Variation of the Recurrent Artery of Heubner in Human Cadavers

Atthaporn Boongird MD*,
Pichayen Duangtongphon MD*

** Division of Neurosurgery, Department of Surgery, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand*

Study the normal anatomical and variation of the recurrent artery of Heubner (RAH) in fifty Thai cadaveric brains were studied under operating microscope. The anterior communicating artery (ACoA) located at the orbital surface of gyrus rectus about 50% and medial surface of gyrus rectus about 50%. The recurrent artery of Heubner originated from the anterior cerebral artery part 2(ACA2) 60.4%, junction of ACoA 31.9%, and anterior cerebral artery part 1(ACA1) 7.7%. Ninety-two percent of the origins of the RAH were identified within 2 mm from the proximal and distal of ACoA. The most common site of its origin from main artery was at its lateral surface 91.0%. The courses of RAH in relation to ACA1 segment were found anteriorly 63.4%, superiorly 29.9% and posteriorly 6.7%, respectively.

Keywords: *Anatomy, Anterior cerebral artery, Arteries, Cadaver*

J Med Assoc Thai 2009; 92 (5): 643-7
Full text. e-Journal: *http://www.mat.or.th/journal*

One of the most common cerebral aneurysms arising from anterior circulation is the anterior communicating artery (ACoA) aneurysm[1]. The recurrent artery of Heubner (RAH) is located closely to this ACoA. The RAH enters the anterior perforated substance and supplies caudate nucleus and anterior limb of internal capsule. Occlusion of this vessel from surgical clip or manipulation may cause hemiparesis with facial and brachial predominance and aphasia on the dominant hemisphere[5]. The variations of this RAH have been reported[2], however, the data in Thai population are not available. The present study aimed to demonstrate vascular anatomy of this RAH and its variation.

Material and Method

Fifty human cadaveric brains were collected with the following inclusion criteria; cadaveric age > 18 years, no gross brain pathology from routine brain autopsy at Ramathibodi Hospital. All the specimens were fixed in the formalin and examined under operating microscope. The dissection was started from internal carotid artery (ICA) bifurcation to ACA1, ACoA, ACA2, and RAH. The terminations in the anterior perforated substance were followed along the course of RAH. The vascular anatomy of the ACoA, RAH, and their variations were collected by drawings and digital photographs.

Correspondence to: Boongird A, Department of Surgery, Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand. E-mail: atthaporn_bg @yahoo.com

Results

Most of the ACoA were single type 41/50 (82%). The multiple ACoA were found in nine cases (18%), which included eight cases of double ACoA and one triple ACoA. The sites of ACoA were identified at the orbital surface of gyrus rectus in about 50% and medial surface of gyrus rectus (within interhemispheric fissure) in about 50% (Table 1). The mean distances from ICA bifurcation to ACoA in the multiple type of ACoA were slightly longer than the single type of ACoA (Table 2).

One hundred and one RAHs were identified in 100 hemispheres. The origins of these vessels were

Table 1. Variations of the ACoAs and their locations

Type	Number of specimens, vessels	Orbital surface of gyrus rectus	Medial surface of gyrus rectus
Single ACoA	41 (82%), 41 vessels	19	22
Multiple ACoAs	9 (18%), 21 vessels	12	9
Total	50 (100%), 62 vessels	31 (50%)	31 (50%)

Table 2. Variations of the distance from ICA bifurcation to ACoA in each type

	Distance from ICA bifurcation to ACoA (cm)		
Type	Orbital surface	Medial surface	Mean (cm)
Single ACoA (Right/Left)	1.60/1.56	1.66/1.60	1.61
Multiple ACoAs (Right/Left)	1.76/1.82	1.74/1.82	1.78

Table 3. Origins of RAH from their parent vessels

Parent artery	Anterior surface	Lateral surface	Posterior surface	Total
ACA 1	0	8 (7.9%)	0	8 (7.9%)
ACA1/ACA2 junction	0	30 (29.7%)	2 (2.0%)	32 (31.7%)
ACA 2	2 (2.0%)	54 (53.5%)	5 (4.9%)	61 (60.4%)
Total	2 (2.0%)	92 (91.1%)	7 (6.9%)	101 (100%)

found arising from ACA 1 7.9%, ACA1/ACA2 junction 31.9%, and ACA2 60.2%. Origins from parent arteries were at the lateral surface 91.0%, posterior surface 6.9% and anterior surface 2.0% (Fig. 1, Table 3). The symmetrical origin of bilateral RAHs was found in only 50% of the cases.

Eight specimens, which RAHs originated from ACA1, were found within 2 mm from ACoA. In ACA2 parent artery, RAHs can be identified within 2 mm distal from ACoA in 52 specimens, 3 mm distal from ACoA in 6 specimens and 4 mm from ACoA in three specimens. In summary, 91.1% of RAHs (92 of 101) can be found within 2 mm from proximal and distal ACoA (Table 4).

