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ANATOMICAL VARIATIONS IN ANTERIOR CEREBRAL CIRCULATION - CADAVERIC STUDY IN INDIAN POPULATION

Neurosurgery

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ABSTRACT

AIM OF THE STUDY : To study the microsurgical anatomy and variations of the anterior cerebral circulation and to discuss its implications with respect to anatomical, pathophysiological and neurosurgical perspectives.

INTRODUCTION : Micro dissection of cadaver is the base on which our knowledge of the of human brain is built. Thorough knowledge of the microsurgical anatomy and its variations are mandatory to adopt the best possible techniques and to have good functional outcome.

MATERIALS AND METHODS : This study was conducted with dissection of 60 brains in the autopsy theatre of Coimbatore Medical College. After injecting red colour to the anterior circulation vessels, magnifying loupes and Vernier callipers were used to take measurements.

RESULTS: Mean outer diameter of A1 segment was 2.53 mm. Most Right & Left A1 segments had equal length with an average length of 13.7mm. ACom artery measurements revealed a mean diameter of 1.63mm. The mean length of ACom artery was found to be 2.1mm. In 63% of cases Recurrent artery of Heubner had arisen from A2.

CONCLUSION: Understanding the microvascular anatomy of anterior circulation in cadavers will pave the way for better surgical outcome.

KEYWORDS

Anterior cerebral artery, microvascular anatomy

INTRODUCTION

Micro Neurosurgery has evolved over the years with the better understanding of the normal and myriads of variation that occur in the miniature structures of the brain. Micro dissection of cadaver specimens is the base on which our knowledge of the intricacies of the human brain is built.

Neurovascular anatomy of the brain, is the most complex of all and the variations encountered are as distinct as a finger print. Most neurovascular surgeons in the pre microscopic era, were handicapped with a poor knowledge of the minute vessels that supplied the vital regions of the brain. They were not able to explain the unexpected deficits patient suffered after apparently uneventful surgery.

The advent of micro neurosurgery and the knowledge of the tiny perforating vessels and their arrangements along the base of the brain has made much awaited changes in the outcome of patients undergoing surgery in relation to neuro vascular structures [1].

Anterior Cerebral Artery is a complex arterial system and anterior half of Circle of Willis of the brain. [2,3] Thorough knowledge of the microsurgical anatomy and the anatomical variations are mandatory for the neurosurgeons to adopt the best possible technique to avoid disaster during surgery and to have good functional outcome in patients.

Various authors have studied, the ACA A1-ACOM-A2 in detail and have explained their variations in other countries. [4,5] No large study of this nature has been done in our population, though few small Indian studies have been done. This study is done to improve the knowledge of the variations in micro surgical anatomy of anterior cerebral artery in our population. [6]

MATERIALS AND METHODS

This study was conducted in the autopsy theatre, Department of Forensic medicine, Madras Medical College and Coimbatore Medical College.

A total number of 60 brains were dissected. Brains of head injury patients, intra cranial pathology patients were excluded from the study. The brains of only those who died due to other causes were taken up for study.

Entire dissection was carried out under 4x magnification using Carl Zeiss magnifying loupe.

Standard Vernier calliper with accuracy of 0.2 mm was used for measurements Other Instruments used are Toothed forceps, needle, syringe, cannula poster colour, cotton, scissors, 11 blade knife, curved and straight artery forceps. 5 mega pixel digital camera was used for taking photographs

METHOD OF DISSECTION

During autopsy, after removal of the skull vault carefully, taking care not to damage the dura, the dura in the frontal region was incised and 15 ml of 20% formaldehyde was injected into the subdural space. After 10 minutes dura was opened transversely and the anterior limit of falx cerebri cut. The two frontal lobes are retracted slowly and carefully to expose and cut the optic nerve and ICA entry into the cranial cavity.

Both the cerebral hemispheres are progressively lifted after cutting cranial nerves one by one at their exit. The brain stem and basilar artery are cut at the level of tentorial hiatus. The falx cerebri posterior attachment is cut to completely remove both cerebral hemispheres. The entire specimen is soaked in 10% formaldehyde solution for about 10-15 minutes.

Further dissections are done under 4x magnification.

The anterior inter hemispheric fissure is injected with 5 ml saline to ease dissection while opening it. The anterior interhemispheric fissure is opened by standard micro neurosurgical technique.

ICA is traced to bifurcation then the ACA, [A1-acom-A2] and its branches coursing over the medial surface of frontal lobe, over the corpus callosum and the cortical areas are carefully dissected.

The ICA at its origin is tied and injected with red poster colour solution to make the vessel prominent and to ease the dissection of perforators. Length of Right A1 segment and Left A1 segment and ACOMA were noted. Number of ACOM arteries and its course noted.

Diameter of Rt A1, LA1, ACom, Rt A2, Lt A2 noted Site of origin of Recurrent artery of Heubner noted. Number and location of basal perforators noted. Branching pattern of A2 is noted

RESULTS

Diameter of A1 segment of ACA was measured just distal to bifurcation, measurements revealed an average outer diameter of 2.53 mm for Right A1 and 2.46 for Left A1. The maximum outer diameter was 3.5mm and minimum 1.0mm for right A1. For Left it ranges from 1.5 to 3.5 mm. When one side A1 diameter decreases the other side correspondingly increases. Most Right A1 and Left A1 segments had equal length with an average length of 13.7mm.

