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Review

Anatomy of the Middle Cerebral Artery: Cortical Branches, Branching Pattern and Anomalies

Karen CILLIERS, Benedict John PAGE

Stellenbosch University, Department of Anatomy and Histology, Cape Town, South Africa

ABSTRACT

The middle cerebral artery (MCA) covers a large part of the cerebral hemispheres and is therefore exposed during surgical intervention in this area. Aspects of cerebral branches tend to vary, different branching patterns can be described, and several anomalies can be observed. Knowledge of these variations and anomalies is important and can be helpful to neurosurgeons and clinicians. The aim of this manuscript was to review the available literature on the cortical branches, branching pattern and anomalies of the MCA, to identify the gaps in the literature, and to fill these gaps by including the results of a pilot study.

Twenty hemispheres were perfused with colored silicone and the MCA was dissected. For the cortical branches, the diameter, length, presence, duplication and origins were noted. Most commonly duplicated was the anterior parietal artery in 30.0%, and most commonly absent was the common temporal artery in 65.0%. A detailed description on the origins is given. Criteria were described for the bifurcation subtypes and medial bifurcation (50.0%) was most commonly observed. No anomalies were observed.

Aspects previously neglected of the MCA cortical branches were reported in the pilot study. The branching subtypes were identified and criteria are given. Illustrations of the different branching subtypes and anomalies are provided. Certain aspects of the MCA anatomy have been neglected, and future studies should give adequate descriptions of the MCA cortical branches, MCA branching pattern, and any anomalies observed.

KEYWORDS: Anomaly, Bifurcation, Branching, Cortical branch, Middle cerebral artery, Trifurcation, Variation

INTRODUCTION

The middle cerebral artery (MCA) covers a large part of the cerebral hemispheres and is exposed during surgical intervention in this area (17,63). Aspects of cerebral branches tend to vary, different branching patterns can be described, and several anomalies can be observed. Knowledge of these variations and anomalies is important and can be helpful to neurosurgeons and clinicians (20). The diameter, length, absence and duplication of the MCA cortical branches are not thoroughly reported. Furthermore, descriptions of the origins and possible common trunks of these branches are still lacking in the literature. Bifurcation and trifurcation branching types are usually described, while most studies fail to mention the different subtypes. Moreover, there is still some confusion on the criteria of these different subtypes. The MCA anomalies are often mentioned in the literature, although the subtypes are rarely elaborated on. Therefore, the aim of this study was to firstly review the available literature on the cortical branches, branching pattern and anomalies of the MCA, secondly to identify the gaps in the literature, and lastly to fill these gaps by including the results of a pilot study.

REVIEW

This review will include a discussion on the cortical branches, on the branching pattern and on the possible anomalies, since these aspects can vary tremendously. The cortical branches typically arise from the main MCA trunk, which can be divided

Corresponding author: Karen CILLIERS
E-mail: 16173112@sun.ac.za

into four segments; the M1 segment (sphenoid or horizontal segment), the M2 segment (insular segment), the M3 segment (opercular segment), and the M4 segment (cortical branches). The branching of the MCA involves the trunk (M1 or M2 segment) of the MCA dividing into two or three smaller trunks. Anomalies can be observed at the first part of the MCA trunk, which includes extra vessels and fenestration (5,39,56,63). The cortical branches, the branching pattern, and the possible anomalies of the MCA will be discussed separately.

Cortical Branches

The cortical branches include the orbitofrontal artery (OfA), prefrontal artery (PfA), precentral artery (PcA), central artery (CA), anterior and posterior parietal arteries, angular artery (AA), temporal arteries (temporopolar, anterior, middle and posterior temporal arteries) and temporo-occipital artery (ToA). These cortical arteries can arise prior to the branching, from the trunks formed by the branching, from another cortical branch or in conjunction with another cortical branch (56). The most common origins of these cortical arteries are illustrated in Figure 1.

Origin prior to branching: If a cortical artery originates prior to the initial branching, the artery is referred to as an "early branch". Early branches can be divided into early frontal branches (EFB) or early temporal branches (ETB) (7,17,23,55,63,71). The OfA, temporopolar artery and anterior temporal artery (ATA) typically arise as early branches (17,63). Four configuration can be defined; no early branches, only EFB, only ETB, or early frontal and early temporal branches (75). Rhoton (63) stated that there is typically only one early branch present, while Ciszek et al. (7) stated that an EFB was frequently positioned between two ETB. Gibo et al. (17) observed five cases (10.0%) of EFB and 17 cases (34.0%) of early temporal branches. Furthermore, Ogeng'o et al. (55) observed 104 cases (36.1%) of EFB and 184 cases (63.9%) of early temporal branches.

