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A Study on the Anatomical Pattern of the Anterior Communicating Artery In The Circle of Willis of the Human Brain With Special Reference to Its Variations in the Population of Assam.

* Farheen A Karim	Assistant Professor, Department of Anatomy, Gauhati Medical College and Hospital,Bhangagargh ,Guwahati-781032, Assam,India., * Corresponding author
Kunja Lal Talukdar	Professor, Department of Anatomy, Gauhati Medical College and Hospital, Bhangagargh,Guwahati, Assam,India
Joydev Sarma	Professor, Department of Anatomy, Silchar Medical College, Assam ,India

ABSTRACT

The Circle of Willis(CW) is an arterial polygon present in interpeduncular cistern in the base of the human brain.The Anterior communicating artery (ACoA) is an anastomic channel present in the the anterior part of the CW ,displays variations in its pattern and calibre.The present study aims to study the variations and abnormalities of ACoA in the population of Assam. Fine dissection of 41 human brains was done to expose the ACoA.Vernier Calliper was used to measure its external diameter and length. Photographic records of variations and abnormalities taken. Data obtained was noted down and analysed using SPSS.Variation observed in the ACoA were dimples(26.83%), hypoplasia(12.2%), duplications(12.2%), plexiform(7.32%) and fenestrations(2.44%). Saccular aneurysms(17.07%) were abnormalities noted in the ACoA and ACoA-A1(precommunicating segment of Anterior cerebral artery) junction.A study of its kind is potentially helpful for surgical planning by Neurosurgeons and Vascular surgeons to in this region

KEYWORDS | Anterior communicating artery,Variations,Population of Assam

INTRODUCTION:

Cerebrovascular diseases present one of the leading problems of modern mankind .They are followed by risk of high mortality rate, and cause high level of disability with people who survive cerebral-vascular incident. (stroke,apoplexy).[1]Stroke has been defined as "rapidly developing clinical signs of focal (or global) disturbances of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin by WHO.[2] . The circulus arteriosus, or the Circle of Willis (CW) lies within the deep interpeduncular cistern, and in normal condition CW is formed anteriorly by two Anterior cerebral arteries ,anterior branches of right and left Internal carotid arteries joined by the Anterior communicating artery (ACoA) .Posteriorly on each side, each internal carotid artery by its posterior branch, the Posterior communicating artery, communicate with the Posterior cerebral artery,which are branches of Basilar artery.The primary purpose of this vascular circle is to provide anastomotic channels if one vessel is occluded. There is considerable individual variation in the pattern and calibre of the vessels which make up the circle of Willis.[3]Interhemispheric blood flow across the ACoA artery and reversal of flow across the proximal anterior cerebral artery provide collateral support in the anterior portion of CW [4] Based on anatomical and radiological studies have shown that 50% of healthy control subjects have anatomical variations in the CW .Patients with effective collateral anastomotic network of the CW have a lower risk of Transient ischemic attacks and stroke .Fetal configurations of CW were found in autopsy of brains with infarcts than in brains without .A correlation exists between cerebral aneurysms and certain variations of the CW.[5] Higher percentage of abnormality of length and diameter of the vessels of CW have been reported in the mentally ill and those with cerebrovascular catastrophe indicating a possible linkage.[6] Different distributions of variations of the CW may partially explain the different incidence of some cerebrovascular diseases in different ethnic or racial groups. Incidence of ischaemic stroke is different among different populations

especially Blacks and Hispanics compared to Whites.[7] . The most common variants of cerebral circulation include: fenestrations and duplications, persistant primitive fetal arteries, hypoplasia and aplasia of arterial segments.[8]

This study aims to determine the presence of variations, persistant fetal configurations and aneurysms in the Anterior communicating artery of the CW in the population of Assam . In addition, available literature and other similar studies including those done in different geographic regions will be reviewed to bring out the significance of the present study.

