Journal of Clinical Neuroscience xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Technical note

Anterior temporal artery to posterior cerebral artery bypass for revascularization of the posterior circulation: An anatomical study

Kaan Yağmurlu [a], M. Yashar S. Kalani [b], Feres Chaddad-Neto [c], Orhun Mete Cevik [d], Baran Bozkurt [a], Evgenii Belykh [a], Hugo Leonardo Doria-Netto [c], Andrew W. Grande [d], Mark C. Preul [a], Robert F. Spetzler [a,*]

[a] Department of Neurosurgery, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, Phoenix, AZ, United States
[b] Department of Neurosurgery, University of Utah School of Medicine, Salt Lake City, UT, United States
[c] Department of Neurosurgery, Federal University of São Paulo, São Paulo, Brazil
[d] Department of Neurosurgery, University of Minnesota, Minneapolis, MN, United States

ARTICLE INFO

Article history:
Received 20 June 2017
Accepted 11 October 2017
Available online xxxx

Keywords:
Anastomosis
Aneurysm
Anterior temporal artery
Donor vessels
Intracranial-to-intracranial bypass
Posterior cerebral artery
Revascularization

ABSTRACT

We describe a novel intracranial-to-intracranial bypass technique between the anterior temporal artery and the posterior cerebral artery for revascularization of the posterior circulation. Four formalin-fixed human heads were examined to demonstrate the detailed anatomy of the middle cerebral artery and the posterior cerebral artery, and to illustrate the step-by-step bypass procedure. The anterior temporal artery, a branch of the middle cerebral artery, can be anastomosed to the P2 segment of the posterior cerebral artery as an alternative to extracranial bypass donor segments for treatment of complex aneurysms requiring revascularization. The anastomosis of the anterior temporal artery as a pedicled donor to the posterior cerebral artery provides a shorter graft, due to its close anatomical position to the posterior cerebral artery, for posterior circulation revascularization.

1. Introduction

Bypass procedures in the posterior circulation are performed for steno-occlusive disease due to atherosclerosis or the presence of an unclippable aneurysm [1]. Recipient vessels in the posterior circulation include the posterior cerebral artery (PCA), the superior cerebellar artery (SCA), the anteroinferior cerebellar artery, the posteroinferior cerebellar artery (PICA), and the vertebral artery. The donor vessel can be extracranial, such as the superficial temporal artery (STA) or occipital artery (OA), or intracranial, such as the internal carotid artery (ICA), and they can be supplemented with interpositional grafts. Several anastomosis options are described, including the STA-to-SCA, OA-to-PICA, OA-to-PCA, and OA-to-SCA. The anterior temporal artery (ATA) can be sacrificed with little sequelae to the patient. The ability to sacrifice the ATA without sequelae, likely due to redundant blood flow, has resulted in its use as a bypass donor artery. The anastomosis of the ATA of the middle cerebral artery (MCA) to the second trunk of the MCA has been used by the senior author (R.F.S.) in cases of MCA aneurysms [2]. The ATA has been used for anastomosis to the anterior cerebral artery (ACA), MCA, and SCA without any significant ischemia in its territory [3–5]. In this report, we describe a novel bypass procedure between the ATA as a pedicled graft to the P2 segment of the PCA for revascularization of the posterior circulation.

2. Methods

Four formalin-fixed adult human heads were injected with colored silicone corresponding to the arterial and venous vasculature and examined under 6× to 40× magnification using a Zeiss surgical microscope (Carl Zeiss AG, Oberkochen, Germany). The typical anatomy of the MCA and PCA was demonstrated. The pterional transsylvian approach was performed to expose the ATA, the tip of the basilar artery, and the P1 and P2 segments of the PCAs.

Abbreviations: ACA, anterior cerebral artery; ATA, anterior temporal artery; EC-IC, extracranial-to-intracranial; ICA, internal carotid artery; IC-IC, intracranial-to-intracranial; MCA, middle cerebral artery; OA, occipital artery; PCA, posterior cerebral artery; PICA, posteroinferior cerebellar artery; SCA, superior cerebellar artery; STA, superficial temporal artery.