Origin after branching: When the cortical branch arises after the branching, it can originate from the superior, middle or inferior trunk. In bifurcation and trifurcation (Figure 1), the inferior trunk usually gives rise to the temporal arteries. The parietal arteries and the angular artery can arise from either trunk in bifurcation, and usually arises from the middle trunk in trifurcation. If bifurcation occurs, the superior trunk typically gives rise to the OfA, prefrontal, precentral and central arteries. With the trifurcation pattern, the superior trunk usually gives rise to the OfA and prefrontal arteries, while the precentral and central arteries can originate from either the superior or the middle trunk (5,39,47,63,72,84).

Branching Pattern

The branching pattern is determined by the division of the main trunk into smaller trunks. Bifurcation and trifurcation is most commonly described, although other types have been observed and several subtypes can be identified. Eleven different branching types can be distinguished from the literature and these include bifurcation subtypes (medial bifurcation, lateral bifurcation, medial pseudobifurcation, and lateral pseudobifurcation), trifurcation subtypes (true trifurcation, pseudotrifurcation, proximal trifurcation, and distal trifurcation), monofurcation, tetrafurcation, and pseudotetrafurcation (Figure 2A-K) (5,19,39,56).

Bifurcation subtypes: For the bifurcation subtypes, medial and lateral branching refers to the distance of the branching from the MCA origin (either close or further away, respectively). In pseudobifurcation (also referred to as false bifurcation), a large cortical artery originates from the main trunk and gives a false impression of a bifurcation (39).

Trifurcation subtypes: In the trifurcation subtypes, true trifurcation (Figure 2H) is rarely observed. In the other trifurcation subtypes, the MCA bifurcates and the dominant branch subsequently bifurcates again to give rise to a middle branch. In pseudotrifurcation (Figure 2I), the first and second bifurcation is less than 2 mm apart. With proximal trifurcation (Figure 2J), the most common subtype, the two bifurcations are more than 2 mm apart. In distal trifurcation (Figure 2K) the two bifurcations are more than 2 mm apart, and more than a quarter of the distance between the MCA origin and the first bifurcation (28).

Other branching types: Grellier et al. (19) described monofurcation as branching after the limen insulae, although monofurcation can also be termed when there is no division of the main trunk. Tetrafurcation (Figure 2B) is when the branching forms four trunks, and pseudotetrafurcation (Figure 2C) is when both the inferior and superior trunks bifurcate again near the initial bifurcation (25).

The prevalence of the branching types and subtypes is summarized in Table I. Monofurcation was observed in 3.8% to 17.5% of cases, bifurcation was present in 64.3% to 92.7% of cases, and trifurcation was found in 7.0% to 61.0% in previous literature. Pseudotrifurcation was reported in 3.0% (three cases) (1), 15.0% (five cases) (28) and 20.0% (two cases) (59) in previous studies. Kahilogullari et al. (28) observed proximal trifurcation in 55.0% (18 cases) and distal trifurcation in 30.0% (ten cases). Tetrafurcation was present in 0.7% to 10.0% (17,55,82-84) of cases, and pseudotetrafurcation was reported in one case (3.3%) (25).

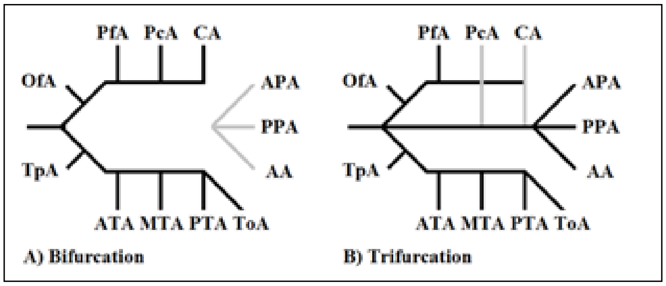

Figure 1: The most common origins of the cortical branches originating from the superior, inferior and middle trunk (grey illustrates more than one typical origin). (AA) Angular artery; (APA) Anterior parietal artery; (ATA) Anterior temporal artery; (CA) Central artery; (MTA) Middle temporal artery; (OfA) Orbitofrontal artery; (PcA) Precentral artery; (PfA) Prefrontal artery; (PPA) Posterior parietal artery; (PTA) Posterior temporal artery; (ToA) Temporo-occipital artery; and (TpA) Temporopolar artery.

