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Original Research Paper

Anatomy

MORPHOLOGICAL STUDY OF ANTERIOR CEREBRAL ARTERY BY MR ANGIOGRAPHY.

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ABSTRACT The anterior cerebral artery is the smaller of twoterminal branches of internal carotid artery. The anterior cerebral artery starts at the medial end of the stem of lateral cerebral fissure and passes anteromedially above the optic nerve to the great longitudinal fissure where it connects with the fellow by a short transverse anterior communicating artery. The present study is designed to know the diameter and variations of anterior cerebral artery included MR Angiographies of 132 patient.

The diameter of anterior cerebral artery measure 2 mm away from its origin and observe variation of artery. The mean diameter ofanterior cerebral artery of all age group are Right - 1.7 mm, and Left - 1.7 mm (2) below age group 60 year- Right – 1.7 mm and Left – 1.7 mm (3) age above 60 year – Right – 1.8 mm and Left- 1.8 mm. Variations in anterior cerebral arteries are Hypoplastic2.27% and Absence 0.37%. The need for the diamensionaldata for diameter of artery and variations by neurosurgeons and radiologist as well as researchers but no comprehensive measurements have been published especially, in the Indian data.

KEYWORDS : Diameter, Variation, Anterior Cerebral Artery.

INTRODUCTION

The Anterior cerebral artery is the smaller of twoterminalbranches of the internal carotid artery. The surgical nomenclature divides the vessels in to three parts ; A1- From the termination of the internal carotid artery to the junction with the anterior communicating artery ; A2- From the junction with anterior communicating artery to the origin of the callosomarginal artery and A3- Distal to the origin of the callosomarginalartery. This segment is also know as thepericallosal artery.

The anterior cerebral artery starts at the medial end of the stem of the lateral cerebral fissure and passes anteromedially above the optic nerve to the great longitudinal fissure where it connects with the fellow by a short transverse anterior communicating artery. The anterior communicating artery is 0.4 mm in length and may be double. It gives off numerous anteromedial central branches which supply the optic chiasma, lamina terminalis, hypothalamus, para-olfactory areas, anterior columns of the fornix and the cingulate gyrus.

The two anterior cerebral arteries traveltogether in the great longitudinal fissure. They pass around the curve of the genu of the corpus callosum and then along its upper surface to its posterior end, where they anastomose with posterior cerebral arteries. They give off cortical and central branches.

The corticalbranches of the anterior cerebral artery are named by distribution, two or three orbital branches ramify on the orbital surface of the frontal lobe and supply the olfactory cortex,gyrus rectus and medial orbital gyrus. Frontal branches supply the corpus callosum, cingulate gyrus, medial frontal gyrus and paracentral lobule. Parietal branches supply the precuneus, while the frontal and parietal branches both send twigs over the superomedial border of the hemisphere supply a strip of territory on the superolateral surface. Cortical branches of the anterior cerebral artery therefor supply the areas of the motor and somatosensory cortices which represent the lower limb.

Central branches of the anterior cerebral artery arise from its proximal portion and entre the anterior perforated substance and lamina terminalis. Collectively, they supply the rostrum of the corpus callosum, the septum pellucidum, the anterior part of putamen,the head of the caudate nucleus and adjacent part of the internal capsule.Immediately proximal or distal to its junction with the anterior communicating artery, the anterior cerebral artery gives rise to the medial striated artery which supply the anterior part of the head of the caudate nucleus and adjacent region of the putamen and internal capsule.

The cranial division of the internal carotid artery give rise to anterior choroidal, middle cerebral and anterior cerebral arteries, the stem of the primitive olfactory artery remaining as a small medial striate branch of the anterior cerebral artery at the stage 20-23 (7-8weeks) furtherexpansion of the cerebral hemispheres produces the completion of the circle of willis, with the development of the anterior communicating arteries by 8 weeks gestation. An annular network of meningeal arteries originates, mainly, from each middle cerebral artery and passes over each developing cerebral hemisphere caudally, similar meningeal branches arising from the vertebral and basilar arteries embrace the cerebellum and brainstem.