After originating from its parent artery, most of RAH ran parallel to ACA1 segment. The present study found that 63.4% of RAHs ran anteriorly to ACA1 (space between ACA1 and optic nerve), 29.9% superiorly to ACA1 (space between ACA1 and frontal base), and only 6.7% posteriorly to ACA1 (space between ACA1 and optic tract). The common course of RAHs can be demonstrated along orbital surface of gyrus rectus to medial olfactory striae, then run parallel to ACA1 segment and terminated into medial and lateral parts of anterior perforated substance. The recurrent artery may enter the anterior perforated substance as a single stem or divide into many branches. The medial and lateral parts of

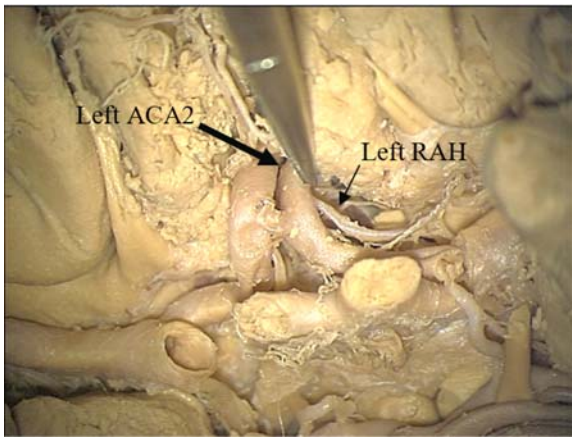

Fig. 1 The origin of left RAH arising from lateral surface of left ACA2

Table 4. Distances of the origins of RAH from ACoA

	Distance of the origin of RAH from ACoA			
Parent artery	1 mm	2 mm	3 mm	4 mm
ACA 1	6	2	0	0
ACA 2	24	28	6	3
Total	30	30	6	3

Table 5. Other variations of the ACA1, ACoA and RAH

Variations	Number
Hypoplastic ACA 1	4
Double ACA 1	3
Triple ACoA	1
Double ACoA	6
Absence of Heubner artery	3
Double Heubner artery	2
Triple Heubner artery	1

anterior perforated substance were divided by the imaginary antero-posterior line from the olfactory tract[3]. The terminations of RAHs located at medial part of anterior perforated substances in 53.3% of the cases and lateral side of anterior perforated substance in 96.2% of the cases. The terminations at the medial or lateral orbital gyrus can be found in only 4.7% of the cases. Other variations around ACoA are shown in Table 5.

Discussion

About one quarter to one third of all treated cerebral aneurysms located at ACoA area[1,14]. Knowing the vascular anatomy and its variation is very important for the neurosurgeons, and neurointerventionists. This present study revealed the similar variations of ACoA that had been examined in 62 Thai cadavers by Sreeasai et al.,1985[4]. They found 67.8% of the cases had a single ACoA, 27.4% of the cases had double ACoA, and 1.6% of the cases had triple ACoA. Additionally, the authors found that either single ACoA or multiple ACoAs located at orbital surface of gyrus rectus 50% and medial surface of gyrus rectus 50%. Two basic approaches to this ACoA are pterional and interhemispheric approach[5]. The interhemispheric approach is preferable if the ACoA is located at the medial surface of gyrus rectus because the gyrus rectus may obscure the aneurysm and ACoA from pterional view. Resection of posterior gyrus rectus, excessive frontal lobe retraction and olfactory bulb injury can be avoided if the suitable approach is chosen based on pre operative anatomical data and characteristic of aneurysm.

RAH was first described by Heubner in 1874. The RAH supplies the anterior part of the caudate nucleus, anterior third of the putamen, anterior part of the outer segment of the globus pallidus, anteroinferior of the anterior limb of the internal capsule, and the uncinate fasciculus[6]. Injury or occlusion of the RAH causes significant hemiparesis predominantly on facial and brachial area and aphasia if injury occurs on the dominant hemisphere[3]. Understanding the anatomy and its variation around the ACoA area is essential for safe and effective dissection of aneurysm. Perlmutter and Rhoton, 1976 found that RAH originated from proximal ACA 2 about 78%. Ninety-five percent of the RAHs can be identified within 4 mm proximal or distal from ACoA[7]. Gomes et al.,1984 reported in 30 unfixed brains that 57% of RAHs originated from ACA2, 35% from the junction of the ACA1/ACA2, and 8% from the ACA1[8]. The observation data from 48 cases of anterior communicating artery aneurysms were described by Aydin et al,1994[9]. They reported that most of the RAHs originated from the junction of ACA1/ACA2 about 58%, ACA2 segment about 23%. These findings were similar to the Loukas M series that 62.3% originated from the junction of ACA1/ACA2 and 23.3% from proximal ACA2[10].

