



## Neuroanatomical study

## An endoscopic, cadaveric analysis of the roof of the fourth ventricle

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## ABSTRACT

We performed endoscopic dissections of the roof of the fourth ventricle in eight fresh human cadaveric heads to characterize the endoscopic anatomy of the roof of the fourth ventricle and the anatomical configuration of the structures forming its roof. We also made three-dimensional (3D) silicone casts of the fourth ventricle in seven formalin-fixed specimens to evaluate the 3D configuration of the structures that create the roof of the fourth ventricle. The roof of the fourth ventricle can be divided into three zones. The upper zone is formed by the superior cerebellar peduncle and superior medullary velum and is associated with the lingula. The middle zone is formed by the inferior cerebellar peduncles and inferior medullary velum and is associated with the nodule in the midline and with the peduncle of the flocculus. The lower zone is formed by the tela choroidea and is associated with the tonsils. The 3D shape of the roof the fourth ventricle resembles that of a rhomboid-based pyramid; the edges of the base represent the borders of the ventricle, and the apex is the cerebellar fastigium. The lateral recess is shaped like a triangular-based pyramid, with its base connected to the cavity of the fourth ventricle and its tip opening into the lateral cerebellomedullary cistern through the foramen of Luschka. Our results may help in the endoscopic exploration of and microsurgical approaches to the fourth ventricle through its roof.

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## 1. Introduction

The anatomy of the roof of the fourth ventricle has been rarely, if ever, described in detail in the neurosurgical and anatomical literature, perhaps because the roof is a tenuous structure, easily ruptured in both operative neurosurgical approaches and anatomical dissections. Yet, the roof has become a popular avenue to reach the cavity of the fourth ventricle, as demonstrated by the telo-velar approach.<sup>1–9</sup> Endoscopic exploration of the fourth ventricle has also been reported.<sup>10–15</sup> Still, few studies describe the roof's anatomy from a microsurgical viewpoint,<sup>8,16</sup> and to our knowledge, no other study focuses on its endoscopic anatomy.

Therefore, we undertook this study to investigate the endoscopic anatomy of the fourth ventricular roof and to demonstrate and highlight the relationship between its different structures.

## 2. Methods and materials

In eight fresh cadaveric heads (five men, three women, aged from 62 years to 75 years) positioned prone on a table-mounted Spetzler headrest (V. Mueller, McGaw Park, IL, USA), we executed a standard suboccipital midline approach, and performed microdissection with the aid of a surgical microscope (Möller-Wedel,

Wedel, Germany), and introduced an endoscope (2.7-mm and 4-mm diameter rigid endoscope with 0° and 30° lenses; MINOP®; Aesculap, Tuttlingen, Germany) into the cavity of the fourth ventricle via the foramina of Magendie and Luschka (Fig. 1). Once inside the ventricle, the endoscope was turned toward the roof, and we studied and documented the anatomical features of the ventricular roof using imaging capture and recording.

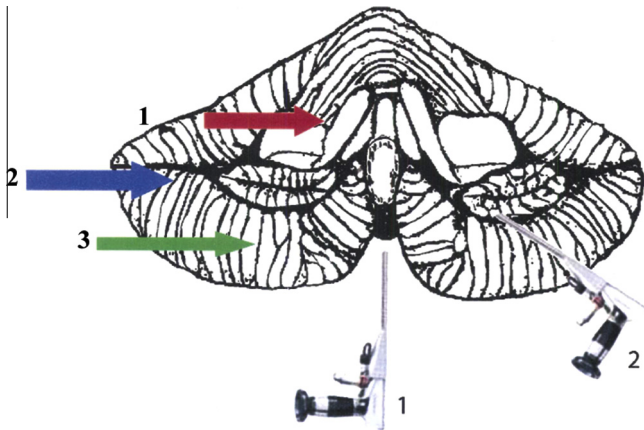
We made seven 3-dimensional (3D) silicone casts of the fourth ventricle by injecting colored silicone into the fourth ventricle cavity of seven formalin-fixed specimens using a quick-solidifying technique described by Kaya's group.<sup>17</sup> We studied the imprints of the anatomical structures and their geometrical configuration grossly and utilizing different magnifications of the surgical microscope.

## 3. Results

The roof of the fourth ventricle can be viewed as an anatomical complex with unique geometrical configuration. Its 3D appearance resembles a rhomboid-based pyramid, the edges of the base represent the borders of the ventricle, and the apex is the cerebellar fastigium. Overall, the roof consists of two symmetrical lateral portions formed by the superior and inferior peduncles (without participation of the middle cerebellar peduncles); these represent bilateral pillars for the midline portions (superior and inferior medullary vela and tela choroidea). Furthermore, the roof can be

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**Fig. 1.** The angles of endoscope insertion into the fourth ventricle. 1. Insertion through the foramen of Magendie. 2. Insertion through the foramen of Luschka. The arrows point to the approximate topographical location of the 3 zones of the roof of the fourth ventricle described in the manuscript. Number “1” = upper zone (red arrow); number “2” = middle zone (blue arrow), and number “3” = lower zone (green arrow). This figure is available in colour at [www.sciencedirect.com](http://www.sciencedirect.com).

