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Original Article

The distance between the posterior communicating arteries and their relation to the endoscopic third ventriculostomy in adults: An anatomic study

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Abstract

Background: The diencephalic leaf of the Liliequist's membrane is a continuous structure that should be perforated in the endoscopic third ventriculostomy. Its lateral borders are penetrated by the third cranial nerve and the posterior communicating arteries. The most important complication of endoscopic third ventriculostomy is the vascular injury, such as the posterior communicating artery. The purpose of this study is to measure the distance between posterior communicating arteries located below the third ventricle floor and anterior of the mammillary bodies.

Methods: In this observational prospective study 20 fresh brains from cadavers were utilized to measure the distance between the posterior communicating arteries in April 2008 at the Death Check Unit of our Institution. A digital photograph of the posterior communicating arteries was taken and the distance between the arteries was measured. The measurement was analyzed using descriptive statistics.

Results: In the descriptive analysis of the 20 specimens, the posterior communicating arteries distance was 9 to 18.9 mm, a mean of 12.5 mm, median of 12.2 mm, standard deviation of 2.3 mm.

Conclusion: The detailed knowledge of vascular structures involved in the endoscopic third ventriculostomy as to the posterior communicating arteries distance provides a safe lateral vascular border when performing such procedure.

Key Words: Cerebral arteries, neuroanatomy, neuroendoscopy, posterior communicating artery, ventriculostomy

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INTRODUCTION

The modern technique of endoscopic third ventriculostomy (ETV) is based on the concept of establishing a channel for the cerebrospinal fluid through the third ventricle floor. The diencephalic leaf of Liliequist's membrane is a continuous structure that has to be perforated after the third ventricle floor fenestration in ETV. Brasil and Schneider,[2] Lü and Zhu[11,12] reported that the lateral border of Liliequist's membrane, was penetrated by the third cranial nerve and the posterior communicating arteries (PCoAs). There is no doubt that the most important complication of the ETV is the vascular injury, including damage to the basilar, posterior cerebral and PCoAs.[23] After an arterial injury, hemorrhage, vasospasm, pseudoaneurysm and late subarachnoid hemorrhage are documented. For this reason it is important to establish the safe lateral vascular border of Liliequist's membrane fenestration. The purpose of this study is to measure the distance between PCoAs, located below the third ventricle floor and anterior of the mammillary bodies.

MATERIALS AND METHODS

In this observational prospective study 20 fresh brains from cadavers were utilized, whose cause of death was assessed at the Death Check Unit (DCU) of our Institution. In April 2008 adult humans between 33 and 88 years, were included, the median age was 67. Twelve were male and eight female. The adult cadavers were randomly selected from those submitted to necropsy at the DCU for diagnoses of cause of death, cadavers where the cause of death was brain diseases, where excluded from the study. This study was approved by the Ethics Committee of our Institution. The research protocol number is 0363/07. Time of death and study varied between 8 to 25 hours. The skull cap was removed and the dura mater was incised. A transverse incision was made in the midbrain at the level of the tentorial notch. The brains were removed from the cranial cavities in one piece. The cerebral arteries were not filled with coloured latex. The PCoAs were exposed. A photograph of the distance between the PCoAs, anterior of the mammillary bodies was taken with a digital camera and a ruler was placed to provide a reference to the dimension [Figure 1]. Then in Geogebra open software 3.0.0.0 version (www.geogebra.org), a line was done connecting the medial borders of PCoAs that tangents the most anterior border of the mammillary body and then measured, having a ruler as reference dimension [Figure 2]. The measurement was analyzed through descriptive statistics calculating the mean, median, and standard deviation.

RESULTS

The results of each specimen studied are given [Table 1]. In the descriptive analysis of the 20 specimens, the PCoAs distance was 9 to 18.9 mm, mean of 12.5 mm, median of 12.2 mm, standard deviation of 2.3 mm.

DISCUSSION

We chose to do the measurement through digital photogrametry because of the contact with the instruments during the direct measurement of tissues that have soft tissue properties that could deform the surface and would lead to an inaccurate measurement.[20] In the digital photogrametry, it is not necessary to search the reference point before doing the photograph, as there is the possibility of conserving the material. This allows several measurements as many as are needed and it is possible to add new references in later measurements.[20]

Schroeder and other authors recommend that the perforation of the third ventricle floor should be done in the halfway between the infundibular recess and the mammillary bodies in the midline.[4,18,7,14] When the floor is firm, however, the instrument may slip from one side to the other and the correct fenestration site may be missed.[16] According to Massimi *et al* a thick ventricular floor represents an important risk factor to arterial damage.[13] The importance to reduce the risk