According to the presented study, the ACA 2 was the most common location of the RAH's origin and the junction of ACA1/ACA2 was the second most common site. Ninety-one percent of RAHs were demonstrated within 2 mm from proximal or distal ACoA. Although lateral projection from the parent artery was very common, the posterior projection can be missed and easily injured during the temporary clipping. Furthermore, this posterior projection vessel may run posterior to the ACA1 in contrast to the more common RAH course, which ran inferior or superior to ACA1. The authors recommended gently dissection on the posterior surface of parent vessel if the common path was not seen (Fig. 2). About 30% of RAHs originated at the junction of ACA1/ACA2 or ACoA area. This RAH may adhere to the wall of anterior communicating artery aneurysm. The clipping without dissection of this vessel can cause significant hemiparesis. Resection of posterior part of gyrus rectus was occasionally done during exposure to this complex aneurysm, this RAH courses were close to this area and can be easily

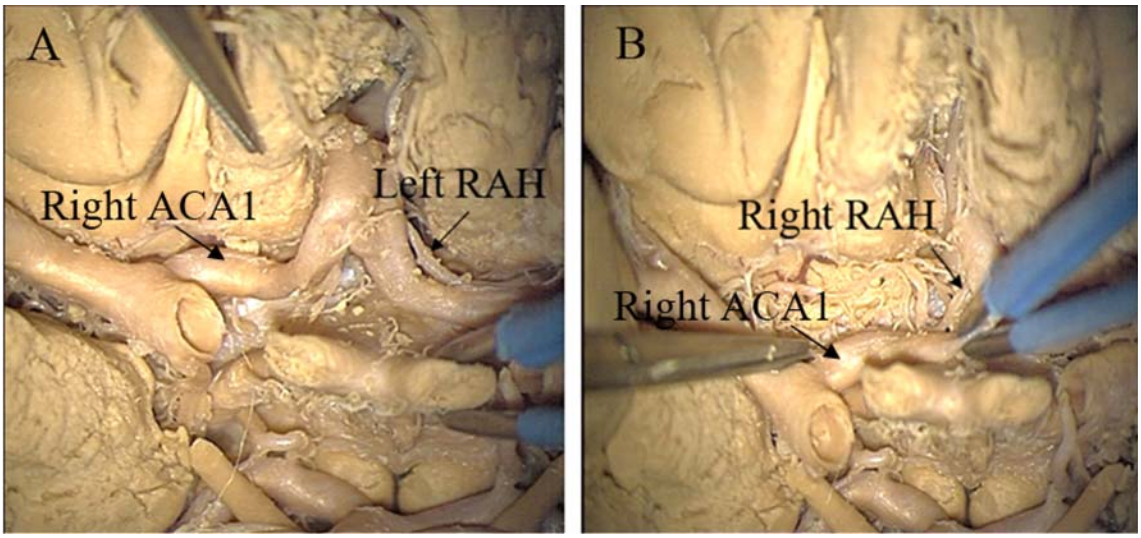

Fig. 2 demonstrated left RAH, but right RAH was not visible.(A) On the same specimen, the right RAH can be seen after transposition of right ACA1 (B).

injured. The absence of this RAH was very rare[2]. These reasons underscore the importance of identifying this RAH before temporary clipping of the parent artery or clipping ACoA aneurysm. Currently, the RAHs can be occasionally demonstrated pre-operatively by CT angiography[11]. The orbitofrontal artery and the frontopolar artery were also originated from ACA2 but their terminations were different from RAH. The orbitofrontal, the smallest branch, courses to the gyrus rectus, olfactory tract, and olfactory bulb. The frontopolar branch terminates at medial subfrontal regions[12]. Injury to these two vessels were not serious as much as the RAH.

Like other series, double ACoA and hypoplastic ACA1 were commonly found. Other basal perforating branches from ACA1, ACoA except from RAH innervated optic chiasm, hypothalamus, and anterior third ventricle area[13]. Injury to the hypothalamic branch can cause disordered mentation, hypokinesis without paralysis[7].

In conclusion, the RAH should be routinely identified before temporary clipping the parent artery and during clipping ACoA aneurysm to prevent post operative neurological deficit. The majority of the RAH can be identified within 2 mm from proximal or distal ACoA. Ninety-one percent originated from lateral surface of parent artery. Atypical posterior course of this vessel should be recognized if the common path was not seen.

