Acta Neurochir (Wien) (1994) 127: 17–20

Acta Neurochirurgica

Heubner's Artery Variations in Anterior Communicating Artery Aneurysms

I. H. Aydin, A. Önder, E. Takçi, H. H. Kadioğlu, Ç. R. Kayaoğlu, and **Y. Tüzün**

Neurosurgical Department, Atatürk University Medical School, Erzurum, Türkiye

Summary

This study attempts to analyse the intra-operative anatomical findings of the recurrent artery of Heubner in 48 patients with Anterior Communicating Artery Aneurysm who were operated on at the Neurosurgical Department of Atatürk University Medical School, Erzurum, Türkiye. All patients underwent radical surgery for aneurysm by the right pterional approach. The findings were recorded during surgical intervention and through the dias and videotapes of the operations. The artery of Heubner originated from the junction of the A 1 and A 2 segments of the anterior cerebral artery (ACA) in 58%, from the A 2 segment of ACA in 23%, and from the A 1 segment of ACA 4%. It was asymmetrically taking off in 13% and hypoplastic in 2% of the cases.

Three types of recurrent artery courses were defined. The type I or the superior course was seen in 71%, the type II or the anterior course was found in 25% and type III or the posterior course was recorded in 4% of patients.

We concluded that the recognition of the anatomical variations of the recurrent artery of Heubner and the detailed knowledge of the microvascular relationships of the anterior communicating artery (ACoA) complex, will allow neurosurgeons to construct a better and safer microdissection plan, to save time, and so prevent postoperative neurological deficit.

Keywords: Recurrent artery of Heubner; variation; aneurysm; anterior communicating artery; intraoperative study.

Introduction

The anterior communicating artery (ACoA) has been one of the most studied arteries of the cerebral circulation, because it is the most frequent site of cerebral arterial aneurysms[1–3, 5, 9–11, 14]. These were mostly based on data derived either from formalin-fixed and polyester resin-injected specimens or from the use of perfusion techniques. Unfortunately, the fine anatomical view obtained in these researches cannot be obtained in the operating theatre. In the operations, the surgical field is dependent on the operative approach selected and the amount of brain retraction utilized for exposure[8]. Furthermore in some cases the operative field is obscured by the effects of a recent, old or fresh haemorrhage or a large aneurysm, making it difficult to recognize vascular structures and to preserve small perforating arteries[7, 8, 12].

In all approaches to the ACoA junction, that can be called as pterional, subfrontal, or anterior interhemispheric, the recurrent artery of Heubner should be looked for at the level of its origin. Hence, Heubner's artery has surgical importance, because it perfuses the anterior-inferior striatum, anterior limb of the internal capsule, olfactory region, and anterior hypothalamus, with some overlapping with the perfusion territory of the perforating branches from the proximal anterior cerebral artery (ACA)[4]. Kribs and Kleihues demonstrated secondary areas of supply in the frontobasal cortex and subcortical white matter of the frontal lobe[6].

The present study was undertaken to analyse the intraoperative anatomical findings of the artery of Heubner in a series of patient with aneurysms of the ACoA Complex.

Clinical Material and Methods

During the period between January 1985 and February 1993, a total of 48 patients with a single aneurysm of the ACoA were operated on at the Neurosurgical Department of Atatürk University Medical School, Erzurum, Türkiye.

Of the 48 patients 29 were female and 19 were male who ranged between 16 and 65 years of age. The records in these cases included bilateral carotid artery angiograms, which allowed us to examine the condition of the anterior portion of the circle of Willis angiographically.