MATERIALS AND METHODS:

The present study was conducted in the Department of Anatomy, Gauhati Medical College and Hospital (GMCH) ,Guwahati . Specimens of human brains with intact CW were collected from autopsies done in the Department of Forensic Medicine within six hours following death.41 brains were randomly collected (including 6 females and 35 males) ages ranging from 14 to 70 years and fixed in 10% formalin .Brains were dissected to expose the CW .Photographic records using Sony digital camera were taken and any morphological variations or abnormalities in the Anterior communicating artery (ACoA) were noted down. The Vernier Calliper ,graduated to measure up to 0.1mm, was used to determine the length and to measure the external diameters of the ACoA at its midpoint and its length. As GMCH is a referral hospital dead bodies from all over Assam are brought here,so they are considered to represent the population of Assam. Permission of the Institutional Ethical Committee was taken for the present study .Statistical analysis was done using SPSS (version 16).

RESULTS AND OBSERVATIONS:
"TABLE 1 about here"

Variations of the Anterior Communicating artery	Frequency	Percent
Length > 4mm (long)	9	21.95%
Length <4mm (short)	26	63.41%
Hypoplasia	5	12.20%
Absence	2	4.88%
Duplications	5	12.20%
Multiple/Plexiform	3	7.32%
Buttonhole(s) /Dimple(s)	11	26.83%
Aneurysm ACoA	1	2.44%
Aneurysm A1- ACoA Junction	6	14.63%
Oblique	14	34.15%
H Shaped	2	4.88%
V Shaped fenestration	1	2.44%

Table 1:The frequency and percentage of variations and aneurysms present in the Anterior communicating artery (ACoA) in the population of Assam.
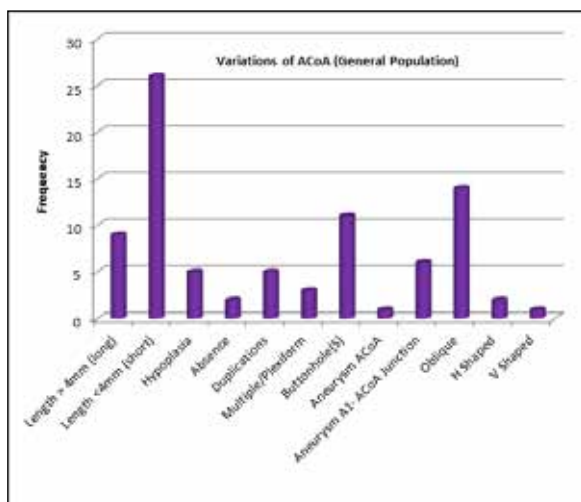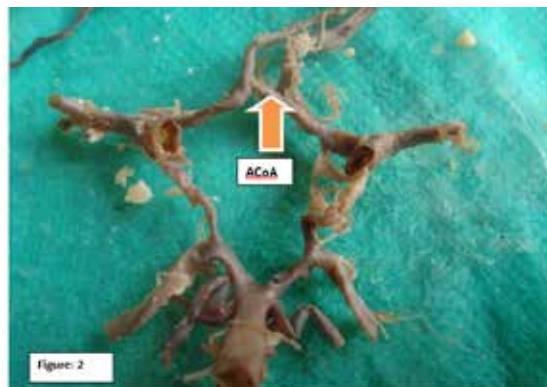
"FIGURE 1 about here"

Figure1: Graphical representation of the variations and aneurysms in the Anterior communicating artery in the population of Assam.