References

1. Yasargil MG. Microneurosurgery. Vol. II. Clinical considerations, surgery of the intracranial aneurysms and results. New York: Thieme; 1984: 1-32.
2. Yasargil MG. Microneurosurgery. Vol. II. Clinical considerations, surgery of the intracranial aneurysms and results. New York: Thieme; 1984: 178.
3. Rosner SS, Rhoton AL Jr, Ono M, Barry M. Microsurgical anatomy of the anterior perforating arteries. J Neurosurg 1984; 61: 468-85.
4. Sreesai M, Kaweewongprasert S, Chentanez V. A study of the circle of Willis in 62 cadavers. Chula Med J 1985; 29: 213-25.
5. Diraz A, Kobayashi S, Toriyama T, Ohsawa M, Hokama M, Kitazama K. Surgical approaches to the anterior communicating artery aneurysm and their results. Neurol Res 1993; 15: 273-80.
6. Rhoton AL Jr. The supratentorial arteries. Neurosurgery 2002; 51 (4 Suppl): S53-120.
7. Perlmutter D, Rhoton AL Jr. Microsurgical anatomy of the anterior cerebral-anterior communicating-recurrent artery complex. J Neurosurg 1976; 45: 259-72.
8. Gomes F, Dujovny M, Umansky F, Ausman JI, Diaz FG, Ray WJ, et al. Microsurgical anatomy of the recurrent artery of Heubner. J Neurosurg 1984; 60: 130-9.

9. Aydin IH, Onder A, Takci E, Kadioglu HH, Kayaoglu CR, Tuzun Y. Heubner's artery variations in anterior communicating artery aneurysms. Acta Neurochir (Wien) 1994; 127: 17-20.
10. Loukas M, Louis RG Jr, Childs RS. Anatomical examination of the recurrent artery of Heubner. Clin Anat 2006; 19: 25-31.
11. Villablanca JP, Rodriguez FJ, Stockman T, Dahliwal S, Omura M, Hazany S, et al. MDCT angiography for detection and quantification of small intracranial arteries: comparison with conventional catheter angiography. AJR Am J Roentgenol 2007; 188: 593-602.
12. Avci E, Fossett D, Aslan M, Attar A, Egemen N. Branches of the anterior cerebral artery near the anterior communicating artery complex: an anatomic study and surgical perspective. Neurol Med Chir (Tokyo) 2003; 43: 329-33.
13. Rhoton AL Jr, Perlmutter D. Microsurgical anatomy of anterior communicating artery aneurysms. Neurol Res 1980; 2: 217-51.
14. Molyneux A, Kerr R, Stratton I, Sandercock P, Clarke M, Shrimpton J, et al. International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomized trial. J Stroke Cerebrovasc Dis 2002; 11: 304-14.

การศึกษาลักษณะทางกายวิภาคศาสตร์และความผันแปรของหลอดเลือดสมอง recurrent artery of Heubner

อัตถพร บุญเกิด, พิชเยนทร์ ดวงทองพล

การศึกษาลักษณะกายวิภาคศาสตร์ของหลอดเลือดสมอง recurrent artery of Heubner ในการตรวจชันสูตรสมองจำนวน 50 ราย พบว่า หลอดเลือดสมอง anterior communicating artery อยู่ที่บริเวณ orbital surface ของ gyrus rectus ร้อยละ 50 และที่ medial surface ของ gyrus rectus อีก ร้อยละ 50 หลอดเลือดสมอง recurrent artery of Heubner มีต้นกำเนิดมาจากหลอดเลือด anterior cerebral artery part 2 (ACA2) ร้อยละ 60.4, จากรอยต่อหลอดเลือด anterior communicating artery กับหลอดเลือด anterior cerebral artery ร้อยละ 31.9 และหลอดเลือด anterior cerebral artery part 1(ACA1) ร้อยละ 7.7 ทั้งนี้ ร้อยละ 91.0 ของหลอดเลือด recurrent artery of Heubner ออกทางด้านข้างของหลอดเลือดสมองต้นกำเนิด นอกจากนี้ยังพบว่า ร้อยละ 92 ของหลอดเลือด recurrent artery of Heubner นี้สามารถตรวจพบได้ภายใน 2 มิลลิเมตร จากหลอดเลือด anterior communicating artery และแนวการวิ่งของหลอดเลือด recurrent artery of Heubner จะอยู่หน้าต่อหลอดเลือด anterior cerebral artery part 1 (ACA1) ประมาณร้อยละ 63.4, อยู่บนหลอดเลือด anterior cerebral artery part 1 (ACA1) ประมาณร้อยละ 29.9 และส่วนน้อยร้อยละ 6.7 ที่พบอยู่ด้านหลังต่อหลอดเลือด anterior cerebral artery part 1 (ACA1) การทราบกายวิภาคศาสตร์ และความผันแปรของเส้นทางของหลอดเลือดช่วยทำให้การทำผ่าตัดบริเวณนี้ปลอดภัยยิ่งขึ้น