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Anatomical variations of artery of angular gyrus

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Abstract

Context: Angular gyrus is an anatomical structure of the brain located in the parietal lobe, taking part in writing and reading, language-use, memory and attention and spatial recognition. It is supplied by the angular gyrus artery, which is one of the caudal branches of the middle cerebral artery. One of the clinical pathologies of the angular gyrus artery is the ischemic stroke of the angular gyrus in the dominant hemisphere, responsible for the presence of Gerstmann Syndrome: left-right disorientation, agraphia, alexia, acalculia and finger agnosia. This systematic review aims to present the variety of anomalies of the main cerebral artery and the angular gyrus artery.

Objective: Preparing a systematic review of papers describing the course anomalies of the angular gyrus artery.

Materials and methods: PubMed and Google Scholar electronic databases was searched for phrases: ‘Angular gyrus artery’, ‘Artery of angular gyrus’, ‘Middle cerebral artery branches’, ‘Branches of middle cerebral artery’, ‘Gerstmann Syndrome’ published between years 2015 and 2023. Also 3 papers published before 2000 were used. From the selected 30 papers, 6 were used to prepare this analysis.

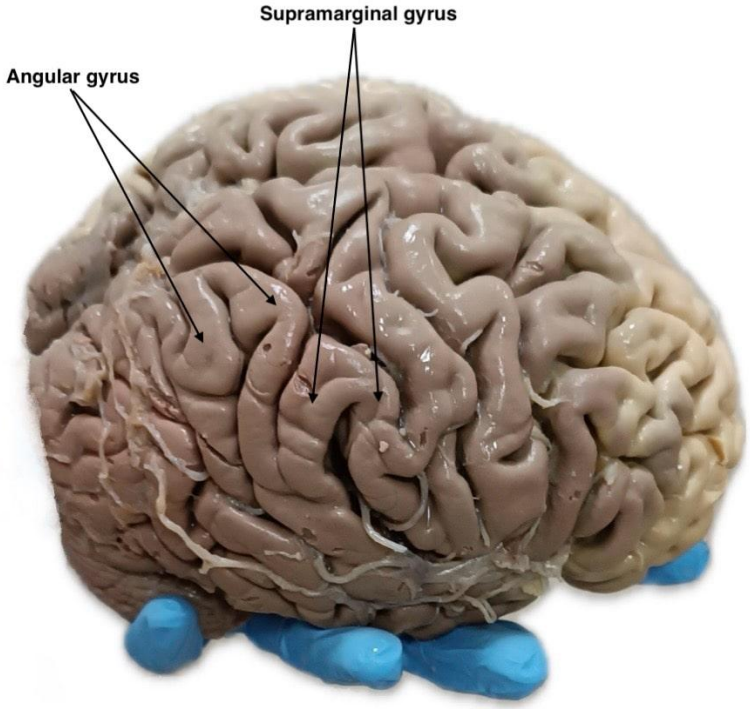
Results: The middle cerebral artery, from which arises the angular gyrus artery, is marked by a significant variety of its division, mainly the number of the dividing trunks of the artery. Depending on the type of the division, the angular gyrus artery can arise from the upper, middle or lower trunk and vary in sizes. It can also appear as a singular or two separate branches. Instances of the anomaly of both the angular gyrus artery and posterior parietal artery are rare, but reported.

Conclusions: The angular gyrus artery is characterised by a number of anomalies in its course, separation from the middle cerebral artery, diameter and branching.

Keywords: parietal lobe, Gerstmann syndrome, ischemic stroke, agnosia, alexia

Introduction

Angular gyrus is a structure located in the area of inferior parietal lobule. It is a significant part of the brain, corresponding with the location of Brodmann area 39. This area takes part in the integration of the information gathered by the body from various locations. We know about its role in such activities as speech, language acquaintance, reading, operational memory storage and word comprehension. [1] It was proven that this area can take partial responsibility for obsessive-compulsive disorder by its intensive spontaneous activity[2], or the occurrence of dyslexia. [3]