Observations: In the present study the length of ACoA was mostly found to be shorter than 4mm (63.41%).14 cases (34.14%) had an oblique course .Hypoplastic or string-like vessels with external diameters less than 0.5mm were present in 5 cases (12.2%).Duplications or double ACoAs lying parallel to each other constituted 12.2%(5 cases),among which 2 cases (4.88%) demonstrated a short vertical segment of artery joining the duplicated parallel ACoAs in the midline displaying an "H-shaped" configuration.A tuft of interconnecting network of blood vessels between the right and left anterior cerebral arteries represented the the plexiform /multiple ACoA in 3 cases (7.32%). ACoA was absent in 2 cases(4.88%). Fenestrations which are segmental duplications of intracranial

arteries was present in the ACoA of 1 case (2.44%), which had a" V-shape". The ACoA showed a depression or dimple on its surface in 11 cases (26.83 %). Saccular aneurysm in the ACoA(2.44%) and the junction of ACoA-Precommunicating segment of Anterior cerebral artery(14.63%) in 1 and 7 cases respectively.
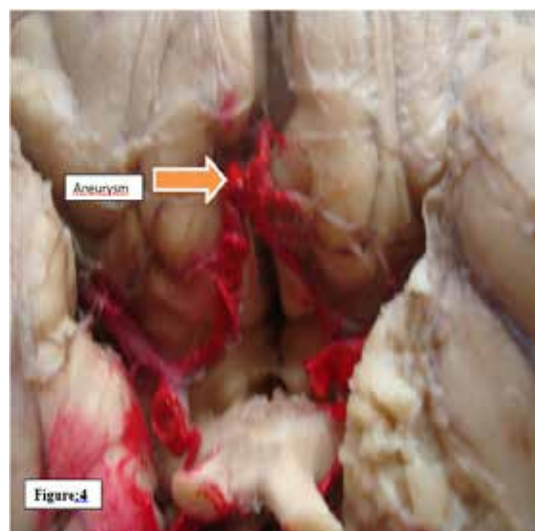

"FIGURE 2 about here"

Figure 2: *Oblique course of the Anterior communicating artery in CW.*

"FIGURE 3 about here"

Figure 3: *"H-shaped" duplication of anterior communicating artery in CW.*

"FIGURE 4 about here"
Figure 4: Aneurysm of Anterior communicating artery in CW.

"FIGURE 5 about here

Figure 5:Hypoplastic and Oblique Anterior communicating artery in the CW.

"FIGURE 6 about here"

Figure 6:Absence or Aplasia of Anterior communicating artery.
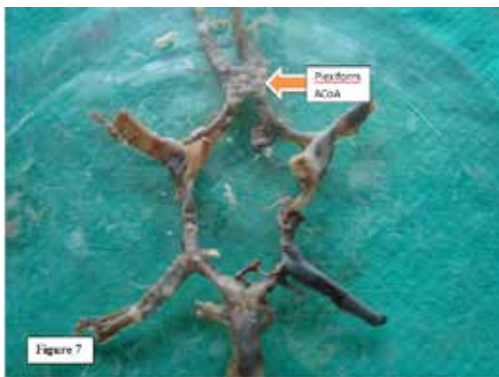
"FIGURE 7 about here"

Figure 7: Plexiform pattern of Anterior Communicating artery.
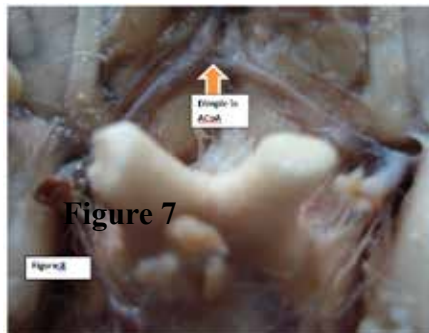
"FIGURE 8 about here"

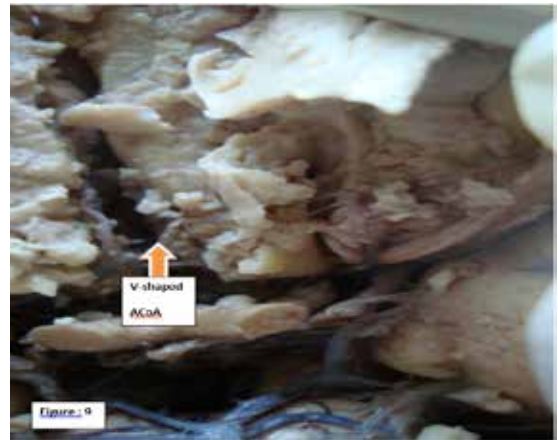**Figure 8:**Dimple in Anterior communicating artery.

