

**VARIATION OF BRANCHING PATTERN OF MIDDLE CEREBRAL
ARTERY AMONG TANZANIAN CADAVERS.**

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**VARIATION OF BRANCHING PATTERN OF MIDDLE CEREBRAL
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By

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**A Dissertation Submitted in (partial) Fulfillment of the Requirements for the Degree
of Master of Sciences (Human Anatomy) of
Muhimbili University of Health and Allied Sciences**

**Muhimbili University of Health and Allied Sciences
October, 2013.**

CERTIFICATION

The undersigned certifies that he has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled **Variation of Branching pattern of middle Cerebral Artery among Tanzanian Cadavers**, in (partial) fulfillment of the requirements for the degree of Master of Sciences (Human Anatomy) of Muhimbili University of Health and Allied Sciences.

Dr. Dennis Russa

(Supervisor)

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DEDICATION

This dissertation work is dedicated to my beloved parents for their love and support during my life in school. Also I dedicate my work to my beloved wife Pamela Mjema for assisting me during the whole period of my study at MUHAS.

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ABSTRACT

The branches of middle cerebral artery are mostly the sites for aneurysms and the accessories arising from it are usually used as collaterals, therefore during surgical procedures it is necessary to produce the working place sufficiently and to prevent ischemic complication by avoiding injury to those early branches. So there is a need to know the anatomy of the middle cerebral artery, which is the common site for the development of these aneurysms. Knowledge on the early branches and the MCA, the size of these branches and the branching pattern will help surgeons to take necessary precautions in treating these neurosurgical pathologies. Also knowing the branching pattern of the middle cerebral artery will help the radiologists in interpreting the cranial magnetic resonance angiographies.

The aim of this study was to study the variation of the branching pattern of middle cerebral artery among Tanzanian cadavers, and postmortem specimens. In this study the branching pattern of the middle cerebral artery were studied among 70 human cadavers at MNH and dissection rooms found in medical schools in Dar es Salaam and Ifakara. The study cases were taken regardless of their age and sex differences, this was a descriptive cross sectional study, in all these study subjects a coronal incision of the skull were made to expose the brain and the middle cerebral artery was identified from the point it branched the internal carotid artery, we therefore measured the length of the middle cerebral artery using a tape measure and determined the branching pattern of the middle cerebral artery. All 70 brains had bilateral middle cerebral arteries which were continuous from the internal carotid arteries. In 50(71%) of the cases branched within the temporal region, while in 20 (29%) of the cases branched within the frontal region. In 58(83%) cases terminated by bifurcation while the rest of arteries, 12(17%) terminated by trifurcation, and also this study revealed that the average length of the middle cerebral artery from its origin to different parts of termination is 10.5cm, further the study revealed that 2(3%) of the cases showed accessory arteries arising from the prebifurcation region. This study has managed to determine the branching pattern of the middle cerebral artery and these findings will assist clinicians in making proper and

appropriate diagnosis of aneurysms and hence proper treatment, also further studies should be done involving larger sample sizes.

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ABBREVIATIONS

MCA	Middle cerebral artery
AA	Accessory Arteries
MUHAS	Muhimbili University of health and allied science
IMTU	International medical and technological university
SFUCHAS	Saint Francis University College of health sciences
ICA	Internal carotid artery
LSA	Lenticulo striate arteries
MRA	Magnetic Resonance Angiography

CHAPTER 1

INTRODUCTION

The middle cerebral artery (MCA) is one of the three major paired arteries that supply blood to the cerebrum. It arises from the internal carotid artery and continues into the lateral sulcus where it then branches and projects to many parts of the brain. It gives branches to the frontal lobe, temporal lobe and the parietal lobe. The branching pattern of the middle cerebral artery has shown some differences among different populations [12].

The MCA being the largest and most complex of the three cerebral arteries has been the subject of extensive anatomical studies, only a limited number of reports have addressed the features of accessory branches arising from the bifurcation trunk of the MCA. The frequency with which the proximal segment of the MCA is encountered in neurosurgical practice increases the importance of understanding the features specific to the early branches [17].

Knowing the anatomy of the MCA will help surgeons to know the proper approaches in treating these neurosurgical pathologies and will help the radiologists in interpreting the cranial magnetic resonance angiographies[7]. To meet this need, we need to study more on the branching pattern of the middle cerebral artery. An understanding of the branching pattern and accessory arteries and termination pattern and the course and number of cortical arteries and LSAs arising from them has practical application in microsurgical approaches [1,6]. Therefore the aim of this study is to document data on the branching pattern of the middle cerebral artery in Tanzania.