The meningeal arteries so formed have been classified in to three groups, paramedian, short circumferential and long circumferential .They can be described both supratentorially and infratentorially, all give off fine side branches and end as penetrating arteries. Of the supratentorial vessels, the paramedian arteries have a short course prior penetrating the cerebral neuropil i.e. branches of the anterior cerebral artery.

Central brancheshaemodynamicsof the circle is influenced by variation in the calibre of communicating arteries and in the segments of the anterior and posterior cerebral arteries which lies between their origins and their junction with the corresponding communicating arteries. The greatest variation in calibre between individuals occur in the posterior communicating artery commonly, the diameter of theprecommunicating part of the posterior cerebral artery is larger than that of the posterior communicating artery in which case of the blood supply to the occipital lobes is mainly from the vertebrobasilar system. Sometimes, however, the diameter of theprecommunicatingpart of the posterior cerebral artery is smaller than that of the posterior communicating artery in which case the blood supply to the occipital lobes is mainly from the internal carotids via the posterior communicating arteries.Agenesis or hypoplasting of the initial segmentof the anterior cerebral artery are more frequent than anomalies in the anterior communicating artery and contribute to defective circulation in about a third of individuals[6].

Though many workers have reported abnormalities in the diameter of the vessels forming the circle of willis, the normal dimensions of these vessel have been not reported. The vessels have been described as, narrow, thread like, string like, but actual diameter has nearly been measured. Its increasing utilization in angiography and development of cevebrovascularsurgary, there is obvious need for validating this concept of the architecture of the circle of willis.

The present study included MR Angiographies of 132 patients, the diameters of vessels were mesured where they formed part of the circle of willis and observed variation only in the right and left anterior cerebral arteries. The need for dimensional data for diameter of vessels is expressed by neurosurgeons and radiologist as well as researchers but no compressive measurement have been published especially in the indian data.

MATERIALS AND METHODS

The study included MR Angiographies of 132 patients (88 males and 44 females) for male age range from 18 to 80 years (mean 48.1years) while for the femaie age range from16 to78 years (mean 49 years) patients having cerebral ischaemia caused by atherosclerosis, embolism and infarction were excluded in this study and also patient with history of accidental head injuries and tumors were excluded. In this study patient having complaints other than those mentioned above were included in the study.

The magnetic resonance imaging (MRI) machine is 1.5 Tesla super conducting magnet (Magnetom, SiemensEriagen, Federal Republic of Germany) that uses liquid helium. Brain images were obtained with a circularly polarized head coil. MRI room is air - conditioned, attached to machine room is console room, which has computerized monitor on which images are directly seen.

The patient is made to lie down in supine position on the table and a specific circularly polarized head coil is adjusted for the head region. The table can moved vertically and horizontally, with the help of these movements, patients head is allowed first inside the machine i.e. head first in supine position in all patients MRI was performed in axial plane. The method of MRI technique used three diamensional - time - of - flight MRA sequence or time- of- flight turbo MRA, circle of willis sequence

There MR angiograms were evaluated on a dedicated work station by using maximum intensity projection anterior cerebral artery assessed by measuring the diameter and section of vessels that were visualized as continuous segments for at least 1 mm in diameter were considered normal, those smaller than 1 mm in diameter were considered hypoplastic.Those segment, which were not visualized, were considered as absent.

The diameters of the vessels were measured where they formed part of the circle of willis. The right and left anterior cerebral arteries are measured 2mm away from its origin and observed variation of vessels

OBSERVATION

TABLE 1 - Observed number of anterior cerebral artery in both males and females of all age groups

SR NO	OBSERVATION	NUMBER
1	Number of observed artery	132
2	Number of observed artery in males	88
3	Number of observed artery in females	44
4	Number of observed artery in below 60 years (both males and females)	101
5	Number of observed artery above 60 years (both males and females)	31
6	Number of observed artery (both males and females) A) Right anterior cerebral artery B) Left anterior cerebral artery	132 129

TABLE 2 - Mean diameter of anterior cerebral artery (all age group)

Sr. No.	Name of Artery	Males		Females		Males + Females	
		No.	Mean (mm)	No.	Mean (mm)	No.	Mean (mm)
1.	Right anterior cerebral artery	84	1.7	43	1.7	127	1.7
2.	Left anterior cerebral artery	85	1.7	44	1.7	129	1.7

TABLE 3 - Mean diameter of anterior cerebral artery (agebelow 60 yrs.)

