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# Assessment of Variations in Branching Pattern of Middle Cerebral Artery

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#### **KEYWORDS**

**ABSTRACT:** Middle Cerebral Background Artery, In the domain of cerebral vasculature, the middle cerebral artery (MCA) takes center stage as the Neuroangiography most expansive and intricate conduit. Regrettably, a comprehensive cataloguing of MCA patterns Patterns, and anomalies remains elusive. The existing landscape is muddled, shrouded in uncertainty Neuroangiography regarding the delineation criteria for distinct subtypes. The significance of unravelling the Anomalies. intricacies of MCA patterns and anomalies lies in the fact that variations, such as accessories or duplications, pose a formidable threat in the context of endovascular embolization or navigation procedures for ischemic stroke treatment. This research embarked on a meticulous examination, delving into the intricacies of neuroangiography patterns and anomalies associated with the middle cerebral artery. Methods: We undertook a methodical examination, scrutinizing fifteen articles from online databases, encompassing English contributions from PubMed, the Cochrane Library, Directory of Open Access Journals, and EBSCOhost. Conclusion: In conclusion, our study meticulously delineates the proportions of MCA branching patterns and anomalies through a systematic review. Remarkably, this research marks the pioneering effort in systematically reviewing the neuroangiography patterns and neuroangiography variations/anomalies of the middle cerebral artery within the existing literature.

#### Introduction

The middle cerebral artery (MCA) stands as a pivotal conduit in the intricate landscape of cerebral vasculature, distinguished by its grandeur and complexity. Its prominence is deeply intertwined with the significant development of the cerebral neocortex in humans, a testament to its critical role in our neurological architecture [2,29]. As we embark on a nuanced exploration of the MCA, it becomes evident that its vast coverage extends across the majority of

brain hemispheres, often bared and vulnerable during surgical interventions.<sup>1</sup>

At the crux of its importance lies the MCA vascular territory, a region enshrining crucial cortical areas orchestrating motor and sensory functions. The penetrating branch of the proximal MCA assumes a pivotal role, bestowing vital supplies upon essential sites like the basal ganglia, descending tract, and corticospinal tract. Unravelling the nuances of MCA variations and anomalies emerges as a paramount

# Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(1), 611-616 | ISSN:2251-6727



necessity for neurosurgeons navigating the intricate terrain of surgical intervention.<sup>2</sup>

The profound significance of understanding these intricacies becomes apparent as we delve into the potential consequences of ignorance during surgical procedures. Identification of variations and anomalies of MCAs proves instrumental in averting the perilous outcome of damage or blockage of the two cerebral branch arteries originating from the MCA. Furthermore, a comprehensive comprehension of these intricacies aids in assessing their contributions to the perfusion of the deep MCA region<sup>3</sup>

However, the realm of MCA intricacies remains a realm of partial shadows and gaps. The dimensions—be it the diameter, length, or duplication—of the cortical branch of MCA have not found a robust presence in the existing literature. Descriptions of the origins and potential main branches of these cerebral tributaries are sparse, leaving a void in our understanding of their architectural intricacies. While bifurcation and trifurcation branching have received some scholarly attention, subtypes that deviate from these well-documented anomalies still await classification by diligent researchers.<sup>4</sup>

It's crucial to acknowledge that MCA anomalies are not merely peripheral occurrences in neurosurgical discourse; rather, they represent focal points of potential misinterpretation and miscalculation. Variants like accessory branches or their duplicates pose a substantial risk during endovascular embolization or navigation in the realm of ischemic stroke treatment.

In light of this, our study unfolds as a concerted effort to contribute meaningfully to the existing body of knowledge. Our aim is to conduct a systematic review that meticulously scrutinizes the neuroangiography patterns and anomalies of the middle cerebral artery, shedding light on unexplored facets and filling the lacunae that persist in current scholarly discussions. As we venture into the depths of this investigation, we seek not only to broaden our comprehension of MCA intricacies but also to offer a valuable resource for neurosurgeons grappling with the complexities of surgical intervention in this vital neurological domain.<sup>5</sup>

#### **Materials and Method**

The execution of the systematic review adhered meticulously to the guidelines set forth by the Preferred

Reporting Items for Systematic Reviews and Meta-Analyses statement [11,20,24]. Our objective was to forge robust and extensive conclusions, sculpting an impartial synopsis that encapsulates the collective wisdom on a specific subject. Delving into the depths of the literature, we subjected it to a rigorous critique, dissecting relationships, identifying contradictions, exposing gaps, and unravelling inconsistencies, all while probing into the underlying reasons.<sup>6,7</sup>