LITERATURE REVIEW

The middle cerebral artery (MCA) is one of the branches that supplies the cerebrum, it shows different types of branching pattern, several studies have been carried out regarding the branching pattern of MCA and found that there is a need of knowing the pattern of branching of cerebral arteries, since it has been found to be injured in people doing boxing and martial arts [1]. Moreover knowledge on branching pattern is important for surgeons to perform microsurgical procedures [2]. Duplications or accessories associated with the branching pattern of the middle cerebral artery play a role in the occurrence of aneurysms [3]. The middle cerebral artery anatomy should be known because of the focal cerebral ischemia in which the artery is frequently occluded [4].

The branching pattern of middle cerebral artery influences frequency of aneurysm and is of potential value in surgical repair and diagnosis of stroke [5]. Also knowing the middle cerebral artery branches help the surgeons to have a better and safer micro dissection plan so as to reduce the risk of neurological defects [6]. The middle cerebral artery with its branching pattern, was found to have some accessory arteries which could be used as collateral to supply blood to parts supplied by the MCA and it was found that the collateral through these accessory arteries could not give sufficient blood supply [7]. This study necessitates more study on the branching pattern that can give other branching accessories that can be used as good collaterals.

Further it was found that the branching pattern of the middle cerebral artery would give accessories which have been found to be anomalies and the main site of aneurysms. This stipulates that, knowing the branching pattern will help in approach of treating aneurysms [8]. Aneurysms are more prevalent in the middle cerebral artery, but the risk of rupture is highest in the vertebrobasilar system [9]. The middle cerebral artery is frequently associated with anomalies, several magnetic resonance angiographies (MRA) have shown anomalies on MCA, therefore knowledge and recognition of these variations is very important during the

Interpretation of Cranial MRA [10]. Accessory middle cerebral arteries have been found to be involved in people or patients with cerebral aneurysms [11].

The branching pattern of the middle cerebral artery among Indian population resembles that of the western population but still there are structural and statistical variations that exist [12]. Therefore there is a need to study more on the branching pattern of the middle cerebral artery among different racial groups. The branching pattern of the middle cerebral artery influence frequency of aneurysms and is of potential value in surgical repair and diagnosis of stroke [13]. Accessory middle Cerebral artery is one of the variation of the intracranial vasculature and these accessory arteries are sites with aneurysms of the anterior cerebral arterial communicating arteries [14]. The duplicates or accessories of the middle cerebral artery (MCA) are closely associated with aneurysms that involve the middle cerebral artery and are used as collaterals for blood supply to the frontal lobe [15].

A Nigerian study was found that the size, course, and distribution, and anomalies of MCA in adult Nigerians resembles that of Caucasians as reviewed from the literature [16].

In East Africa the branching pattern of the MCA was studied and it was found that the branching pattern of the Kenyan population resembles that of other races, hence suggesting equal susceptibility to stroke and aneurysm [17]. However in meeting these challenges, there is a need to know the anatomy of the middle cerebral artery, which is one of the common site for the development of those aneurysms. A detailed knowledge on the early branches arising from the MCA, the size of these branches, and the branching pattern need to be known, since the early branches of the MCA play a key role in treating those aneurysms. Also knowing the branching pattern of the middle cerebral artery will help the radiologists in interpreting the cranial magnetic resonance angiographies. There is no data on the branching pattern of the MCA, therefore this study is important to produce baseline data that may be useful for surgeons and radiologists in understanding and interpreting anatomical patterns and variations that may be crucial in the performance of vascular reconstructive procedures.

STATEMENT OF THE PROBLEM

Complex intracranial aneurysms rank high among the most technically demanding neurosurgical pathologies..Extensive work and effort need to be directed to the treatment of these challenging vascular lesions. However in meeting these challenges, there is a need to know the anatomy of the middle cerebral artery, which is the common site for occurrence of those aneurysms. Knowledge on the early branches arising from the MCA, the size of these branches, and the branching pattern need to be known, since the early branches of the MCA have been reported to be frequently involved in aneurysms.

Knowledge of the branching pattern of the middle cerebral artery is a good tool for radiologists in interpreting the cranial magnetic resonance angiographies. There is no study that has been done in Tanzania. Therefore it is important to document and establish baseline data that will help in the management of cerebral aneurysm.