In all cases, a right pterional craniotomy was used. After craniotomy, Sylvian microdissection techniques described by Yaşargil were employed in all cases without any modification. After

the dural opening and frontal lobe retraction, the basal Sylvian cistern was opened on the frontal side of the Sylvian vein and the M 1 segment of the middle cerebral artery (MCA) was followed to the bifurcation of internal carotid artery. The carotid cisterns were opened to release cerebrospinal fluid (CSF) and to gain optimal relaxed brain condition. The microdissection was continued along the anterior cerebral artery (ACA) until the ACoA complex was reached. In most cases, the entire aneurysm including the aneurysmal neck was first isolated, together with afferent and efferent arteries (H Segment), and especially the right recurrent artery of Heubner, and the relationships between the aneurysm and arteries were clearly demonstrated and the vascular anatomy confirmed before and after clipping of the neck of the aneursysm. All patients were operated on by the senior author (IHA).

We recorded the site of origin of the recurrent artery of Heubner, its course, and branching pattern not only during the operations but also by the dias taken with the operation microscope and videotapes. All data were carefully analysed and Heubner's artery variations were identified and registered.

Results

Anatomical variations of the ACoA complex and the projection of aneurysms are shown in Fig. 1. The most frequent variations were: hypoplasia of the right A 1 segment of the ACoA (n = 27, 56%) and hypoplasia of the left A 1 segments (n = 13, 27%). In all cases, aneurysms arise from the side of the ACoAs that receive the larger A 1 portion when the proximal ACAs are unequal, and they arise from the midportion of the ACoA when the proximal ACAs are equal (n = 8, 17%). The micro-anatomical features of the recurrent artery of Heubner were studied in every case. The results of the intraoperative anatomical findings and records of dias and videotapes are summarized in Table 1.

In 85% of the patients, the recurrent artery of Heubner takes off the same level on both sides. It originated from the A 1–A 2 junction in 28 cases (58%), from the A 2 segment in 11 cases (23%) and from the A 1 segment in 2 cases (4%) (Fig. 2). The origin of Heubner's artery from the A 2 segment as multiple branches is shown in Fig. 3. The artery showed an asymmetrical origin in 6 cases (13%) and it was hypoplastic in one case (2%)

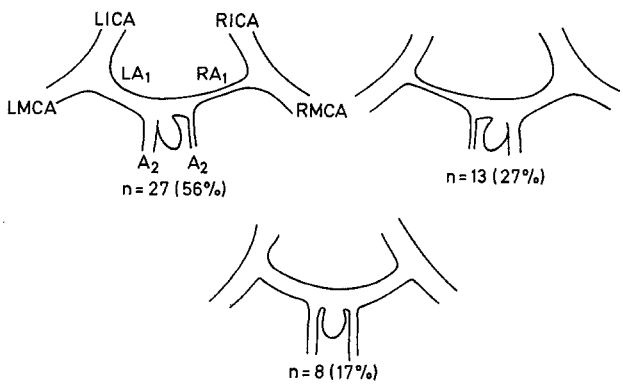

Fig. 1. Schematic representation of the anatomical variations of the ACoA complex and the projection of aneurysms