Table I: The Prevalence of Monofurcation, Bifurcation, Trifurcation and Tetrafurcation

		Monofurcation		Bifurcation		Trifurcation		Tetrafurcation	
Authors	**Total**	**Cases**	**%**	**Cases**	**%**	**Cases**	**%**	**Cases**	**%**
Jain (1964) (27)	300	-	-	270	90.0%	30	10.0%	-	-
Grellier et al. (1978) (19)	280	49	17.5%	199	71.1%	32	11.4%	-	-
Gibo et al. (1981) (17)	50	-	-	39	78.0%	6	12.0%	5	10.0%
Umansky et al. (1984) (84)	70	4	5.7%	45	64.3%	20	28.6%	1	1.4%
Antunes (1985) (2)	37	-	-	33	89.2%	4	10.8%	-	-
Umansky et al. (1985) (83)	34	-	-	24	70.6%	7	20.6%	3	8.8%
Umansky et al. (1988) (82)	104	4	3.8%	69	66.3%	27	26.0%	4	3.8%
Anderhuber et al. (1990) (1)	100	-	-	-	-	7	7.0%	-	-
Meneses et al. (1997) (47)	14	1	7.1%	12	85.7%	1	7.1%	-	-
Idowu et al. (2002) (23)	100	6	6.0%	81	81.0%	13	13.0%	-	-
Kulenović et al. (2003) (39)	-	-	-	-	70.0%	-	30.0%	-	-
Tanriover et al. (2003) (71)	50	-	-	44	88.0%	6	12.0%	-	-
Tanriover et al. (2004) (72)	43	-	-	38	88.4%	5	11.6%	-	-
Pai et al. (2005) (59)	10	-	-	8	80.0%	-	-	-	-
Vuillier et al. (2008) (87)	100	17	17.0%	73	73.0%	9	9.0%	-	-
Nowinski et al. (2009) (53)	-	-	-	-	78.0%	-	12.0%	-	-
Ogeng'o et al. (2011) (55)	288	18	6.3%	237	82.3%	31	10.8%	2	0.7%
Sadatomo et al. (2013) (64)	124	-	-	115	92.7%	9	7.3%	-	-

