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Vascular

Superficial vascular anatomy of the medial prefrontal cortex: an anatomical study

Yusuf Izci, MD, Basheal Agrawal, MD, Özkan Ateş, MD, Mustafa K. Başkaya, MD*
Department of Neurological Surgery, University of Wisconsin-Madison, Madison, WI 53792, USA
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Abstract

Background: Superficial vascular anatomy of the medial prefrontal cortex, which is exposed after craniotomy for the anterior interhemispheric approach, has received little attention in the anatomy literature. This study focuses on the precise vascular anatomy of the medial part of the prefrontal cortex and provides more detailed information for surgery.

Methods: Five adult cadaveric heads were used in this study. After a bifrontal craniotomy, the dura was opened and the superficial vascular structures of the medial prefrontal cortex were exposed in 10 hemispheres. The CS was used as a landmark, and the location and the course of the medial cortical vessels were recorded. The variations were noted and photographed.

Results: There are 4 major superficial veins and 3 arteries on the medial prefrontal cortex, which are important during the surgery. Anterior frontal vein, MFV, PFV, and frontopolar veins drain the superficial part of the medial prefrontal cortex to the SSS. The frontomarginal artery and cortical branches of the frontopolar and callosomarginal arteries supply this region. One great BV on each hemisphere poses risk during the opening of the dura of the prefrontal cortex. All of the veins drain to the SSS.

Conclusions: The surface of the medial prefrontal cortex has a rich and complex vascular network and represents the first obstacle for surgery. The upper part of the medial prefrontal cortex seems safer than the lower part; the CS is a reliable and crucial landmark in planning and performing surgery in this region.

Keywords: Anterior cerebral artery; Frontal veins; Prefrontal cortex

1. Introduction

The prefrontal cortex is the anterior part of the frontal lobes of the brain. It includes the area lying in front of the motor cortex and includes the premotor areas. The prefrontal cortex is divided into the lateral, orbitofrontal, and medial prefrontal areas. The prefrontal cortex has been implicated in planning complex cognitive behaviors, expressing personality, and moderating correct social behavior.

Understanding the vascular anatomy of the frontal cortex is essential when performing an anterior interhemispheric approach. The anterior interhemispheric approach offers an excellent operative view for suprasellar, lateral and third ventricle lesions, and vascular lesions of the distal ACA and AComA [2,5-8]. This approach, however, is not without risks and requires good anatomical knowledge of the midline vascular structures. The midline vascular structures of the frontal cortex narrow the surgical corridor and place the frontal lobes at risk for either venous or arterial infarction [1,6]. Although it is known that brain

Abbreviations: ACA, anterior cerebral artery; AComA, anterior communicating artery; AFV, anterior frontal vein; AMF, anterior medial frontal; BV, bridging vein; CMA, callosomarginal artery; CS, coronal suture; FPA, frontopolar artery; FPV, frontopolar vein; IFA, internal frontal artery; IMF, intermediate medial frontal; MFV, middle frontal vein; PFV, posterior frontal vein; PMF, posterior medial frontal; SSS, superior sagittal sinus.

* Corresponding author. Tel.: +1 608 263 1410; fax: +1 608 263 1728.
E-mail address: m.baskaya@neurosurg.wisc.edu (M.K. Başkaya).

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retraction may lead to injury of cortical branches of the ACA, less attention has been paid to the influences of venous involvement [6,11,15]. For example, sacrifice of the frontal BVs for adequate exposure may aggravate brain injury due to retraction; cutting a frontal parasagittal BV leads to occlusion of the medial and lateral ascending draining veins straddling the superior portion of the hemisphere, resulting in venous hypertension of this spacious territory of the frontal lobe. The larger the sacrificed BV and the more extensive the draining territory of the occluded ascending draining veins, the higher the risk of postoperative venous infarction.

There are considerable variations in the size and connections of the arteries and veins of the superficial medial prefrontal cortex, making it difficult to define a normal pattern. The nomenclature used to describe the vessels has infrequently been applicable to an operation. The purpose of this study is to assist the surgeon by showing the superficial vascular anatomy of this region and to make morphometric measurements using a reliable landmark, the CS.