* Corresponding author at: c/o Neuroscience Publications, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, 350 W. Thomas Rd., Phoenix, AZ 85013, United States.

E-mail address: Neuropub@barrowneuro.org (R.F. Spetzler).

https://doi.org/10.1016/j.jocn.2017.10.047
0967-5868/© 2017 Elsevier Ltd. All rights reserved.

3. Results

The temporal lobe is supplied by the cortical branches of the MCA and PCA. The superior group of temporal arteries arises from the MCA, and the inferior group of temporal arteries arises from the PCA [6]. There are two different arteries called the ATA: the one originating from the posterior temporal artery, which occasionally reaches a portion of the temporal pole and the lateral cerebral surface in the region of the middle temporal sulcus and gyrus, and the one originating from the MCA, which we discuss here [6]. The ATA arises from the M1 segment (MCA sphenoidal segment) or from the proximal M2 segment (MCA insular segment) as a single branch or from the temporopolar branch as a trunk [7] (Fig. 1).

The PCA is divided into four segments, P1 through P4 [6] (Fig. 1). The P1 segment, called the *precommunicating segment,* extends from the basilar bifurcation to the level of the posterior communicating artery. The P2 segment begins at the posterior communicating artery and lies within the crural (P2A subdivision) and ambient (P2B subdivision) cisterns, to terminate laterally at the posterior edge of the midbrain. The P2A segment courses between the midbrain medially, the uncus laterally, and the optic tract and basal vein superiorly in the crural cistern. The P2B segment courses between the lateral midbrain medially, the parahippocampal and dentate gyri laterally, and the optic tract, basal vein, and geniculate bodies superiorly. The P3 segment courses within the quadrigeminal cistern and terminates at the beginning of the calcarine sulcus. Finally, the P4 segment is the cortical part of the PCA. The P2A is the best segment for bypass due to the ease of exposure of the crural cistern through the transsylvian route.

The classic pterional approach is performed to expose the sylvian fissure (Fig. 2). The sylvian fissure dissection exposes the origin of the ATA from the M1 segment or the proximal M2 segment of the MCA. At a deeper point, the ICA, posterior communicating artery, basilar tip, and PCA are exposed, and the PCA is followed distally to where it passes medially to the uncus. The ATA is followed up to the temporal cortex and cut as distal as possible. A temporary clip is placed proximally to control bleeding. Finally, temporary clips are placed at the P2 segment of the PCA, and an end-to-side anastomosis is performed.

4. Discussion

The details of the microsurgical anatomy and morphometric features of the ATA are reported elsewhere [6,8]. Hence, we focus on the detailed surgical technique of the ATA-to-PCA bypass procedure. In Tanriover et al.'s [8] study of 50 hemispheres, they identified 72 early branches of the M1 segment of the MCA. Of these 72 early branches, 22% (n = 16) were found to give off an early frontal branch and 78% (n = 56) were found to give off an early temporal branch. Forty-five hemispheres contained early temporal branches, of which 78% (n = 35) were found as a single trunk, 20% (n = 9) as two branches, and 2% (n = 1) as three branches. The ATA arose entirely from the early temporal branch in 30% (n = 34) of 112 early temporal branches in 50 hemispheres with 133 cortical arteries.