Sr No.	Name of Artery	Males		Females		Males + Females	
		No.	Mean (mm)	No.	Mean (mm)	No.	Mean (mm)
1.	Right anterior cerebral artery	69	1.7	30	1.7	99	1.7
2.	Left anterior cerebral artery	68	1.7	30	1.7	98	1.7

TABLE 4 - Mean diameter of anterior cerebral artery (age above 60 yrs.)

Sr. No.	Name of Artery	Males		Females		Males +	Females
		No.	Mean (mm)	No.	Mean (mm)	No.	Mean (mm)
1.	Right anterior cerebral artery	15	1.8	13	1.8	28	1.8
2.	Left anterior cerebral artery	17	1.8	14	1.8	30	1.8

TABLE 5 – Variations in the anterior cerebral arteres.

S. NO.	Description	Number	Percentage
1	Anterior cerebral artery	264	
2	Hyperplasia	-	-
3	Hypoplasia	6	2.27
4	Absence	1	0.37
5	Partial duplication	-	-

DISCUSSION

Sir Thomas Willis [16]first indicated the collateral potential of the circle in his CerebriAnatome in 1664. The development of such collateral routes depends on individual morphological and hemodynamic factors. Though many workers have reported abnormalities in the diameter of vessels forming the circle of willis, the normal dimensions of these vessels have not been reported. The vessels have been described as, narrow, thread like, string like. But actual diameters have rarely been measured. With increasing utilization of angiography and development of cerebrovascular surgery, there is obvious need for validating this concept of the architecture of the circle of willis.

However three dimensional time-off-flight MR as angiography MJ Krabbe-Hartkamp et al (1998): studied 150 healthy person were examined, 50 individual age 20 to 25years (mean age,22.7yrs) and 100 individuals aged 60-88 years (mean age, 70.7 years). All person underwent three-dimensional time-of-flight MR angiography of the circle wills. All component of vessels of the circle of wills were assessed by measuring the diameter on the individual transverse section. The vessels were visualized as continuous segments of at least 0.8 mm in diameter were considered present. Those smaller than 0.8 mm in diameter were considered hypoplastic. MR angiography presence of complete circle of willis in normal brain, a complete anterior circle 74%, complete posterior circle 52% and entirely complete circle 42%, The presence of an entirely complete circle willis was slightly higher in younger persons and in women. The mean vessels diameter observed internal carotid artery 3.8 mmanterior cerebral artery vessels 1.8 mm.

Blatter DD et al (1991)[5]:studied intracranial MR angiograms of 23 nonselective individuals aged between 27 - 68 years. All MR angiographic studies were performed with use of an unmodified 1.5 Tesla MR imager with use of standard patient position and with guadrature head coil. MR angiography was performed by using the MOTSA technique. The presence or absence of the vessel lumen diameter was measured on both direct contrast enhanced and MR angiograms. The percentage of visibility of each vessel segment with lumen diameter, internal carotid artery 4.08 mm, posterior communicating artery 1.01 mm, Anterior cerebral artery 1.67 mm, anterior communicating artery not visualized and posterior cerebral artery 1.60 mm.

Though in the present study visibility of a vessel's diameter, anterior cerebral artery and tabulated separately for males and females, for

comparison purpose with other workers diameter the mean of male and female subjects have been considered together because these workers do not specify the sex. The values of dimensions by Kamath S (1981), Saeki N et al (1977) and David Perlmuttar et al (1976) withdissection studies Karbbe- Hartkamp MJ et al (1998) and Blatter DD et al (1991) with help of MRA studies are considered.