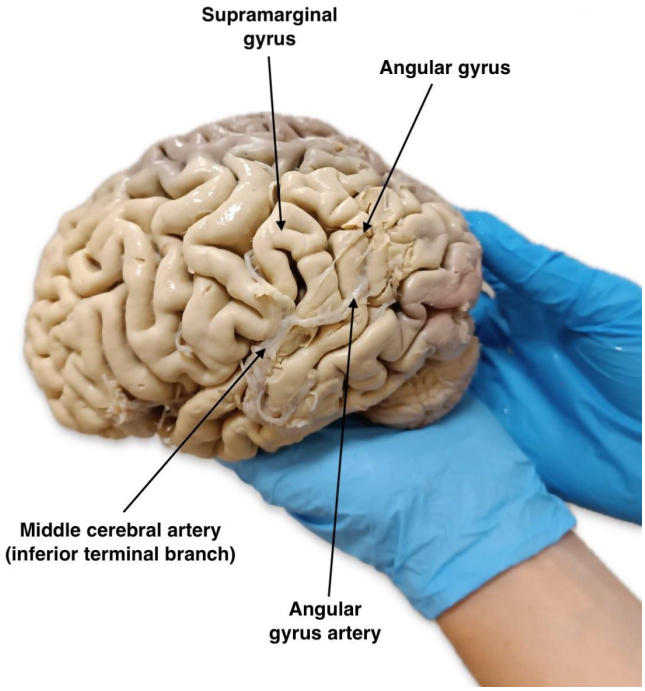
Picture 1: Location of the angular gyrus in relation to the supramarginal gyrus

Photo source: Human Anatomy Research Group, Medical University of Lublin

Angular gyrus is supplied by the angular gyrus artery (AGA)- one of the final cortical branches of the middle cerebral artery (MCA). MCA is the direct extension of internal carotid artery- one of the components of the cerebral arterial circle. The extent of vasculature provided by MCA consists of insula, frontal lobe, parietal lobe, occipital lobe, as well as parts of the white substance and nuclei of the telencephalon. [4-6]

The course of the AGA is crucial in medical imaging as well as clinical interventions. Clinical manifestation of pathology within AGA can be, for example, ischaemic stroke of the dominant (left, in most of the population) hemisphere's angular gyrus- one of the most common causes of Gerstmann's syndrome. A case of the syndrome caused by the right hemisphere's pathology has been described in literature. [7] Gerstmann's syndrome is manifested by the tetrad of symptoms- finger agnosia, acalculia, side disorientation and agraphia. [8] In some cases, aphasia and alexia can be observed. [9] Aforementioned symptoms, potentially not connected with one another, can be caused by the pathology of white matter of angular gyrus area, which composes the crossing of neural pathways connecting functionally different areas of the cortex. [10]

It is important to differentiate between the AGA (a branch of MCA) and angular artery (a branch of facial artery). The aim of this systematic review is to summarise present-day knowledge of variations of AGA and the frequency of manifestation of such variations, as well as to draw attention to the deficiency of studies related to this topic.



Picture 2: Location of the angular gyrus artery in relation to the angular gyrus and middle cerebral artery

Photo source: Human Anatomy Research Group, Medical University of Lublin

Methods

In following systematic review, 500 papers from PubMed database, matched with the phrases 'Angular gyrus artery', 'Artery of angular gyrus','Middle cerebral artery branches', 'Branches of middle cerebral artery', and 'Gerstmann Syndrome' were analysed, as well as 100 papers from Google Scholar database (matched with same phrases). During the research, the publication date criteria was restricted to years 2015-2023. In addition, 3 papers published

before 2000 were included. Among the selected 30 papers, 6 were chosen for this analysis. Three of those were original papers.