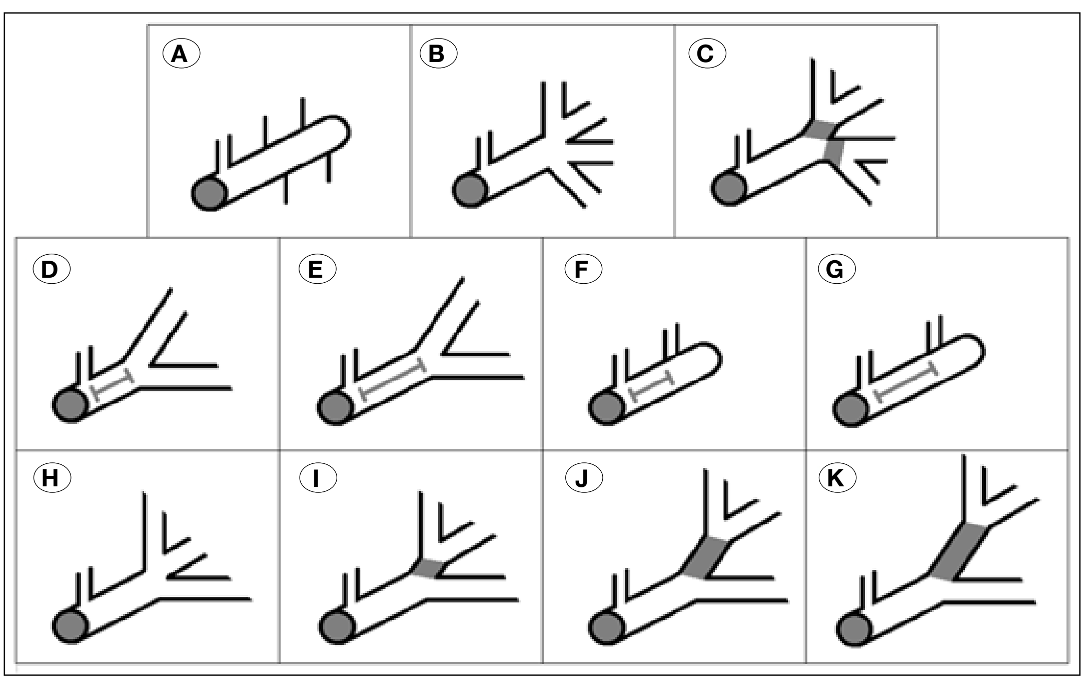

Figure 2: The 11 different branching patterns of the middle cerebral artery. **A)** Monofurcation; **B)** Tetrafurcation; **C)** Pseudotetrafurcation; **D)** Medial bifurcation; **E)** Lateral bifurcation; **F)** Medial pseudobifurcation; **G)** Lateral pseudobifurcation; **H)** True trifurcation; **I)** Pseudotrifurcation; **J)** Proximal trifurcation; and **K)** Distal trifurcation.

Early branching: Excluding the bifurcation subtypes, the other branching types do not specify any criteria for how far from the MCA origin it can be observed. If branching occurs within 5 mm from the MCA origin, it is referred to as early branching (31,55,73,77). Early branching has also been defined as branching within the proximal half of the M1 segment (90). Grellier et al. (19) stated that the main trunk could be either short (3-12 mm), medium (13-22 mm) or long (23-40 mm). The short length could refer to early branching; however, most authors (31,55,73,77) agree that branching within 5 mm is referred to as early branching. Teal et al. (73) reported three cases, one branched at 3 mm and two branched at 4 mm from the MCA origin. Forty-three cases of early branching have been reported in previous literature, with a range of 2.7% to 11.3% (2,18,31,32,55,58). Early branching can be observed unilaterally or bilaterally (60).

Anomalies

True anomalies occur more frequently in other cerebral arteries compared to the MCA, although the three most common anomalies include fenestration, a duplicated MCA and an accessory MCA (Figure 3A-K) (17,23,25,36,56,57,73,82). The duplicated and accessory MCAs are additional branches; the accessory MCA arises from the anterior cerebral artery, while a duplicated MCA originates from the internal carotid artery (ICA) (5,17,37,39,73). The duplicated MCA usually supplies the temporal lobe and the accessory MCA typically supplies the frontal lobe (25,30,57, 60,77,80).

Duplicated middle cerebral artery: Two subtypes can be defined concerning origin and diameter (Figures 3F and 3G). Type A (most common) has a similar diameter compared to the main MCA trunk and arises from the top of the ICA (a more distal origin). Type B has a smaller diameter compared to the main MCA trunk and arises between the top of the ICA and anterior choroidal artery (a more proximal origin) (29,50). Type A can be regarded as an atypical early arising MCA trunk, and Type B as an atypical early arising MCA cortical branch (6).

The duplicated MCA was present in 0.3% to 7.1% (Table II) of cases in the literature. Kobari et al. (36) observed two additional branches (triplicated MCA), and all three branches originated from the ICA. Lame et al. (43) observed a “crossover” duplicated MCA that supplied the right hemisphere despite the branch originating from the left ICA.

Accessory middle cerebral artery: Compared to a duplicated MCA, the accessory MCA is typically smaller and consequently supplies a smaller area (37). The accessory MCA usually arises from the A1 segment close to the origin of