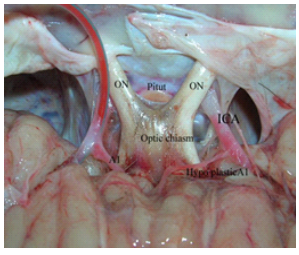
Right A2 segment of ACA had a maximum outer diameter of 3.5mm and minimum size of 2mm with an average outer diameter of 2.58 mm. Whereas the Left A2 had an average outer diameter of 2.39mm. A positive correlation is noted between outer diameter of A1 and A2, When diameter of A1 increases the diameter of A2 also increases.

ACom artery measurements revealed a minimum outer diameter of 1mm and maximum of 2.5mm with a mean diameter of 1.63mm. The mean length of ACom artery was found to be 2.1mm.

In a total of 54 cases a single ACom was present accounting to 90% of cases, whereas 5 cases (8%) had 2 and 1 case (2%) had 3 ACom arteries.

In 63% of cases Recurrent artery of Heubner had arisen from A2, in 24% from ACom junction and in 13% from A1. Also in 62% Heubners artery runs in a superior course to A1.

Figure 1: Hypoplastic A1 **Figure 2: Aneurysm at Acom Junction**



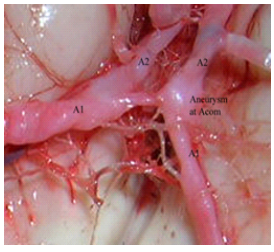


Figure 3:Duplication of AcomA and crossing of A2

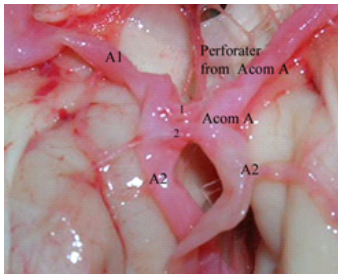
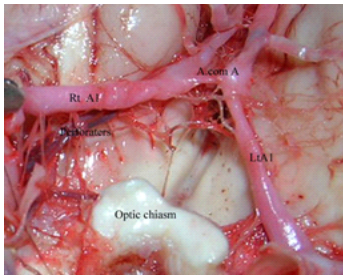


Figure 4: Perforator branches of A1



DISCUSSION

Most of the A1 anterior communicating artery junction lies over the optic chiasm [1], when the A1 segment is longer it lies over the optic nerves; when it is shorter it lies over the optic chiasm; A1 diameter less than 1.5mm is very rare. When it is less than 1.5mm then it is called hypoplastic. 6.5% of A1 were hypoplastic in our study. Most of the perforators from A1 arises from the proximal segment of the A1. Hypoplastic A1 segment is associated with aneurysm at the junction of A1 with Acom artery [7].

The length of A1 was comparatively larger in the present study when compared to the western population. The difference is minimal when compared to the other Indian study (SB Bai et al study) [18]. The outer diameter is almost equal when compared SB Bai et al study. The Acom length is slightly short when compared to other studies. The Acom outer diameter is slightly less when compared SB Bai et al study. [Table 1].

Table 1: Comparison of A1Outer Diameter, A1 Length Acom length and diameter

Parameter	Our Study	Perlmutter etal[8]	SB Bai etal[18]	Smitha etal[19]	Sande etal[20]
Rt A1OD	2.53	2.6	2.8	2.05	2.6
Lt A1 OD	2.46	2.6	2.8	2.8	2.4
Lt A1 Length	13.7	12.7	14.6	13	14.7
ACom Length	2.1	2.6	2.45	2.3	1.8
Acom Diameter	1.63	1.5	2.80	1.9	2.1

Most of the recurrent artery of the Heubner arises from A2 segment and also most of them from initial 3mm of A2. RAH runs in the superior course to A1 in 50% of brain. Recurrent artery of the Heubner arises from lateral aspect of the parent vessel [3]. AComA cross sectional area increases when there is hypoplasia of any one of the H limb [9]. This favours the cross circulation between right and left side. Anterior communicating artery perforators supply the lamina terminalis, hypothalamus, optic chiasm and septal nucleus. [10] With occlusion of this vessels may lead on to unconsciousness, memory disturbances and visual deficit. Recurrent artery of Heubner supply anterior limb of the internal capsule, caudate nucleus, lentiform nucleus. Occlusion of this vessels leads to weakness of upperlimb and face and emotional disturbances. When compared to MCA A1 arises at an angle from ICA [11].

So the territory supplied by the ACA is likely to suffer from hypotension-more often and earlier than MCA. This effect is compensated by nature to some extend by ACom artery and its duplication as well as by equal total cross sectional area of Rt A1+Lt A1 and Rt A2 + Lt A2 [12,13].

In view of multiple anatomic variations in the A1-ACom-A2 complex region and in view of important perforators supplying the vital structures detailed angiographic evaluation is mandatory to get the three dimensional vision of A1 ACom A2 complex and to know the direction of dome of the aneurysm and to know the dominant A1[14] Cautious inspection for recurrent artery of Heubner is essential because most of the RAH runs through superior course and maybe adherent to the A1 segment [15]. Irrespective of the length of A1 it is not freely mobile as the tie of the perforator which hampered the mobility. Most of the A1 perforators arises from the proximal segment of A1 so temporary clipping may be safely applied on distal A1. If the recurrent artery of Heubner arises from A1 segment least likely to be damaged during ACom Aneurysmal Surgery [16]. In the trans callosal approach the position of A2 segment is variable. But it can be mobilised on either side. It is usually safer to enter lamina terminalis cistern through sub pial resection of gyrus rectus [17].

CONCLUSION:

The study of microsurgical anatomy of anterior cerebral artery clearly shows the differences between dimensions of A1, Acom and A2 in Indian and western studies. Flow dynamics of the anterior circulation depends on the diameter of bilateral A1 and Acom. Knowledge about the various anomalies will provide crucial information during intraoperative dissection

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