



## Clinical Study

## Choroid plexus of the fourth ventricle: Review and anatomic study highlighting anatomical variations



R. Shane Tubbs<sup>a</sup>, Mohammadali M. Shoja<sup>b</sup>, Anjali Aggarwal<sup>c</sup>, Tulika Gupta<sup>c</sup>, Marios Loukas<sup>d</sup>, Daisy Sahni<sup>c</sup>, Shaheryar F. Ansari<sup>e</sup>, Aaron A. Cohen-Gadol<sup>e,\*</sup>

<sup>a</sup>Seattle Science Foundation, Seattle, WA, USA

<sup>b</sup>Pediatric Neurosurgery, Children's of Alabama, Birmingham, AL, USA

<sup>c</sup>Department of Anatomy, Postgraduate Institute of Medical Education and Research, Chandigarh, India

<sup>d</sup>Department of Anatomical Sciences, St. George's University, Grenada

<sup>e</sup>Goodman Campbell Brain and Spine, Indiana University Department of Neurological Surgery, 355 W 16th Street, Suite 5100, Indianapolis, IN 46202, USA

## ARTICLE INFO

## Article history:

Received 15 September 2015

Accepted 10 October 2015

## Keywords:

Anatomy  
Cerebrospinal fluid  
Neuroimaging  
Neurosurgery  
Posterior cranial fossa

## ABSTRACT

Relatively few studies have been performed that analyze the morphology of the choroid plexus of the fourth ventricle. Due to the importance of this tissue as a landmark on imaging and during surgical intervention of the fourth ventricle, the authors performed a cadaveric study to better characterize this important structure. The choroid plexus of the fourth ventricle of 60 formalin fixed adult human brains was examined and measured. The horizontal distance from the midline to the lateral most point of the protruding tip of the horizontal limbs was measured. In the majority of the 60 brain specimens, right and left horizontal limbs of the choroid plexus were seen extending from the midline and protruding out of their respective lateral apertures of the fourth ventricle and into the subarachnoid space. However, on 3.3% of sides, there was absence of an extension into the foramen of Luschka and in one specimen, this lack of extension into the foramen of Luschka was bilateral. On two sides, there was discontinuity between the midline choroid plexus and the tuft of choroid just outside the foramen of Luschka. For specimens in which the choroid plexus did protrude through the foramen of Luschka (96.7%), these tufts were located anterior to the flocculus and inferolateral to the facial/vestibulocochlear nerve complex and posterolateral to the glossopharyngeal/vagal/accessory complex. A thorough understanding of the normal and variant anatomy of the fourth ventricular choroid plexus is necessary for those who operate in, or interpret imaging of, this region.

© 2015 Elsevier Ltd. All rights reserved.

### 1. Introduction

Surgically and pathologically, knowledge of the anatomy of the choroid plexus is important. This tissue is composed of two inverted, L-shaped, highly branching vascular tufts, which hang from the tela choroidea inferiorly and project into the cavity of the fourth ventricle where they are separated from the true cavity by the epithelial lining of the roof. Furthermore, the two ends of the plexus extend beyond the fourth ventricle into the cerebellopontine angle proximally and cerebellomedullary fissure distally. The three-dimensional anatomy and the relationships of this choroid plexus are complex owing to the intricate morphology of the fourth ventricle, cerebellomedullary fissure and cerebellopontine angle.

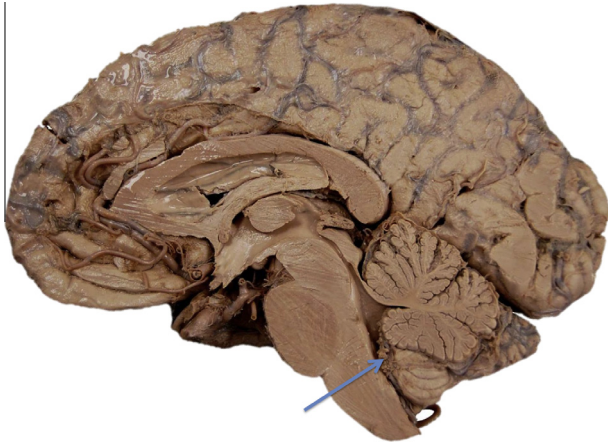
The choroid plexus of the fourth ventricle is a landmark structure during neurosurgical approaches and is sometimes seen on neuroimaging (Fig. 1–3). This tissue is used as a landmark structure during retrosigmoid approaches for auditory brainstem implantation [1]. However, few anatomical studies have been performed on this structure with almost none making comments regarding its anatomical variations. Therefore, the present review and anatomical study were conducted to better understand this structure of the fourth ventricle.

### 2. Material and methods

The choroid plexus of the fourth ventricle of 60 formalin fixed adult human brains was studied. The fourth ventricle was opened and the choroid plexus identified. The horizontal distance from the midline to the lateral most point of the protruding tip of the horizontal limbs was measured. To measure the length of lateral limbs,

\* Corresponding author. Tel.: +1 317 362 8760; fax: +1 317 924 8472.

E-mail address: [acohenmd@gmail.com](mailto:acohenmd@gmail.com) (A.A. Cohen-Gadol).