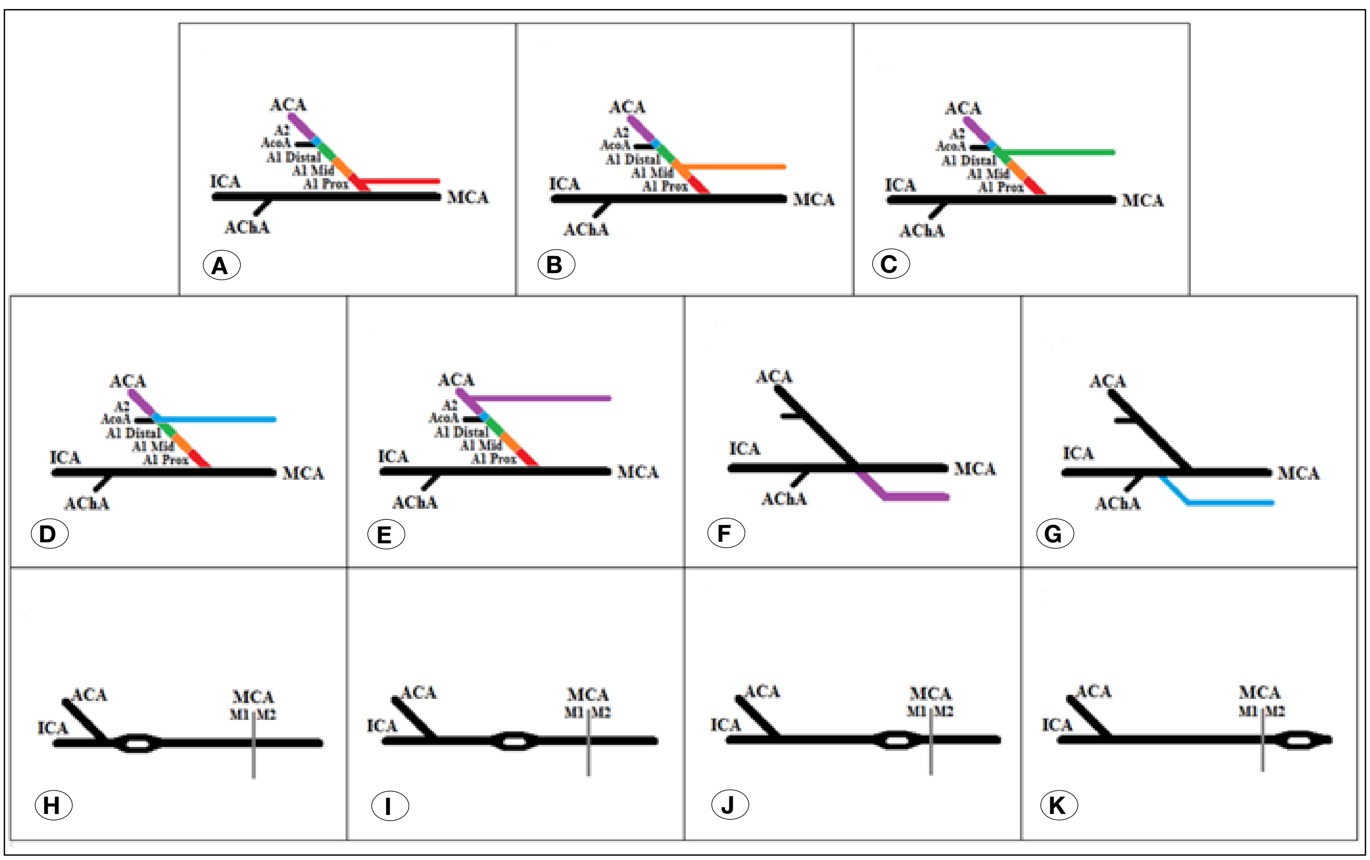

Figure 3: Anomalies of the middle cerebral artery. **A)** Accessory MCA from proximal A1 segment; **B)** Accessory MCA from middle A1 segment; **C)** Accessory MCA from distal A1 segment; **D)** Accessory MCA from AcoA level; **E)** Accessory MCA from A2 segment; **F)** Duplicated MCA Type A; **G)** Duplicated MCA Type B; **H)** Proximal M1 fenestration; **I)** Intermediate M1 fenestration; **J)** Distal M1 fenestration; and **K)** M2 segment fenestration.