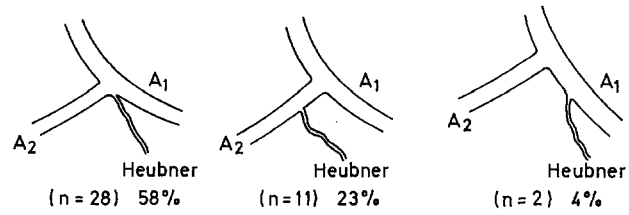

Fig. 2. Schematic representation of the recurrent artery of Heubner origin

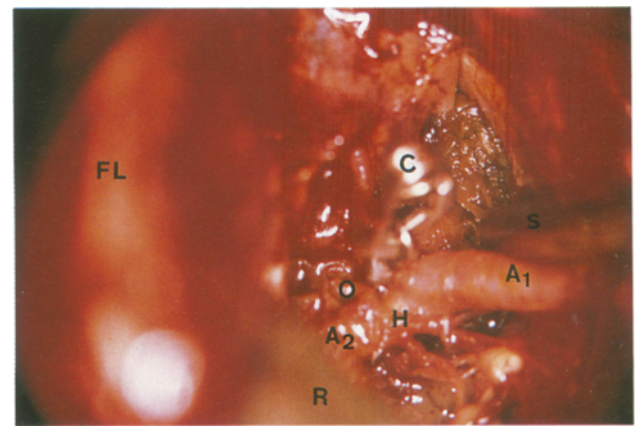

Fig. 3. Intra-operative photograph showing the view obtained with the right pterional approach. The origin of Heubner's artery from the A_2 segment as multiple branches was seen. A_1:A_1 segment of ACA, A_2:A_2 segment of ACA, *H* recurrent artery of Heubner, *O* orbitofrontal artery, *C* clip, *S* suction tube, *R* retractor, *FL* frontal lobe

Table 1. *Different Features of Heubner's Artery*

Features	n	%
Multiple branching	38	79
Very close to aneurysmal neck	34	71
Coursing as a branch	9	19
Adherent to aneurysmal sac	2	4
Double branching	1	2

Table 2. *The Variations of the Origin of Heubner's Artery*

	n	%
Symmetrically	41	85
From the junction of A 1 and A 2	28	58
From A 2 segment	11	23
From A 1 segment	2	4
Asymmetrically	6	13
Hypoplastic	1	2

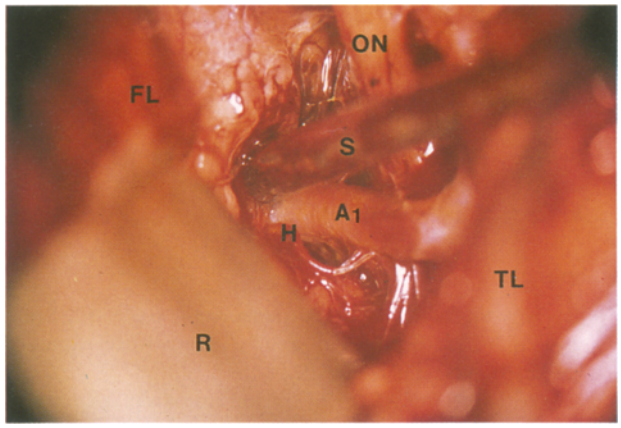

Fig. 4. Intra-operative view of the dissection of the ACoA aneurysm by the right pterional approach. The superiorly coursing (Type I) of recurrent artery of Heubner was shown. $A_1 : A_1$ segment of right ACA, *H* recurrent artery of Heubner, *R* retractor, *ON* optic nerve, *S* suction tube, *FL* frontal lobe, *TL* temporal lobe

Table 3. *The course of Heubner's Artery (According to Gomes et al.)*

	n	%
Type I (superior coursing)	34	71
Type II (anterior coursing)	12	25
Type III (posterior coursing)	2	4

(Table 2). The course of Heubner's artery was superior (Type I) in 34 patients (71%), (Fig. 4), anterior (Type II) in 12 patients (25%) and posterior (Type III) in 2 cases (4%) (Table 3).

Discussion

The artery of Heubner in man as the remnant of the anastomosis around the paleo-olfactorium between the ACA and middle cerebral artery (MCA) found in lower vertebrates, was interpreted by Abbie as phylogenetic concept. Information about the frequency, branching, mean and range values of the outer diameter, origin and course of the artery is valuable to neurosurgeons who consider vascular procedures that involve this vessel and sellar and parasellar areas[4].

Although it has been pointed out that anomalies of the circle of Willis or haemodynamic abnormalities are frequently associated with aneurysm cases and ACoA aneurysms are the most frequent types of cerebral aneurysm, no previous researches studied the variations of Heubner's artery in patients with ACoA aneurysm during operation except Yaşargil and Smith. Several postmortem studies have described the anatomy of the anterior cerebral vascular complex involving the ACA, ACoA and recurrent artery of Heubner[2, 4, 6, 10, 11]. We studied this artery in 48 patients with ACoA aneurysm intraoperatively.