Results

MCA is revealed to have significant versatility in its division, as well as branching. MCA can divide into two, three, four arterial trunks or not divide at all. Most common is the case of division of MCA into two arterial trunks (superior/frontal and inferior/temporal)- bifurcation, and the least common is division into four arterial trunks. [4] In the case of bifurcation, AGA usually begins with the division of MCA, while in the case of the trifurcation (into superior, middle and inferior trunk) it commences as a branch of the middle trunk. Cases of AGA diverging from superior or inferior (more often) trunk have been observed, as well as duplications of AGA. [11] In surgical terminology, MCA diverges into four parts- M1 (before the bi-,tri- or quadrifurcation), M2 (the course inside the lateral sulcus), M3 (after leaving the lateral sulcus) and M4 (cortical branches). Cases of MCA separating directly into M1 and M2 or extending into AGA, no creation of the trunk, were observed. [4] Chauhan P, Rathawa A, Jethwa K, et al. describes that in the case of MCA bifurcation, AGA most often begins in the inferior trunk, but there are cases of beginning in the superior trunk; as for trifurcation, AGA began only at the inferior trunk. This and other papers show that both left and right AGAs have the largest diameters among cortical branches of MCA, separating from it at the length of 34.8$\pm$0.9 of MCA (from the beginning of this artery). [12] In least common cases, AGA has the same diameter as the temporooccipital and the posterior parietal artery, and rarely, a smaller diameter than aforementioned vessels. [13] Generally, AGA appears as a singular branch (88%), seldom as two separate branches (12%) of MCA. Near the angular gyrus or directly below, AGA often (63%) divides into two final branches: superior and inferior; less often (21%) into three or four final branches or no branches at all (16%). In the case of the division into two final branches, superior branch ends in intraparietal sulcus (25%), transverse occipital sulcus (30%), superior and inferior temporal gyrus (40%) or inferior temporal gyrus (5%); inferior branch ends in lunate sulcus (25%), superior temporal gyrus (5%) or middle and inferior temporal gyrus (70%). [13] Ring, B. A. study showed that inferior branch of AGA ended 1 to 3 centimetres away from occipital pole dorsally in 42% of 34 telencephalons. [14] Based on this research it was established that AGA supplies areas 17, 18, 19, 22, 37, 39, 40, 41, 42 and 52, and temporoparietal region (areas 22, 37, 39) is the middle part of the vascular territory of AGA. [13] Usually, AGA and posterior occipital artery start at the similar

place at MCA- according to one study [14] either both leave MCA as a joint trunk (52%) or as separate branches divided by fissure (32%) or remain undivided (4%). Alternative possibilities are less common (12%). A study conducted by S V Marinkovic, M S Kovacevic, and V S Kostic describes a case of posterior parietal artery arising from AGA. [13]

Table 1: Division of MCA- frequency of variations:

	Gunnal, S., Farooqui, M., & Wabale, R. (2019). Study of middle cerebral artery in human cadaveric brain. [4]	**Cilliers, K., & Page, B. J. (2017). Anatomy of the Middle Cerebral Artery: Cortical Branches, Branching Pattern and Anomalies. [11]**
Bifurcation	64,7%	-
AGA arises at superior trunk	-	21,1%
AGA arises at inferior trunk	-	78,9%
Trifurcation	12,35%	-
Quadrifurcation	2,35%	-
Single trunk	20,58%	-

		Marinkovic, S. V., Kovacevic, M. S., & Kostic, V. S. (1984). The isolated occlusion of the angular gyri artery. A correlative neurological and anatomical study—Case report. [13]	
Two branches (superior and inferior)		63%	-
Superior branch termination	On intraparietal sulcus	-	25%
	On transverse occipital sulcus	-	30%
	On superior and middle occipital gyri	-	40%
	On inferior occipital gyrus	-	5%
Inferior branch termination	On the lunate sulcus	-	25%
	On the superior occipital gyrus	-	5%
	On the middle or inferior occipital gyri	-	70%

Three or four branches		21%	-
No final branches		16%	-

Table 2: Division of angular gyrus artery into final branches and location of their termination:

Discussion

This review examines available literature about the AGA, MCA and its branches. It was written to condense collected information about anatomical variations of AGA, its origin from MCA, its diameter, number of trunks and possible branches. Knowledge about anatomical traits of AGA is crucial, for the ischaemic stroke of the part of the brain supplied by this vessel is the main cause of Gerstmann's Syndrome- a greater expertise about symptoms and clinical presentation of it in patients requiring neurological and neurosurgical care can result in improvement of diagnosis and more rapid and structured medical interventions. [7]

Conclusions

A large limitation of this paper is the negligence of some of the aspects of AGA studies. Following research should contain larger research groups and pay more attention to AGA's measures, its branching and anomalies. There are still not enough studies conducted about this vessel, which results in a lacking amount of literature on this topic and in turn, insufficient knowledge about the clinical aspects of its variations.

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