RATIONALE

The middle cerebral artery is frequently involved in aneurysm and the data on the branching pattern is very important in surgical planning for aneurysm repair. In meeting these challenges, there is a need to know the anatomy of the middle cerebral artery, which is the common site for the occurrence of those aneurysms. Knowing the early branches arising from the MCA, the size of these branches, and the branching pattern helps in treating those aneurysms and also performing anastomosis and grafting. Knowing the branching pattern of the middle cerebral artery will also help the radiologists in interpreting the cranial magnetic resonance angiographies.

From the literature reviewed, it has been found that the collaterals arising from the middle cerebral artery are frequently involved in aneurysm repair. There is therefore a need to have baseline data for the branching pattern. This will be a good reference for cerebrovascular surgeons in Tanzania to perform micro vascular reconstructive procedures such as anastomosis, grafting and reimplantation.

OBJECTIVES

Main objective is to document the branching pattern and variations of MCA among Tanzanian cadavers

Specific objectives

1. To determine the branching pattern of MCA in the parietal, temporal and frontal lobes of 76 brains of human cadavers.
2. To determine the length of the middle cerebral arteries(MCA) at the point it branches off the ICA and the terminal tip of the artery.
3. To determine the accessory arteries arising from the(MCA)
4. To determine the termination pattern of the middle cerebral artery

CHAPTER 2

SAMPLES AND METHODOLOGY

The sample size was calculated by using the Cochran`s formula

$$N = \frac{Z^2 Pq}{E^2}$$

N= Sample size

Z=percentage point corresponding to significant level of 5%=1.96

P=prevalence of early branching of middle cerebral artery is 5.2% (Ogeng'o et .al 2011)

Q=100-p

E=Maximum error likely=5%

N= 76 human brain from cadavers

N= $\frac{1.96 \times 1.96 \times 5.2 \times 94.8}{5 \times 5} = 76$

5x5

METHODOLOGY

76 brains from cadavers processed for dissection were used. Removal of the brain was done by lying the cadaver in the supine position, coronal section of the scalp was done between the left and right mastoid process. Using the scalpel the temporalis muscle was reflected inferiorly. After the reflection the bone of the calvaria was seen and it was cleaned using the scalpel. Then a rubber band was put around the circumference of the skull, and it was 2cm superior to the supraorbital margin and 2cm superior to the external occipital protuberance. Then using a pencil a line was marked around the circumference of the skull. The saw was used to cut along the pencil line. While sawing the cadaver was alternated from the supine to prone position. Then the calvaria was removed from the dura matter using the handle of the forceps. Using two fingers of the hand which were inserted to the brain stem, the brain stem was cut and the brain was removed. After removal, of the brain the middle cerebral artery was identified and the length was measured and observed the branching pattern and termination pattern of the middle cerebral artery, also photographs were taken.

ETHICAL CLEARANCE

The ethical clearance was obtained from MUHAS ethical clearance committee, and also from Muhimbili national hospital, and SFUCHAS

Data analysis

The data was analyzed by using the statistical package for social sciences (SPSS). They were presented in tables and frequencies were calculated.

CHAPTER 3

RESULTS

Observations were made on the middle cerebral arteries of 76 human cadavers and autopsy cases; from which 70 were suitable for the study, the rest of the brain from 6 human cadavers were not suitable for the study. Among the 70 human cadavers, 65 human cadavers were males, while 5 human cadavers were females. The specimens were obtained from autopsy done at Muhimbili National Hospital and from dissection rooms at SFUCHAS and MUHAS.

3.1 Variation of the termination pattern of the middle cerebral artery

In 58(83%) of the cases the MCA terminated by bifurcation, while 12 (17%) of the cases terminated by trifurcation

Table 1: Variations of the termination pattern of the middle cerebral artery

Termination pattern	Number of cases	Percentage
Bifurcation	58	83%
Trifurcation	12	17%
Total	70	100%

3.2 Variation of pattern of branching of the MCA

In 50(71%) of the cases the MCA branched within the temporal region, while in 20(29%) of the cases branched within the frontal region.

Table 2: Variations of the pattern of branching

Region	Number of cases	Percentage
Temporal	50	71%
Frontal	20	29%
Total	70	100%

4.1 Variations of the lengths of the middle cerebral artery

The length of the middle cerebral artery was measured from the point it branches off the internal carotid artery to different points where it either terminated by bifurcation or trifurcation, and the average lengths of the middle cerebral artery was found to be 10.05cm, from the point of origin to different parts of termination

Number of cases	Range of length of the middle cerebral artery(cm)
19	8.5-9.5
51	9.5-10.5

In this study the accessory arteries arising from the middle cerebral artery were also studied and it was found that 2(3%) cases showed accessory arteries arising from the pre bifurcation region, the rest of the middle cerebral arteries had no accessory arteries..