From the data obtained intra-operatively in 375 patients with ACoA aneurysm, Yaşargil reported that in 52.5% of the cases, the aneurysm arose from the junction of the left A 1 segment and the ACoA, with a hypoplastic right A 1 segment, and in 28.8% of the patients from a similar position on the right, with a hypoplastic left A 1 segment. In 18.7% of the cases, the aneurysm was based on the midportion of the ACoA[13]. These data were 57%, 27% and 17% respectively in our study. Nathal *et al.* have reported that hypolasia of an A 1 segment associated with an ACoA aneurysm was present in 21.6% of cases[8]. The duplication or triplication of the ACoA has been reported with an incidence as high as 43.3% in autopsy studies by Gomes *et al.*[4]. This finding was seen in 11.1% of patients by Nathal *et al.*[8] and in 5.7% of the cases by Kwak *et al.*[7] intra-operatively. In our study, there were no cases similar to this anomaly.

The relationship between a hypoplastic A 1 segment and the origin of the recurrent artery of Heubner was shown by Yaşargil in his series[13].

In 1982, Yaşargil and Smith reported that in 85% of the cases, Heubner's artery takes off at the same level on both sides[15]. Later, Yaşargil reported this ratio as 76 per cent in his personal series of 375 cases with ACoA aneurysm in 1984[13]. However, in the study of Gomes *et al.*, only 30% of the origins were found to be symmetrical[4]. Dunker and Harris described the artery as originating directly opposite to the ACoA in 90% of the 28 brains studied[2]. Perlmutter and Rothon reported that it arose from the A 2 segment in 78% of the cases, from the A 1 segment in 14%, and at the level of the ACoA in 8%[10, 11]. Kribs and Kleihues[6], and Gomes *et al.*[4] reported similar findings: the recurrent artery of Heubner originated from the A 2 segment in 57% of the cases, from the ACA-ACoA junction in 35%, and from the A 1 segment in 8% of the cases. Although Nathal *et al.* reported that with the pterional approach it was not unusual for the origin of Heubner's artery to appear on the operative side[8], intra-operative visualization of this artery origin was made possible in our study with the same approach. In our intra-operative study, in 85% of the patients, the recurrent artery of Heubner takes off at the same level on both sides symmetrically. It originated from the junction of A 1 and A 2 in 58%, from A 2 segment in 23% and from A 1 segment in 4% of the patients. Asymmetrical

origins were seen in 6 patients (13%). The artery was hypoplastic in one case. In our opinion, these differences in the studies result from the different researches. Because most of Heubner artery studies are carried out on the brains of cadavers without any ACoA aneurysm and another vascular anomaly.

Perlmutter and Rothon described that the recurrent artery of Heubner coursed anteriorly to the A 1 segment in 60% of the cases and superiorly in 40%[10]. Dunker and Harris reported the intimate relationship of the vessel with the most distal 7 mm of the A 1 segment, and pointed out that inadvertent occlusion of this artery could easily occur if a clip was placed at that level[2]. In Gomes *et al.'s* work, three types of recurrent courses were observed. In the Type I or superior course, seen in 63% of the arteries, the artery followed the superior wall of the A 1 segment. In the Type II or anterior course, the arteries found in 34% of specimens maintained a rostral position in relation to the A 1 segment. In the Type III or posterior course, seen in 3% of the arteries[4]. In our study, these data were 71%, 25% and 4% respectively.

The recurrent artery of Heubner should be visualized for at the level of its origin either from the A 2 segment or from the junction of the A 1 and A 2 segments, in sellar and parasellar surgical interventions, and especially in any surgical approach to the ACoA junction (pterional, subfrontal, or interhemisferic). Microdissection of the artery is mandatory if temporary clipping of the proximal A 1 segment is considered[13–15]. Often, multiple arachnoid strands reaching from the artery to the A 1 segment will be found along its wall. Gomes *et al.* reported the ratio of this peculiar relationship as 65 per cent in their study[4].