"Figure 9 about here"

Figure 9 : V-shaped fenestration of Anterior communicating artery.
"FIGURE 10 about here"

Figure 10:Vernier Callipers

DISCUSSION:
"Table 2 about here"

Table 2:A comparison of the variations and aneurysms present in the Anterior communicating artery in different geographical locations with the present study done in the population of Assam.

AUTHOR (year) / Country	Dimple	Absence	Hypoplasia	Duplica-tion	V,Y,H Shape	Plexiform	Fenestra-tion	Aneurysms
Fawcett & Blachford (1985) UK [9]		0.14		7.28	7.5			
Alpers eT al. (1959) USA [10]		2	2.8		9			
Puchades-orts et al.,(1976) Spain. [11]		3.2	6.4	6.4	3.2	4.8		
Ozaki et al.(1977), , Japan.[12]					18.8			2.7
Fujimoto & Tanaka (1989) Japan. [13]					28			
Efthekar et al. (2006) Iran [7]		1	11					
Reddy et al. (1972) India. [14]		0.6			7			
Kapoor et al. (2008) India [15]		1.8	2.1		10	0.4		1
De Silva et al.(2009) Sri Lanka. [6]			25.07		10			0.4
Kardile et al. (2013) India. [16]	2	8		10		32		

Gunnal (2014) Maharashtra ,India. [17]		8	10	10.66			3.33	
Iqbal (2013) Kerala, India. [18]		4		6				
Von Mitterwallner (1955). [19]		0.27		20.55	3.88			
Vare & Bansal (1970) India [20]		1.14		2.85				
Jain et al. (1990) India [21]		0.69		13.19				
Present Study(2015) Assam,India	26.83	4.88	12.2	12.2	7.32	7.32	2.44	2.44

In the present study percentage of the absence of ACoA (4.88%) was relatively similar to a study done by Iqbal(4%)[18] in Kerala ,India .Hypoplasia was one of the most common variations in the present study (12.2%),by a study done by Efthekar et al (11%) [7] in Iran, Gunnal (10%)[17] in Maharashtra, India and De Silva et al (25.07%)[6] in Sri Lanka . The percentage of V,Y,H,N shaped ACoA in the study done by Reddy et al (7%)[14] was similar to the present study(7.32%).Duplication was the most common variation by a study done by Gunnal (10.66%)[17], Jain et al (13.19%)[21] and one of the common in the present study(12.2 %) .Percentage of Aneurysms involving the ACoA in the present study(2.44%) was relatively close to a study done in Japan by Ozaki et al (2.7%)[12].The current study showed a high incidence of dimples in ACoA (26.83%) unlike only 2% in the study done by Kardile(2%)[2].

SUMMARY:

The present study is based on the analysis made from gross dissection done on 41 post mortem human brains representing the population of Assam. The variations of Anterior communicating artery of the Circle of Willis were photographed and its calibre (external diameter and length) measured by using Vernier Callipers using specific reference points. Data analysed by SPSS revealed Oblique course(34.14%), Dimples(26.83) and Hypoplasia(12.2%) as some of the most common variations of ACoA. Saccular aneurysms(17.07%) were the most common abnormality affecting the ACoA and A1-ACoA junction.

C0NCLUSION:

A larger number of cases needs to be studied in the population of Assam and other geographical regions, racial groups or ethnicity and comparison with similar studies on the ACoA of the CW with more sophisticated methods ie. Magnetic Resonance Angiography is required to come to a statistically significant and valid conclusion whether the variations of ACoA differ in different populations.

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