Termination by bifurcation

One of the branches of the MCA

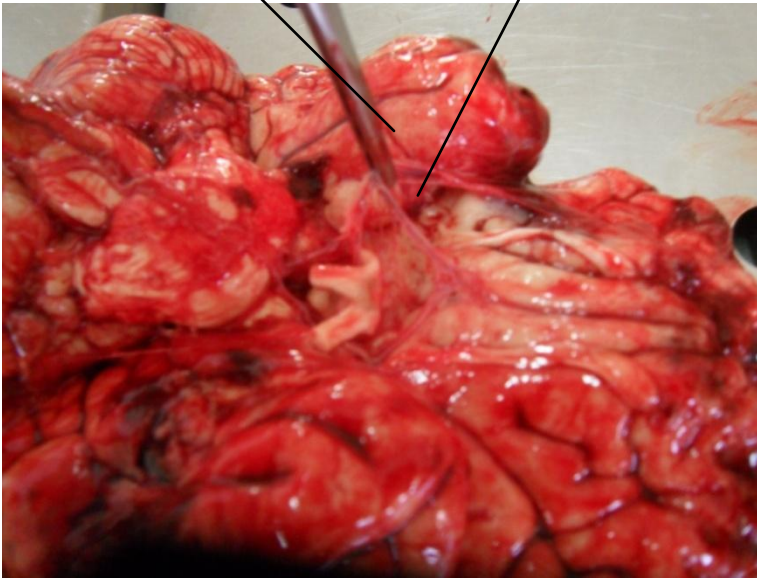


FIGURE 1:

A – One of the branches from the middle cerebral artery

B - Termination pattern by bifurcation

Termination by trifurcation

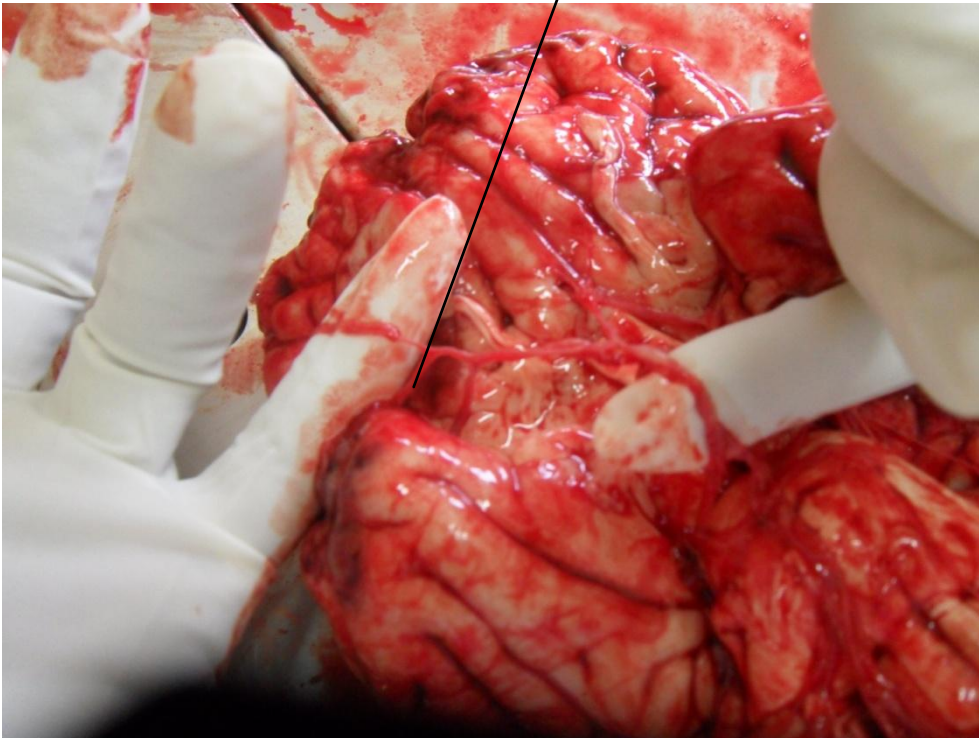


FIGURE 2:

A – Termination pattern of the middle cerebral artery by trifurcation

Internal carotid artery

Accessory artery arising from the MCA

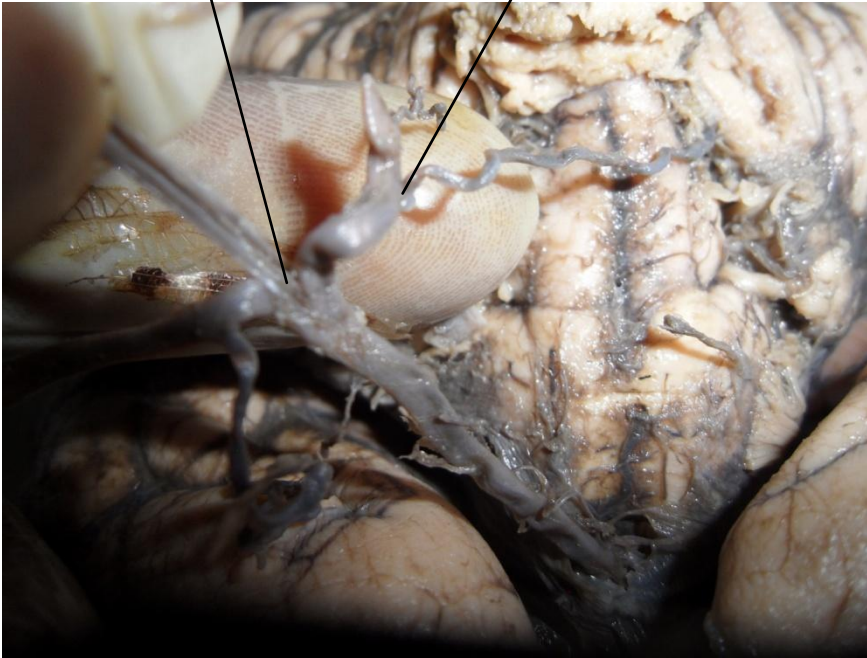


FIGURE 3:

A – Accessory artery arising from the middle cerebral artery

B – Point of origin of the middle cerebral artery from the internal carotid artery

CHAPTER 4

DISCUSSION

This study is the first to be carried out in Tanzania however such studies have been carried out in Europe and America, and also other countries in Africa like Nigeria and Kenya. Results obtained will be useful as baseline data in the treatment of aneurysms. This study has revealed that the origin of the middle cerebral artery is the internal carotid artery; this is consistent with other report [12]. This gives an implication that if the internal carotid artery is occluded, then it will impair perfusion of the areas usually supplied by the middle cerebral artery.

Accessory branches were also seen among 2(3%) cases, which were arising from the pre bifurcation region, these accessory arteries probably arose during embryological period, and they are very important because they can serve as collaterals when there is middle cerebral artery occlusion [7,8,17], during surgical procedures if they are damaged can lead to ischaemia and brain infarcts[7,8]

50(71%) cases branched in the temporal region, while in the frontal region, 20(29%) cases branched, these results obtained show that there is consistency with the literature report [12] and in Nigeria, the same study revealed the results that showed that the branching pattern was more frequent in the temporal[16]

Termination pattern was also studied and found out that 58(83%) cases terminated by bifurcation, and 12(17%) cases were found terminating by trifurcation, there was no case which terminated by quadrifurcation. Therefore this termination pattern resembles other populations like Kenyans, Indians and Nigerians [9,12, 16].

The study also gave the results of the middle cerebral artery from the point of origin to different points of termination, and it has been found that the average length of the middle cerebral artery is 10.05cm, from its origin to different points of termination (i.e. bifurcation or trifurcation, in many literatures I reviewed, there are no data about the length of the middle cerebral artery, This study therefore shows that the branching pattern of the middle cerebral artery of the Tanzanian population is actually similar to other population and therefore our population is prone to aneurysms and stroke which do occur mostly to points of bifurcation, therefore much carefulness during microsurgical procedures on the middle cerebral artery is insisted.

CHAPTER 5

CONCLUSION

The branching pattern of the middle cerebral artery in Tanzanian cadavers resembles that of other populations.

RECOMMENDATIONS

1. This is the first study in Tanzania to establish the variation of the branching pattern of the middle cerebral artery. Further studies should be done involving larger sample sizes and in different localities within Tanzania.

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APPENDICES

Data Sheet.

1. Case number
2. Sex Male
- Female.....

- 1 Pattern of termination of the middle cerebral artery
1. Trifurcation.....
2. Bifurcation.....

- 2 Branching pattern of the middle cerebral artery
1. Temporal region
2. Frontal region

- 3 Accessory arteries arising from the middle cerebral arteries.....

- 4 Length of the middle cerebral artery from point of origin to different parts of
 termination.....