**Fig. 1.** Sagittal cadaveric view of the choroid plexus of the fourth ventricle (arrow). This figure is available in colour at <http://www.sciencedirect.com/>.

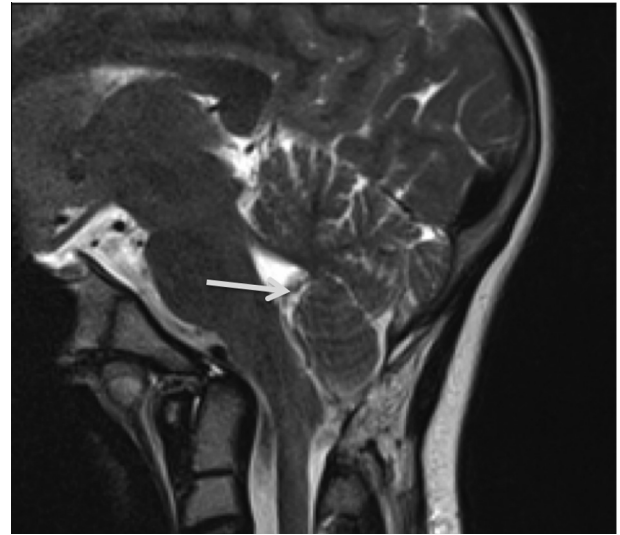
a thread was placed along the horizontal limbs. The junction of the vertical and horizontal limbs as well as the end of the horizontal limbs was marked on the thread. The length of this marked segment of thread was then measured. All measurements were performed with a digital caliper with a precision of 0.02 mm (Mitutoyo, Japan). Statistical analysis was made using Statistica for Windows (Microsoft, Redmond, WA, USA) with significance set at  $p < 0.05$ . Mean distances (range) are presented.

### 3. Results

In the majority of the 60 brain specimens, right and left horizontal limbs of the choroid plexus were seen extending from the midline and protruding out of their respective lateral apertures of the fourth ventricle and into the subarachnoid space (Fig. 4). The mean distance of the lateral most point of the protruding tip of right and left horizontal limbs from the midline was 18.15 mm (6.03–25.22 mm) and 7.96 mm (12.33–24.05 mm), respectively, with a combined mean of 18.36 mm (12.77–24.67 mm). Paired *t*-test showed no significant difference between right and left sides ( $p > 0.05$ ). After exposing the choroid plexus, the mean length of the right horizontal limb was 25.43 mm (18.36–32.34 mm). The average length of the left horizontal limb was 22.94 mm (18.46–28.70 mm). The mean length of the right limb was greater than the left limb. A paired *t*-test was applied. The length of the right



**Fig. 2.** T1-weighted unenhanced sagittal MRI illustrating the choroid plexus of the fourth ventricle (arrow).



**Fig. 3.** T2-weighted sagittal MRI illustrating the choroid plexus of the fourth ventricle (arrow).

and left horizontal limbs was found to differ significantly ( $p < 0.001$ ). On four sides (3.3%), there was absence of the extension into the foramen of Luschka (Fig. 5) and in one specimen, this lack of extension into the foramen of Luschka was bilateral (Fig. 6). On two sides (1.7%) we observed a disconnection between the medial and lateral extensions of the choroid plexus (Fig. 7). For choroid plexus that did protrude through the foramen of Luschka (96.7%), these tufts were located anterior to the flocculus and inferolateral to the facial/vestibulocochlear nerve complex and posterosuperior to the glossopharyngeal/vagal/accessory complex.

### 4. Discussion

#### 4.1. Embryology

During development of the fourth ventricle, a transverse fold, the plica choroidea, appears [18]. This structure begins in the midline and subsequent smaller folds grow from its edges. With continued growth of the hindbrain, the now choroid plexus, which begins in an extraventricular location, increases in width [2]. Interestingly, this extraventricular location may be maintained in the Chiari II malformation [3]. At the seventh week of development, alterations in the roof of the rhombencephalon are important in the development of cerebrospinal fluid containing chambers within the brain. During this time, the mesoderm dorsal to the rhombencephalon is vascularized, and this is followed by infolding of the choroid plexus of the future fourth ventricle and division of the roof of the rhombencephalon into cranial and caudal parts. The structure of the tela choroidea inferior is composed of a duplicated layer of pia mater brought together by opposition of the inferior surface of the cerebellum to the dorsal surface of the developing medulla oblongata. At stage 19, choroid villi are seen in the fourth ventricle, and a mesencephalic evagination is detectable [4].

#### 4.2. Histology

Histologically, the choroid plexus is a villous structure composed of highly branching tufts of blood vessels in a collagenous stroma covered by cuboidal or columnar epithelial cells overlying a basal lamina. The vascular tufts are thin-walled, large and fenestrated (sinusoid), and epithelial cells contain long bulbous microvilli on the luminal surface. The tela choroidea inferior is formed

Download English Version:

<https://daneshyari.com/en/article/3058290>

Download Persian Version:

<https://daneshyari.com/article/3058290>

[Daneshyari.com](https://daneshyari.com)