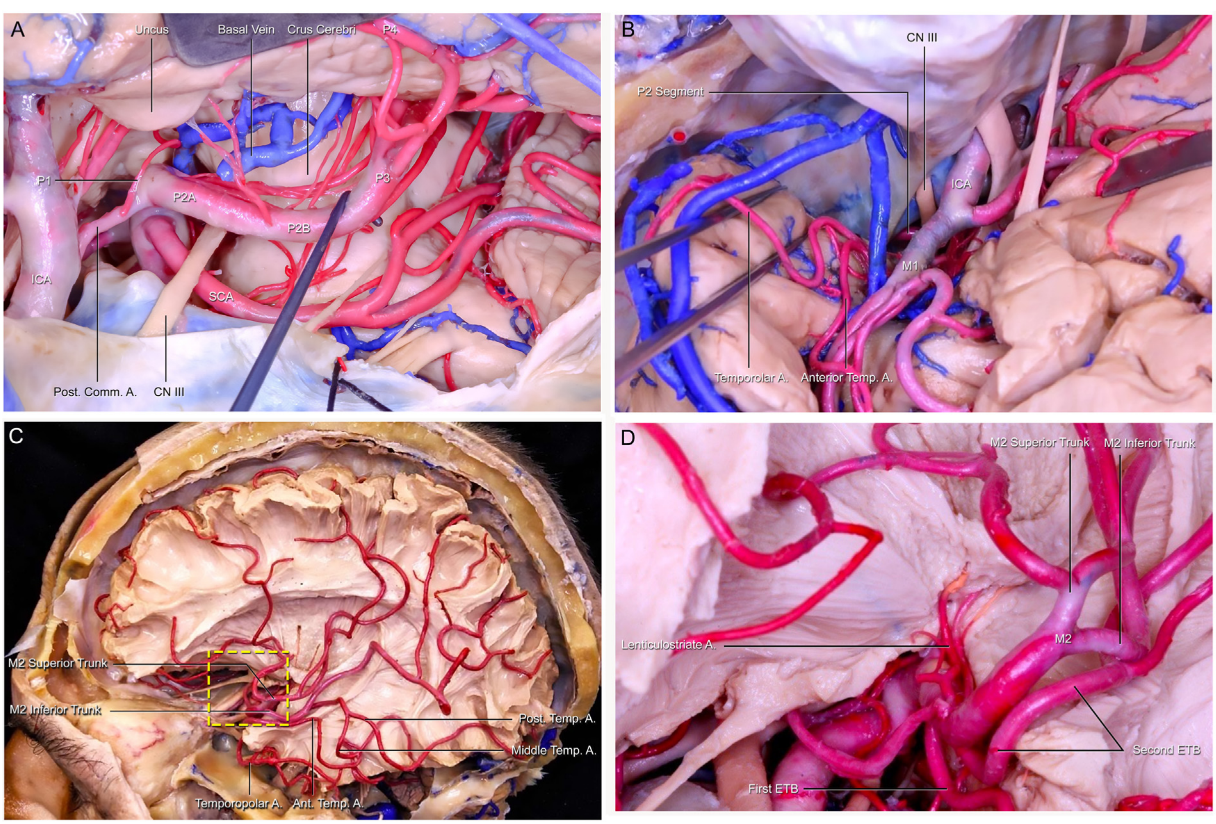

Fig. 1. Descriptive anatomy of the posterior cerebral artery (PCA) and the anterior temporal artery (ATA). (A) The segments of the PCA on the left side. In the crural cistern, the P2A segment courses between the uncus laterally, the crus cerebri medially, and the basal vein superiorly. (B) A left pterional transsylvian approach provides the exposure of the ATA and the P2 segment of the PCA. In this specimen, the temporopolar artery arises from the first early temporal branch (ETB) of the internal carotid artery, and the ATA arises from the second ETB to course parallel to the main trunk of the M1 segment of the MCA. (C and D) In another specimen, the temporopolar artery arises from the first ETB, whereas the anterior, middle, and posterior temporal arteries of the middle cerebral artery arise from a common trunk, the second ETB. Fig. 1D is an enlarged view of the outlined area (yellow dashed line) marked in Fig. 1C. *Abbreviations: A., artery; Ant., anterior; CN, cranial nerve; Comm., communicating; ICA, internal cerebral artery; M., segment of the middle cerebral artery; P., segment of the posterior cerebral artery; Post., posterior; SCA, superior cerebellar artery; Temp., temporal. These dissections were prepared by Kaan Yagmurlu, MD. Reproduced with permission from the Rhoton Collection. (*http://rhoton.ineurodb.org*), CC BY-NC-SA 4.0 (*http://creativecommons.org/licenses/by-nc-sa/4.0*).*

Please cite this article in press as: Yağmurlu K et al. Anterior temporal artery to posterior cerebral artery bypass for revascularization of the posterior circulation: An anatomical study. J Clin Neurosci (2017), https://doi.org/10.1016/j.jocn.2017.10.047