Diameter : Anterior cerebral Artery (Diameter in mm)

Anterior Cerebral Artery	Kamath S [9] (1981)	Krabbe hart kamp MJ [10] et al(1998)	Saeki N [15] et al (1977)	David Permutte ret al [37] (1991)	Blatter DD [5] et al (1991)	Present Study
Right	2.2	1.7	-	-	-	1.7
Left	2.4	2.2	-	-	-	1.7
Both	-	-	2.6	2.6	1.67	1.7

The diameter of the right anterior cerebral artery mentioned by Kamath S (1981) with dissection method is 2.2 mm, Krabbe-Harkamp MJ et al (1998)with the help of MRA is 1.7 mm and in the present study it is 1.7 mm. The diameter with the help of MRA study is matching with the present study and the diameter by the dissection method is 0.5 mm greater than the present study.

The diameter of the left anterior cerebral artery mentioned by Kamath S (1981) with dissection method is 2.4 mm, Krabbe – Hartkamp MJ et al (1998) with the help of MRA is 2.2 mm and in the present study it is 1.7 mm. The diameter by the dissection method is greater by 0.7 mm and MRA study is greater by 0.5 mm than the present study.

The diameter of both anterior cerebral arteries mentioned by Saeki N et al (1977) with dissection method is 2.6 mm, David Perlmutter et al (1976) with heip of autopy is 2.6 mm,Blatter DD et al(1991)with MRA method is 1.67 mm, and in the present study it is 1.7 mm.The diameterwith the help of MRA study is matching with the present study and the diameter bythe dissections method is 0.9 mm greater than the present study.

Variation : percentage of variations in anterior cerebral arteries.

Posterior Cerebral Artery	Puchades-orts [32] A et al (1975)	Alper BJ [1] al et (1972)	Reddy R [33] (1972)	Rigg HE Rupp C [34] (1962)	Present Study
Hypoplastic	6.4	-	-	-	2.27
Absence	0.8	-	-	-	0.37
Total	7.2	12.3	18.7	14.83	2.67

Hypoplasia of anterior cerebral arteries noted by Puchades – orts A et al (1975) with dissection method is 6.4% and in the present study it is 2.27%. The percentage of hypoplasia of anterior cerebral arteries by dissection method is greater than that of the present study.

Absence of anterior cerebral arteries by Puchades-orts A et al (1975) with dissection method is 0.8% and in the present study it is 0.37%. The percentage of absence of anterior cerebral arteries found by dissection method is greater than that of the present study

Both hypoplasia and absence of anterior cerebral arteries by Puchades – orts A et al (1975) with dissection method is 7.2%, Alper BJ et al (1959) with the help of autopsy is 12.3%, Reddy RD et al (1972) with dissection method is 18.7%, Riggs HE and Rupp C (1962) with dissection method is 14.83% and in the present study it is 2.64%. The percentage of both hypoplasia and absence of anterior cerebral arteries found by dissection method, by carotid angiography is greater than that of the present study.

Alpers BJ et al (1959),Puchades-orts A et al (1975), Riggs HE and Rupp C (1962), Reddy RD et al (1972) have reported hypoplasia of vessels as the commonest anomaly in the circle of willis. They also reported abnormal diameters most commonly in the anterior communicating arteries, followed by the anterior cerebral artery.

Kamath S (1981) found that common occurrence of abnormal narrowing of vessel on the right may be related to the need for a better blood supply to the left hemisphere. The only artery which showed a smaller average diameter on the left side, coupled with a higher incidence of abnormal diameters on the left side, was the posterior communicating artery. Since a significant inverse relationship existed between the diameters of the posterior communicating and posterior cerebral arteries of the same side, a smaller posterior communicating on the left could be associated with a large posterior cerebral on that side, thus ensuring better blood supply to the left hemisphere from both internal carotid and basilar system.

The second most favored is the anterior cerebral artery, its variation compensated by hypertrophy of the anterior communicating artery.The least favored artery is the posterior cerebral artery. The caliber of the anterior communicating artery is usually in inverse relation with respect to the anterior cerebrals. However if the anterior cerebral arteriesare normal, anterior communicating artery may be of any shape or even be absent.

The need for dimensional data for diameters of vessels is expressed by neurosurgeon and radiologist as well as researchers but no comprehensive measurements have been published, especially the Indian data.

The knowledge of size of these vessels is helpful to the surgeon in selection of patients as well as assessing the feasibility of shunt operations.

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