divided into upper, middle, and inferior anatomical zones, each of which corresponds to a specific anatomical cerebellar structure

### 3.1. The upper zone

The upper zone corresponds to the lingula of the cerebellum. Here, the roof is formed laterally by the superior cerebellar

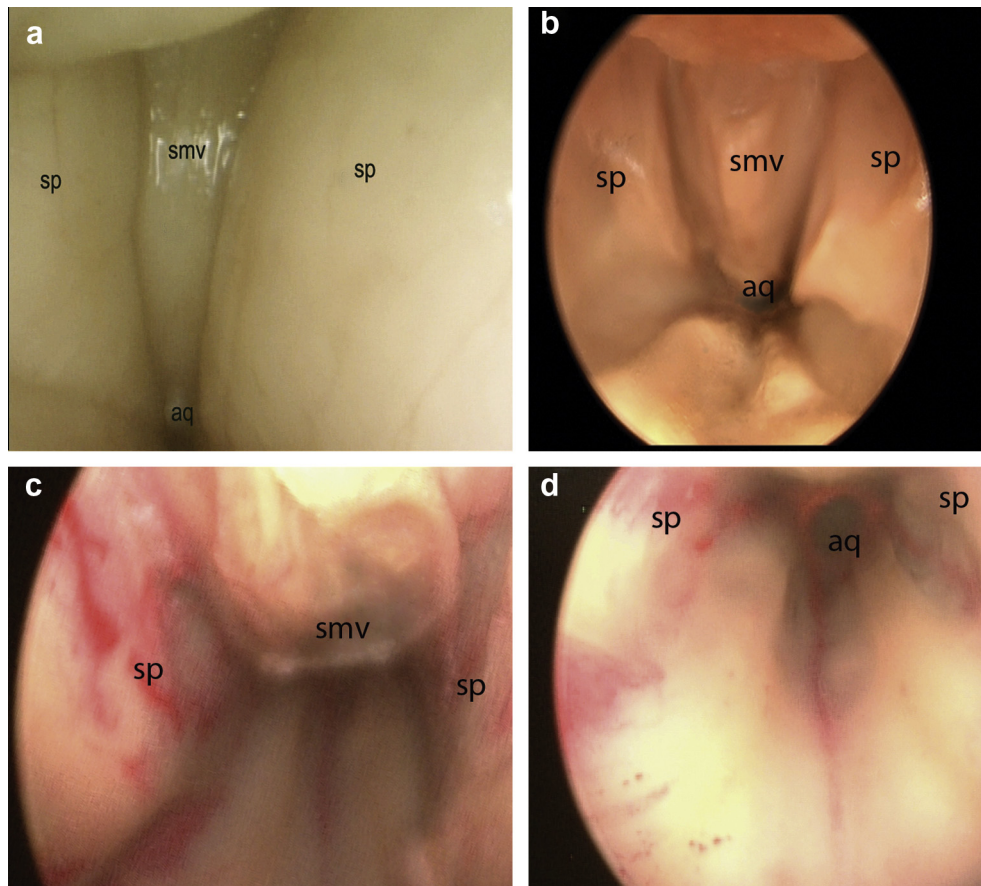
peduncles and in the middle by the superior medullary velum, which act as a bridge to connect these two structures (Fig. 2). However, in the uppermost point of the roof, the superior cerebellar peduncles converge in the midline.

### 3.2. The middle zone

The middle zone corresponds to the nodule in the midline and the peduncles of the flocculus laterally. The portion of the inferior cerebellar peduncles that reflect toward the hilum of the cerebellum forms the lateral portion of the roof, and the inferior medullary velum (attached to the medial border of the reflected portion of the inferior cerebellar peduncles) forms the middle portion of the roof (Fig. 3). The border between the upper and middle zones faces the other at an acute angle and corresponds to the cerebellar fastigium (Fig. 4).

### 3.3. The lower zone

The lower zone is associated with the tonsils. Here, the roof is formed by the tela choroidea. The tela attaches inferiorly to the medial margin of the inferior cerebellar peduncles through a thickened area of atrophic white matter (the tenia) and crosses the inferior cerebellar peduncles rostrally where they reflect at an obtuse angle to reach the cerebellum, thereby forming both the lateral and middle portions of the roof. The upper margin of the tela attaches to the inferior margin of the inferior medullary velum. Together with the inferior portion of the inferior medullary velum, the part of the tela that jets over the reflection of the inferior



**Fig. 2.** Endoscopic view of the upper zone of the roof of the fourth ventricle. (a) Zero-degree endoscopic view; endoscope inserted through the foramen of Luschka. (b) Zero-degree endoscopic view; endoscope inserted through the foramen of Magendie. (c) Thirty-degree endoscopic view; endoscope inserted through the foramen of Magendie. (d) Thirty-degree endoscopic view with focus on the cerebral aqueduct area; endoscope inserted through the foramen of Magendie. aq = cerebral aqueduct, smv = superior medullary velum, sp = superior cerebellar peduncle. This figure is available in colour at [www.sciencedirect.com](http://www.sciencedirect.com).

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