg Radiol Anat*. 2019 Jun ; 41(6) : 613-624. doi : 10.1007/s00276-019-02218-7. Epub 2019 May 22.
6. Nigri F, Viana JDS, Ferreira Pinto PHDC, Simões EL, Telles Ribeiro CR. Microsurgical treatment of intraventricular cavernoma with prior planning neuroendoscopy. *Case Rep Neurol*. 2018 Jan 16 ; 10(1) : 1-6. doi : 10.1159/000485374. eCollection 2018 Jan-Apr.

**** Corresponding author***

Irina Nedelcu
e-mail: arhire.irina@yahoo.com