Streszczenie w języku angielskim

Tytuł w języku angielskim:

Morphometric analysis of the fluid spaces of the middle telencephalon in magnetic resonance images among pediatric patients.

Introduction

Intracranial fluid spaces are complex compartments containing cerebrospinal fluid and playing an important role in the pressure homeostasis of the cranial cavity. In daily clinical practice, attention is primarily directed to the ventricular system, the subarachnoid cisterns at the base of the brain, or the fluid reserves over the cerebral convexities. However, apart from these commonly discussed spaces, cavum of septum pellucidum (CSP) and the cavum Vergae (CV) must also be included in this group. These spaces are located along the midline of the brain, bounded superiorly by parts of the corpus callosum and inferiorly by the fornices, between which the leaflets of the septum pellucidum—forming the lateral walls of the cavities—are stretched. Ultrasonographic evaluation of the CSP is an important component in assessing fetal wellbeing during routine obstetric examinations of pregnant women. It is estimated that up to 100% of preterm neonates present with a CSP. With age, this percentage decreases due to the gradual "closure" of the cavity, which occurs within the first year of life, typically by 5–6 months. In the available literature, the CSP and CV are treated in most cases as anatomical variants, although their more frequent occurrence in individuals with certain psychiatric disorders, e.g., schizophrenia, is well known. The cavum of velum interpositum (CVI), occasionally referred to as the "cavum of the inserted lamina," exists in official neuroanatomical terminology as the cistern of the transverse fissure, classified among the supratentorial subarachnoid cisterns. It is a space located between separated layers of the tela choroidea and arachnoid mater forming the roof of the third ventricle. Enlargement of the CVI may be misinterpreted as a pineal cyst, an arachnoid cyst of the quadrigeminal cistern, or an extensive cavum Vergae. The assessment of these spaces, apart from their cognitive value and contribution to understanding morphometry of various brain regions, may be useful

when planning operative approaches to pathologies involving the third ventricle or the pineal gland. In surgery of this region, approaches using the microscope or endoscope remain standard. High caution and delicate dissection are required when using transcallosal, interforniceal, or transchoroidal approaches in order to maintain spatial orientation and minimize the risk of injuring the fornices or causing venous stroke by compromising the internal cerebral veins. Similarly, in sub- or transtentorial approaches to pineal lesions, one of the key pieces of information the surgeon must possess is the location of the internal cerebral veins relative to the pathology and the need to account for this during surgery.

Aim of the study

The aims of the study were:

1. To perform measurements of the cavum of septum pellucidum, cavum Vergae, and cavum of velum interpositum across different age groups.
2. To develop an original classification of the CSP applicable to all age groups.
3. To determine the relationship between different types of CSP and the presence of CV and CVI.
4. To determine the positions of surrounding structures—the fornices and the internal cerebral veins—in different age groups and relative to the CVI.
5. To assess the relationship between the size of the CSP and the width of the ventricular system and biparietal diameter.

Material and methods

A retrospective analysis was performed on magnetic resonance imaging studies from a cohort of 201 individuals selected from patients hospitalized at the Department of Neurosurgery, Prof. Dr. Jan Bogdanowicz Children's Hospital in Warsaw between January 2019 and December 2021. They were assigned to age groups of similar size: under 1 year, 1–2 years, 2–5 years, 5–12 years, and 12–18 years. MRI examinations were performed using a Philips Achieva 1.5T scanner according to the standard protocol. T2-weighted sequences in axial, coronal, and sagittal planes were used. Based on the developed study protocol, the material was independently analyzed by two

researchers. Image evaluation, measurements, and classification into appropriate categories were performed using RadiANT DICOM Viewer version 2023.1 (64-bit, Medixant, Poznań, Poland). The collected data were entered into a Microsoft Excel spreadsheet according to the measurement protocol and subsequently analyzed using appropriate statistical tools.

Results

Median CSP width ranged from 2.14 mm in the 5–12-year age group to 2.98 mm in infants under 1 year of age. Median CSP length ranged from 2.38 mm in the 1–2-year group to 3.17 mm in infants under 1 year. Overall, the most common CSP type according to the newly developed classification was type B1. This was also the most common configuration in each age group, except in infants under 1 year, where type A predominated. No cases classified as type C were found in the oldest age group. This distribution corresponded closely to the Nopoulos classification—type B1 represented a small CSP, whereas type C represented a large CSP.
For the CV, width was the measured parameter and ranged from 2.32 mm to 18.88 mm. Due to the small number of cases (10) identified across the cohort by both researchers, the author did not calculate means or medians but instead presented all measurements grouped by age. No cases of CV were found in the oldest age group. Analysis of the relationship between CSP type and CV presence revealed that all cases of CV occurred in the presence of type C CSP. Measurements of CVI height and length were performed. Median values ranged from 2.85 mm in the 5–12-year group to 4.57 mm in the 1–2-year group for height, and from 18.20 mm in the 5–12-year group to 20.82 mm in the 1–2-year group for length. No significant association was found between CSP type or CV presence and the presence of CVI.
An analysis of the distribution of internal cerebral veins and fornices across age groups was performed based on the Tsutsumi protocol. Inter-observer agreement was moderate. No statistically significant relationship was found between a specific forniceal configuration and CVI height. Measurements of ventricular width and biparietal diameter were performed; as expected, both dimensions increased with age. The strongest correlation was observed between CSP width and length, with a

correlation coefficient of Rho = 0.91, $p < 0.001$. Correlations between CSP dimensions and lateral ventricular width were weak—both CSP width and length showed very low correlation coefficients with ventricular width (Rho = 0.06 and Rho = 0.07, respectively). Similarly, the correlation between CSP width and biparietal diameter was negligible (Rho = 0.00). A moderate correlation was found between lateral ventricular width and biparietal diameter (Rho = 0.49, $p < 0.001$).

Conclusions and summary

1. The cavum of septum pellucidum is present in all pediatric age groups. A tendency toward decreasing size and reduced morphometric variability with age is observable. Changes in its width are associated with changes in its length.
2. The author's newly proposed CSP classification is reproducible and reliable. By using the relative position of the septal leaflets, it can be applied unchanged across age groups. Because it is based on axial imaging, it can be adapted for ultrasound assessment, which was not feasible with the Nopoulos classification.
3. The cavum Vergae shows a tendency to decrease in width with age in pediatric patients. No cases were observed in the oldest age group, and all identified cases were associated with type C CSP. Therefore, CV should be regarded as part of a continuum of CSP morphology, and the lack of a separate official neuroanatomical term is justified.
4. The cavum of velum interpositum is present across all pediatric age groups. It appears both in the absence of CSP or CV and in cases of fully developed CSP. In each CSP group, cases with CVI constituted the majority compared to those without CVI.
5. No significant correlations were found between CSP dimensions and ventricular width or biparietal diameter.
6. No significant pattern in the positioning of the internal cerebral veins or fornices was found across age groups. No significant variation in CVI height was observed depending on the forniceal configuration.