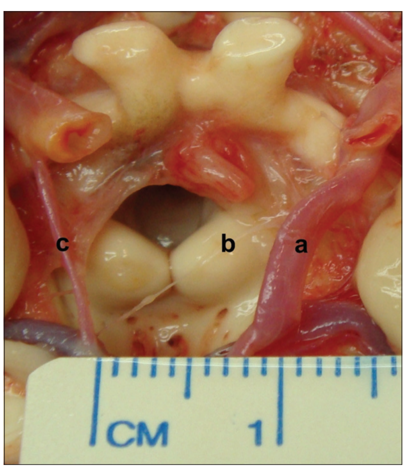

Figure 1: An overview of the third ventricle floor (ventral view) using a ruler as a reference measurement, identifying the left posterior communicating artery (a), mammillary body (b), and right posterior hypoplasic communicating artery (c)

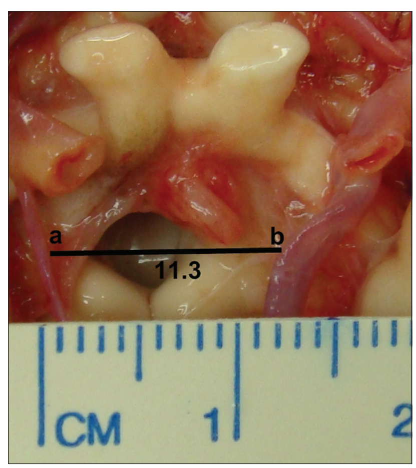

Figure 2: An overview of the third ventricle floor (ventral view) with a subsequent measurement performed between the posterior communicating arteries using Geogebra software (a-b = 11.3 mm), using as reference a measuring ruler

Table 1: Distance between the posterior communicating arteries in 20 specimens

Age (years)	Sex	PCoAs distance (mm)
69	F	11.8
80	M	10.1
74	F	10.1
80	M	12.3
44	F	15.1
55	M	18.9
88	F	14.2
86	M	11.3
66	M	9
65	M	12.1
62	M	10.4
71	F	13.2
41	M	11.9
72	F	12.6
86	M	10.3
33	M	11.6
68	F	12.6
51	M	13
46	M	16.6
63	F	14.2

F: Female, M: Male, PCoAs: posterior communicating arteries

of major vascular damage is emphasized by Kelly in a stereotactic angiographic target-point cross-correlation technique when performing the third ventriculostomy.[9] Even though arterial rupture in ETV is a rare complication, it is reported in about 1% of cases. This has a high level of morbidity and mortality.[13] Therefore, this vascular anatomic study is important because it gives us the tools that permit minimal risk to the patients. Figure 3 presents an endoscopic view of the third ventricle showing the anatomic landmarks to perform ETV.

The ETV is held mainly in the pediatric population, however it is not only in this age group. This research utilizes adult corpses with ages varying between 33 and 88 years. Buxton *et al* reports ages between 17 and 77 years in adult hydrocephalus submitted to the ETV.[3] Therefore, the measurement of the present research has its applicability in the adult age.

In the interpretation of the PCoAs distance results, we should consider a possible bias due to a *postmortem* changing of arterial diameter, since we did not used arterial injection and the arterial border was used as lateral measurement.

The posterior communicating artery originates from the dorsal aspect of the carotid siphon and follows posteromedial, inferior to the optic tract and the floor of the third ventricle and joins the posterior cerebral artery.[19] Its branches penetrate between the optic chiasm, and

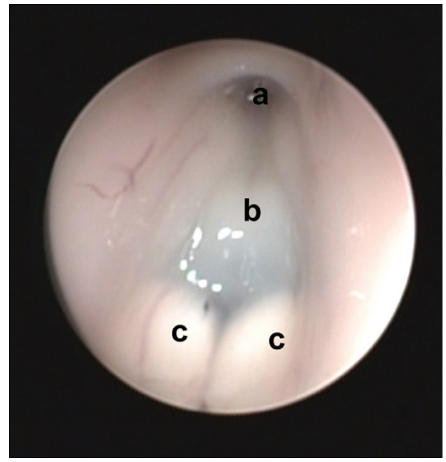

Figure 3: An endoscopic view of the third ventricle showing the landmarks to perform endoscopic third ventriculostomy, identifying infundibular recess (a), tuber cinereum (b), and mammillary bodies (c)

cerebral peduncle to reach the thalamus, hypothalamus, subthalamus, and internal capsule.[24] Bergland *et al* described the distance between the carotid siphons as 14 mm.[1] There is extensive literature on the posterior communicating artery and its diameter and length, but there are no reports measuring the distance between the PCoAs.[10,21,5,22,6,8,15,17] Knowing that the posterior communicating artery has its origin at the carotid siphon and follows posteromedial, it is possible to compare the distance between the carotid siphon 14 mm, reported in the literature, with an average distance between PCoAs of 12.5 mm, present in this research. We conclude that the value found was consistent with the available measurement used for comparison, because the posterior communicating artery is directed medially after its origin.

CONCLUSIONS

On completion of the ETV, not only the dimensions of the third ventricle are important, but also detailed knowledge of the vascular structures involved and also the distance between the PCoAs. This provides a maximum lateral vascular limit when performing the third ventriculostomy.

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