2. Materials and methods

Five adult cadaveric heads fixed in formalin and perfused with colored silicone rubber were used. Bifrontal craniotomy just in front of the CS was performed, and the orbital rim was removed to expose the frontal pole. The SSS was preserved and the dura was opened bilaterally. The arachnoid membrane, which covered the prefrontal cortex, was removed using the microscope and micro-surgical instruments to avoid any injury to underlying brain and vessels.

First, the sulcal and gyral pattern of each medial prefrontal cortex was examined in 10 hemispheres. In the next step, the arteries were identified and named. Then, the distance between the CS and the arteries on the midline were measured and recorded. In the third step, the superficial cortical veins were recognized, and the distances between the veins and the CS were measured. The course and the variation of each cortical draining vein was noted.

3. Results

3.1. Gyral and sulcal patterns

Four major gyri can be identified on the medial prefrontal cortex: superior frontal gyrus, and superior, middle, and inferior transverse frontopolar gyri. The superior frontal sulcus lies between the superior and middle frontal gyri. The transverse frontopolar gyri course horizontally from the superior frontal gyrus to the frontal pole in a serpentine fashion and terminate with the frontomarginal gyrus. The middle transverse frontal gyrus is more voluminous than the others but sometimes divided by a small sulcus (Fig. 1).

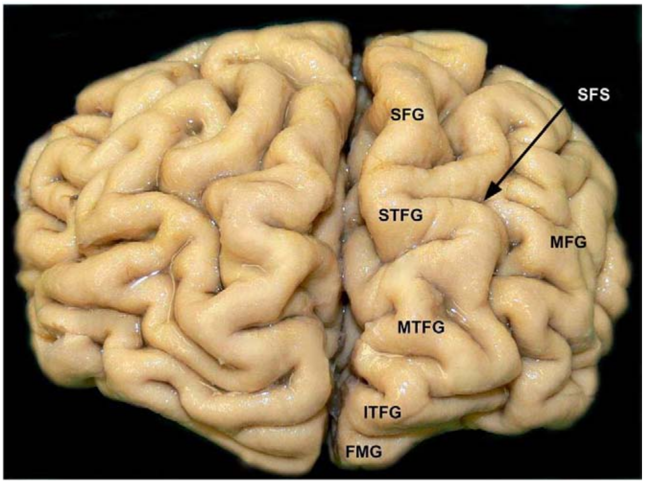

Fig. 1. Photograph showing the gyral and sulcal patterns of the medial prefrontal cortex. SFG indicates the superior frontal gyrus; STFG, superior transverse frontopolar gyrus; MTFG, middle transverse frontopolar gyrus; ITFG, inferior transverse frontopolar gyrus; FMG, frontomarginal gyrus; SFS, superior frontal sulcus; MFG, middle frontal gyrus.

3.2. Arterial and venous anatomy

The cortical arteries and veins were named on the basis of their locations and the territories they supply or drain. The cortical veins that were located on the medial prefrontal cortex were the FPV, AFV, MFV, and PFV consecutively from the frontal pole to the CS (Figs. 2 and 3). The arteries of this region were the FPA, AMF, IMF, and PMF branches of the CMA (Fig. 4).

Bridging veins also traversed the medial frontal cortex to drain into the SSS. Bridging veins were formed by 2 or more contributing veins that drained the lateral part of the frontal lobe. These veins were larger than the ascending frontal veins. There was usually one BV in each hemisphere, but in 40% of the specimens, there were 2 BVs in one hemisphere. In some specimens, the MFV was connected to the BV proximal to the SSS. The frontopolar vein existed in some, but not all, specimens.

The CS was considered as landmark for the medial prefrontal arteries and veins, and the distances were measured according to this suture. The mean distance between the CS and left BV was 62.5 mm (range, 50-75 mm) and between the CS and right BV was 70 mm (range, 65-75 mm). The left BV was closer to the CS than the right one. The mean distance between the CS and AFV was 82.7 mm (range, 70-90 mm); CS and MFV, 76.5 mm (65-88 mm); and CS and PFV, 65 mm (60-70 mm). The veins were closer to the CS on the left hemispheres than the right hemispheres.

There were usually 2 medial cortical branches of FPA in the frontal pole. We named these branches as superior and inferior cortical branches of FPA according to their locations. The mean distance between the CS and superior FPA was 92 mm, and the most distant artery from the suture was the inferior branch of the FPA with the mean distance of 107 mm.