As a result, an attempt should be made to dissect precisely the artery of Heubner from the dome of aneurysm, if there are any attachments. The artery should not be confused with the orbitofrontal and frontopolar branches, which may be adherent to large or giant ACoA aneurysm, during dissection. I believe that the hemiparesis with brachial predominance and involvement of the face, palate and tongue, that may occur during surgery for an aneurysm of that area, the artery of Heubner and/or the most proximal perforating branches of the A 1 segment, injured at operation, are mostly responsible for the neurological deficit. The recognition of the anatomical variations of Heubner's artery and also ACoA complex, and the detailed knowledge of the microvascular relationships at that level, will allow the neurosurgeon to construct a better and safer microdissection plan, to save time and to prevent postoperative neurological deficits.

Acknowledgements

We are grateful to Dr. Ruhi Esengün for proofreading of the manuscript and to the Photography Laboratory of Atatürk University for technical cooperation.

References

1. Dujovny M, Kossovsky N, Barrionuevo PJ, *et al* (1982) Ependymitis and arachnoiditis induced by intraventricular contrast media. Surg Neurol 18: 216–224
2. Dunker RO, Harris AB (1976) Surgical anatomy of the proximal anterior cerebral artery. J Neurosurg 44: 359–367
3. Fujimoto K, Waga S, Kojima T, *et al* (1981) Aneurysm of the distal anterior cerebral artery associated with azygos anterior cerebral artery. Acta Neurochir (Wien) 59: 65–69
4. Gomes F, Dujovny M, Umasky F, *et al* (1984) Microsurgical anatomy of the recurrent artery of Heubner. J Neurosurg 60: 130–139
5. Kaplan HA, Krieger AJ (1980) Vascular anatomy of the preoptic region of the brain. Acta Neurochir (Wien) 54: 233–241
6. Kribs M, Kleihues P (1971) The recurrent artery of Heubner. A morphological study of the blood supply of the rostral basal ganglia in normal and pathological conditions. In: Zülch KJ (ed) Cerebral circulation and stroke. Springer, Berlin Heidelberg New York, pp 40–56
7. Kwak R, Niizuma H, Hatanaka M, Suzuki J (1980) Anterior communicating artery aneurysms with associated anomalies. J Neurosurg 52: 162–164
8. Natahl E, Yasui N, Sampei T, Suzuki A (1992) Intraoperative anatomical studies in patients with aneurysms of the anterior communicating artery complex. J Neurosurg 76: 629–634
9. Ogawa A, Suzuki M, Sakurai Y, Yoshimoto T (1990) Vascular anomalies associated with aneurysms of the anterior communicating artery: microsurgical observations. J Neurosurg 72: 706–709
10. Perlmutter D, Rothon AL Jr (1976) Microsurgical anatomy of the anterior cerebral-anterior comunicating-recurrent artery complex. J Neurosurg 45: 259–272
11. Perlmutter D, Rothon AL Jr (1978) Microsurgical anatomy of the distal anterior cerebral artery. J Neurosurg 49: 204–228
12. Suzuki J, Mizoi K, Yoshimoto T (1986) Bifrontal interhemisferic approach to aneurysms of the anterior communicating artery. J Neurosurg 64: 183–190
13. Yaşargil MG (1984) Microneurosurgery, Vol II. Thieme, Stuttgart, pp 165–232
14. Yaşargil MG, Fox JL, Ray MW (1975) The operative approach to aneurysms of the anterior communicating artery. In: Krayenbühl HA (ed) Advances and technical standards in neurosurgery, Vol 2. Springer, Wien New York, pp 113–170
15. Yaşargil MG, Smith RD (1982) Management of aneurysms of anterior circulation by intracranial procedures. In: Youmans JR (ed) Neurological surgery, 2nd Ed, Vol III. Saunders, Philadelphia, pp 1663–1696

Correspondence: Ismail Hakki Aydin, M.D., Department of Neurological Surgery, Atatürk University Medical School, P.O.Box. 299, Erzurum 25000, Türkiye.