Table II: The Prevalence of Duplicated and Accessory MCAs, and MCA Fenestration

	Total	Duplicated MCA		Accessory MCA		Fenestration	
Authors		**Cases**	**%**	**Cases**	**%**	**Cases**	**%**
Crompton (1962) (9)	347	10	2.9%	1	0.3%	1	0.3%
Jain (1964) (27)	300	2	0.7%	8	2.7%	-	-
Wollschlaeger et al. (1967) (89)	582	-	-	-	-	1	0.2%
Ito et al. (1977) (26)	1129	-	-	-	-	3	0.3%
Grellier et al. (1978) (19)	280	1	0.4%	3	1.1%	-	-
Milenković (1981) (48)	60	1	1.7%	-	-	-	-
Kayembe et al. (1984) (32)	44	-	-	4	9.1%	-	-
Kayembe et al. (1984) (32)	146	-	-	10	6.8%	-	-
Umansky et al. (1984) (84)	70	-	-	2	2.9%	-	-
Antunes (1985) (2)	37	-	-	-	-	1	2.7%
Kitami et al. (1985) (35)	704	6	0.9%	4	0.6%	4	0.6%
Tran-Dinh (1986) (74)	150	-	-	3	2.0%	-	-
Umansky et al. (1988) (82)	104	1	1.0%	2	1.9%	1	1.0%
Yamamoto et al. (1992) (90)	455	7	1.5%	14	3.1%	-	-
Sanders et al. (1993) (65)	5190	-	-	-	-	9	0.2%
Meneses et al. (1997) (47)	14	1	7.1%	1	7.1%	-	-
Ozaki et al. (1997) (58)	153	2	1.6%	9	5.9%	-	-
Uchino et al. (2000) (76)	425	9	2.1%	5	1.2%	2	0.5%
Gailloud et al. (2002) (15)	1170	-	-	-	-	5	0.4%
Idowu et al. (2002) (23)	100	-	-	1	1.0%	-	-
Tanriover et al. (2003) (71)	50	1	2.0%	2	4.0%	-	-
Uchino et al. (2003) (78)	900	14	1.6%	-	-	-	-
Karazincir et al. (2004) (31)	176	1	0.6%	-	-	-	-
Tanriover et al. (2004) (72)	43	-	-	2	4.7%	-	-
Kim et al. (2005) (33)	448	2	0.4%	2	0.4%	2	0.4%
Kim et al. (2005) (33)	743	6	0.8%	1	0.1%	1	0.1%
D'Ávila & Schneider (2006) (10)	50	-	-	1	2.0%	-	-
Bharatha et al. (2008) (4)	504	-	-	-	-	2	0.4%
Vuillier et al. (2008) (87)	100	-	-	-	-	3	3.0%
Gielecki et al. (2009) (18)	304	2	0.7%	-	-	-	-
Kim & Lee (2009) (34)	1250	-	-	16	1.3%	-	-
van Rooij et al. (2009) (86)	208	-	-	-	-	12	5.8%
Bayrak et al. (2011) (3)	395	-	-	-	-	4	1.0%
Chang & Kim (2011) (6)	1250	9	0.7%	-	-	-	-
Chang & Kim (2011) (6)	1452	9	0.6%	-	-	-	-

Table II: Cont.

	Total	Duplicated MCA		Accessory MCA		Fenestration	
Authors		**Cases**	**%**	**Cases**	**%**	**Cases**	**%**
Chang & Kim (2011) (6)	2527	7	0.3%	-	-	-	-
Ogeng'o et al. (2011) (55)	288	5	1.7%	-	-	-	-
Sun et al. (2012) (68)	4652	-	-	-	-	3	0.06%
Uchino et al. (2012) (77)	3491	-	-	-	-	3	0.09%
Hamidi et al. (2013) (21)	500	7	1.4%	1	0.2%	10	2.0%
Cooke et al. (2014) (8)	10927	-	-	-	-	10	0.09%
Kovač et al. (2014) (38)	455	-	-	-	-	1	0.2%
van Rooij et al. (2015) (86)	140	-	-	-	-	4	2.9%

the anterior communicating artery (AcoA) (9, 17,63,71,84,91), although, the accessory MCA can be classified into five different subtypes with regards to the region of the anterior cerebral artery it arises from (Figures 3A-E). This branch can originate from the A1 segment (proximal (33,76), middle (34) or distal part (33,76), at the AcoA level, or from the A2 segment (34).

The accessory MCA was observed in 0.1% to 9.1% (Table II) by previous authors. Two accessory MCAs can be present in the same hemisphere (88) and Kim and Lee (34) reported a case of bilateral accessory MCAs. Gibo et al. (17) and Kitami et al. (35) described a hemisphere with an accessory and a duplicated MCA.