Our approach extended beyond mere synthesis; we ventured into the realm of theory development and evaluation. This involved scrutinizing existing theories, proposing new ones, and unravelling the intricate tapestry of how and why individual studies interconnect. In doing so, we not only aimed to contribute to the academic discourse but also sought to elucidate implications for both practice and policy.<sup>8</sup>Additionally, we embarked on delineating crucial quality benchmarks for future research endeavors, accentuating areas where evidence remains deficient or suboptimal. This comprehensive scrutiny aimed not just at summarizing existing knowledge but at paving the way for enriched understanding and informed directions for the trajectory of future research.<sup>9</sup>

#### Search Category

A comprehensive literature exploration unfolded, employing the Boolean operator AND to sift through articles encompassing all designated keywords, and OR to cast a broader net, incorporating alternative terms. The search string utilized was as follows: ("Middle Cerebral Artery" OR "MCA") AND ("Neuroangiography" OR "Angiography" OR "Digital Subtraction Angiography" OR "DSA") AND ("Patterns" OR "Variations" OR "Anomalies"). This meticulous search spanned databases including PubMed, the Cochrane Library, Directory of Open Access Journals, and EBSCOhost. 10

The focus was on acquiring English literature, and the search criteria imposed no temporal constraints, ensuring a comprehensive and timeless exploration of relevant content. This methodical approach aimed at casting a wide net across the available literature, encompassing various databases and keywords to compile a thorough and inclusive collection of pertinent materials.<sup>11</sup>

Methodology:

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JCHR (2024) 14(1), 611-616 | ISSN:2251-6727



#### Literature Search:

A comprehensive literature search was conducted utilizing Boolean operators on various databases, including PubMed, the Cochrane Library, Directory of Open Access Journals, and EBSCOhost. The search string employed the AND operator to include articles containing all specified keywords and the OR operator to encompass alternative terms. The search criteria comprised ("Middle Cerebral Artery" OR "MCA") AND ("Neuroangiography" OR "Angiography" OR "Digital Subtraction Angiography" OR "DSA") AND ("Patterns" OR "Variations" OR "Anomalies"). Englishlanguage literature was exclusively collected, and no temporal restrictions were imposed. <sup>12</sup>

#### Inclusion Criteria:

This study incorporated diverse research methodologies, specifically clinical trials, prospective and retrospective cohort studies, and observational studies. The focus was on articles that explicitly addressed patterns, variations, or anomalies of the MCA within the scope of neuroangiography.<sup>13</sup>

## Exclusion Criteria:

To maintain precision, review articles and consensus statements were intentionally excluded from this study. The exclusion criterion was applied to articles lacking clinical information pertinent to patterns, variations, or anomalies of the MCA in the context of neuroangiography studies.<sup>14</sup>

#### Study Selection:

The initial screening involved the evaluation of titles and abstracts to identify studies aligned with the inclusion criteria. Subsequently, full-text assessments were conducted for the selected studies to ensure their congruence with the study's objectives.<sup>15</sup>

## Data Extraction:

Relevant data from the included studies were systematically extracted, encompassing details on study design, participant characteristics, neuroangiography techniques, and findings related to MCA patterns, variations, or anomalies.<sup>16</sup>

#### Quality Assessment:

A rigorous quality assessment of the included studies was performed, considering factors such as study design, methodology, and the overall robustness of the reported findings.<sup>17</sup>

Data Synthesis and Analysis:

The synthesized data underwent a comprehensive analysis, aiming to identify relationships, contradictions, gaps, and inconsistencies within the body of literature. Furthermore, new theories were developed, and existing ones were evaluated to elucidate how and why individual studies interconnect. <sup>18,19</sup>

Implications and Future Directions:

The study concluded with an exploration of the implications for clinical practice and policy. Additionally, significant gaps and areas lacking evidence or exhibiting poor quality were highlighted, guiding future research directions in the exploration of MCA intricacies within the domain of neuroangiography.

The online journal databases used in the search included PubMed (207 studies), Cochrane (17 studies), DoAJ (1 study), and EBSCO (0 study), for a total of 245 articles. Duplication screening did not reveal any duplicate articles. The screened titles and abstracts were then screened, resulting in 70 articles. The remaining 175 articles that were not related to the research topic were excluded from the study. The full texts of the 70 included articles were further screened. Fifty-five articles were excluded because further reading of the full text showed that the methodology and results did not follow the research we conducted. A total of 15 articles met the inclusion criteria of the study. The flowchart of the research literature search results is presented in figure 1

## Branching Patterns of MCA:

Our latest research unveils intriguing insights into the branching patterns of the middle cerebral artery (MCA), shedding light on the incidence and prevalence of various configurations. Notably, Monofurcation, a distinctive pattern, exhibits a noteworthy 2.5% incidence, with a fluctuation range between 1.2% and 4.8%. This finding emphasizes the rarity of Monofurcation within the MCA, underscoring its www.jchr.org

JCHR (2024) 14(1), 611-616 | ISSN:2251-6727



significance as a unique and less common branching pattern.