Fenestration: Fenestration is when a vessel has a common origin, splits into two channels and then rejoins (4,15,60). These fenestrations can be either small slit-like or large convex-like (8, 79) and small slit-like fenestrations are the most common (18). Fenestrations of the MCA are typically observed in the M1 segments, although it can also be present in the M2 segment (Figure 3K). Three subtypes of M1 segment fenestrations can be defined; the proximal, intermediate and distal type (Figures 3H, I, J). Fenestration of the proximal M1 segment is the most common (11,25,26,33,52,66,76,79)). Middle cerebral artery fenestrations were present in 0.1% to 5.8% (Table II) of cases in the literature. Several previous studies noted that the temporopolar artery frequently arises as an early temporal branch in association with fenestrations (15,25,26,33,60,77,79).

Selected authors noted an association between duplicated MCAs and aneurysms (50,61,62), although very few studies have reported aneurysms at the origin or near the anomalous branch (12,24,29,42,49,57,70). Several authors observed an association between accessory MCAs and aneurysms (30,80,91). Few studies have, however, reported aneurysms at the origin or near the anomalous branch (14,16,22,41,45,46,51,67,88). Fenestration might predispose patients to aneurysm formation (62) and selected authors have observed an association between fenestration and aneurysms (proximal or distal to the fenestration) (13,44,52,54,62,65,81). Limited studies have, however, reported aneurysms at the site of the MCA fenestration (11,26,66,69). Furthermore, van Rooij et al. (85) noted that fenestrations with and without aneurysms were not statistically significantly different.

In summary, information on the origin of the cortical branches is available; however, cortical branches arising from or in conjunction with another cortical branch have not been described. Additionally, few reports have been given on the diameter, length, absence and duplication of MCA cortical branches. Eleven different branching types can be distinguished from the literature; however, some criteria are still lacking. The prevalence of the MCA anomalies has been adequately reported in the literature; however, few studies mention the different subtypes. Therefore, a pilot study was done to fill these gaps.

■ PILOT STUDY

For the pilot study, 20 hemispheres were perfused with colored silicone and the MCA was dissected (Figure 4). The diameter and length of the cortical branches were measured, any absent or duplicated arteries were reported, and the origins were noted. The diameter was measured using a digital micrometer and the length was measured using string and a ruler. The branching pattern was identified and any anomalies were noted.

■ RESULTS

Cortical Branches

There is substantial deviation in the size, number and origin of the MCA cortical branches (17). Table III gives the frequency that each cortical branch was observed and duplicated. The average diameter and length of each cortical branch is noted, as well as the origins.

The temporopolar artery was the smallest and shortest artery and the posterior parietal artery was the largest and longest cortical branch. Most commonly absent was the common temporal artery in 65.0% and most commonly duplicated was the anterior parietal artery in 30.0%. There were no triplicated cortical branches.

The inferior trunk usually gave rise to the temporal arteries and the superior trunk typically gave rise to the OfA, PfA, precentral and central arteries. The angular artery and parietal arteries originated from either the superior or the inferior trunk. The temporopolar artery (54.5%) and the prefrontal artery (27.8%) typically originated as early branches. Common trunks included the PfA and precentral artery in 42.1%, the temporopolar artery and ATA in 31.6%, and the PcA and central artery in 31.6% of cases.

Figure 4: Illustration of the middle cerebral artery perfused with a colored silicone.

Branching Pattern

Eleven different branching types can be distinguished from the literature (Figure 2A-K). However, the precise distances used to classify the different branching subtypes are not reported in previous studies. Since most authors define early branching as branching before 5 mm (40,71), medial and lateral branching were defined as branching between 5 mm and 20 mm, and branching after 20 mm, respectively.

The bifurcation subtypes that were observed included medial bifurcation (50.0%), lateral bifurcation (25.0%), and lateral pseudobifurcation (5.0%). Medial pseudobifurcation was not observed. Trifurcation subtypes that were observed included proximal trifurcation (10.0%) and distal trifurcation (5.0%). True trifurcation and pseudotrifurcation were not observed. Not all studies differentiate between true trifurcation and pseudotrifurcation since these branching types are very similar. Nevertheless, this distinction is important to determine the correct prevalence of these branching types. Tetrafurcation and pseudotetrafurcation were not observed, however, one case of monofurcation was present. The prevalence of these branching subtypes has a large range, and this may indicate that authors do not always use the same criteria for the same branching types.