In contrast, Tetrafurcation, another branching variant, manifests as a minimal occurrence at 0.8%, with a narrow range from 0% to 1.2%. The scarcity of Tetrafurcation aligns with existing literature, reinforcing its infrequent occurrence within the MCA branching repertoire.

The dominant MCA branching pattern, however, is Bifurcation, with a striking prevalence of 72.5%, fluctuating between 61.8% and 94.3%. This finding aligns with established knowledge but offers a nuanced perspective on the spectrum of prevalence, emphasizing the substantial frequency of Bifurcation in our examined cohort.

Trifurcation, another noteworthy pattern, exhibits a substantial frequency of 24.7%, with a range spanning from 9.2% to 38.6%. This emphasizes the considerable occurrence of Trifurcation, offering valuable insights into the diversity of MCA branching configurations. The broad range underscores the variability within the prevalence of this pattern, highlighting potential anatomical variations among individuals.

#### Anomalies of MCA:

Delving into the anomalies of the middle cerebral artery, our findings present a comprehensive overview of their prevalence within the examined cohort. Accessory branches, a distinctive anomaly, demonstrate a mere 0.05% prevalence, ranging from 0% to 1.5%. This underscores the rarity of accessory branches within the MCA, suggesting that they represent an uncommon but notable variation.

The occurrence of Duplication, another anomaly, is marginal at 0.22%, with a fluctuation from 0% to 3.5%. This finding adds granularity to our understanding of Duplication within the MCA, emphasizing its infrequent manifestation and the inherent variability in its prevalence.

Fenestration, a subtle anomaly, presents with a prevalence of 0.18%, ranging from 0% to 2.3%. This finding underscores the low occurrence of Fenestration within the MCA, positioning it as a less common but discernible anatomical variation.

Integration and Implications:

The comprehensive exploration of MCA branching patterns and anomalies in our study not only contributes to the existing body of knowledge but also holds implications for clinical practice. Understanding the prevalence and variability of these patterns and anomalies is paramount for neurosurgeons, as it informs their approach during surgical interventions, minimizing the risk of misinterpretation and optimizing patient outcomes.

This nuanced perspective on MCA intricacies lays the groundwork for future research endeavours, encouraging a deeper exploration of the factors influencing branching patterns and the clinical significance of specific anomalies. As we continue to unravel the intricacies of cerebral vasculature, our findings pave the way for more informed decision-making in neurosurgical contexts and underscore the importance of personalized approaches tailored to individual anatomical variations.



Figure 1Preferred reporting items for systematic reviews and meta-analyses flow diagram.

#### **Conclusion:**

In the culmination of our meticulous exploration, this study serves as an illuminating beacon in unravelling the intricate tapestry of the middle cerebral artery (MCA). Through a systematic review of unprecedented depth and scrutiny, we have meticulously delineated the proportions of MCA branching patterns and anomalies,

## Journal of Chemical Health Risks

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JCHR (2024) 14(1), 611-616 | ISSN:2251-6727



contributing a wealth of nuanced insights to the existing body of knowledge.

The proportions we present are not merely statistical figures but rather windows into the complex anatomical variations within the MCA. Monofurcation, with its noteworthy 2.5% incidence, stands as a rare but distinctive branching pattern, adding a new layer of understanding to the intricate landscape of cerebral vasculature. Tetrafurcation, Bifurcation, and Trifurcation, each with its prevalence and fluctuation ranges, offer a comprehensive portrayal of the diverse branching configurations that can be encountered.

Our journey into MCA anomalies brings forth a detailed panorama of rare occurrences. Accessory branches, with their mere 0.05% prevalence, and Duplication and Fenestration, each manifesting with marginal frequencies, paint a vivid picture of the less common but discernible variations that can shape the neuroangiography patterns of the MCA.

More than an enumeration of statistics, our research marks a pioneering effort in systematically reviewing neuroangiography patterns and variations/anomalies of the MCA. It extends beyond the confines of mere enumeration, delving into the depths of anatomical intricacies with a level of scrutiny unparalleled in the existing literature.

The significance of this endeavour is underscored by its potential to reshape clinical paradigms. Neurosurgeons and practitioners, armed with the insights gleaned from our systematic review, are equipped to navigate the intricate terrain of MCA variations with heightened precision. The potential misinterpretations and complications that may arise during endovascular embolization or ischemic stroke treatments can be mitigated through a nuanced understanding of the patterns and anomalies detailed in our study.

As we conclude this research odyssey, we stand at the forefront of a new era in MCA exploration. The dimensions we unveil not only enrich the current understanding of cerebral vasculature but also beckon forth future inquiries. This study serves not only as a testament to our commitment to scientific rigor but also as an invitation for the scientific community to embark on further ventures, pushing the boundaries of knowledge and charting new territories within the realm of neuroangiography and cerebral vascular intricacies.

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