Table III: The Average Diameter (mm), Average Length (mm), Presence, Duplication and Origins of the Middle Cerebral Cortical Branches Observed in the Pilot Study

	OfA	PfA	PcA	CA	APA	PPA	AA	ToA	CTA	TpA	ATA	MTA	PTA
Presence	95.0	90.0	95.0	100	90.0	100	95.0	65.0	35.0	60.0	95.0	90.0	90.0
Duplication	15.0	5.0	25.0	25.0	30.0	15.0	5.0	-	-	-	-	-	5.0
Diameter	1.4	1.5	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.1	1.2	1.1	1.4
Length	33.1	43.3	63.5	65.0	74.6	90.9	90.0	81.6	33.7	33.0	38.7	61.9	66.0
EB	23.8%	22.2%	-	-	-	-	-	-	16.7%	54.5%	27.8%	-	16.7%
INF	-	-	-	4.3%	17.4%	40.9%	78.9%	91.7%	66.7%	27.3%	50.0%	47.1%	61.1%
SUP	47.6%	77.8%	95.7%	91.3%	78.3%	50.0%	21.1%	8.3%	-	-	-	-	-
CTA	-	-	-	-	-	-	-	-	-	18.2%	22.2%	29.4%	11.1%
PfA	28.6%	-	-	-	-	-	-	-	-	-	-	-	-
PcA	-	-	-	4.3%	-	-	-	-	-	-	-	-	-
CA	-	-	4.3%	-	4.3%	-	-	-	-	-	-	-	-
AA	-	-	-	-	-	9.1%	-	-	-	-	-	-	-
ToA	-	-	-	-	-	-	-	-	-	-	-	5.9%	11.1%
PTA	-	-	-	-	-	-	-	-	16.7%	-	-	17.6%	-

Monofurcation was excluded for origins. ***AA:*** *Angular artery,* ***APA:*** *Anterior parietal artery,* ***ATA:*** *Anterior temporal artery,* ***CA:*** *Central artery,* ***EB:*** *Early branches,* ***INF:*** *Inferior trunk,* ***MTA:*** *Middle temporal artery,* ***OfA:*** *Orbitofrontal artery,* ***PcA:*** *Precentral artery,* ***PfA:*** *Prefrontal artery,* ***PPA:*** *Posterior parietal artery,* ***PTA:*** *Posterior temporal artery,* ***ToA:*** *Temporo-occipital artery,* ***TpA:*** *Temporopolar artery, and* ***SUP:*** *Superior trunk.*

Anomalies

Unfortunately, there were no MCA anomalies observed in the 20 hemispheres. The average prevalence of the MCA anomalies calculated from Table II are very low (accessory MCA (1.4%), duplicated MCA (0.9%) and MCA fenestration (0.3%)). This low prevalence indicates that a larger sample size is needed.

DISCUSSION

This study reviewed the available literature on the cortical branches, branching pattern and anomalies of the MCA. A pilot study was done to fill the gaps that were identified. Limited research with regard to the diameters, length, presence and duplication of the MCA cortical branches have been done, therefore these aspects were reported in the pilot study. The origins and possible common trunks are also not thoroughly discussed in the literature and were thus noted in the pilot study. The MCA branching types have been discussed in previous studies, although the subtypes are normally neglected. The criteria for each branching subtype has not been previously described, therefore this was described in the pilot study. The branching types were identified in the 20 hemispheres and an illustration of the different subtypes is given to ensure there is no confusion on these subtypes in future studies. Although there were no MCA anomalies observed in the pilot study, the review summarized the prevalence and described the different subtypes. An illustration of these anomalies is given to ensure future studies can correctly classify the anomalies, and consequently be able to mention the specific subtypes.

A shorter length may play a role in aneurysms formation and changes in diameter can indicate certain diseases (92). Knowing the range of these aspects is therefore important. Aneurysms are frequently observed at areas where branching occurs; therefore, knowledge on the different patterns is crucial for aneurysm related surgeries (17,28,55). The accessory or duplicated MCA can offer potential collateral supply in the event of a stroke; therefore, the clinical signs of a stroke can be confusing if the anatomy of the MCA is not known (27,55,73,84). Furthermore, these anomalies may be associated with aneurysms.

CONCLUSION

Certain aspects of the MCA anatomy have been neglected. Future studies should give adequate descriptions of the MCA cortical branches, MCA branching pattern, and any anomalies observed.

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