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SNI: Neuroanatomy and Neurophysiology

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Original Article

A case series of gyrus rectus arteriovenous malformation: Clinical characteristics, angioarchitecture, microsurgical treatment, and outcome

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Received : 19 May 2023
Accepted : 09 June 2023
Published : 23 June 2023

DOI
10.25259/SNI_433_2023

Quick Response Code:

ABSTRACT

Background: Gyrus rectus arteriovenous malformation (AVM) is one of the intricate pathologies that can lead to gyrus rectus hematoma. However, there is a paucity of research on this topic. This case series aims to delineate the characteristics of gyrus rectus AVMs, their outcomes, and treatment strategies.

Methods: We enrolled five cases of gyrus rectus AVM that presented to the Neurosurgery Teaching Hospital in Baghdad, Iraq. Patients with the presence of gyrus rectus AVM were analyzed according to the demographic data, clinical status, radiological imaging, and outcome.

Results: Of the total cases enrolled, all five cases were ruptured at the presentation. Most of the AVMs had arterial feeders from the anterior cerebral artery (80%) and superficial venous drainage through the anterior third of the superior sagittal sinus occurred in four cases (80%). Two of the cases were classified as Spetzler-Martin grade 1 AVMs, two were grade 2, and one was grade 3. With regard to the modified Rankin Score (mRS), four of them had a score of 0 after observation for 30, 18, 26, and 12 months, respectively, while one patient had an mRS score of 1 after 28 months of observation. All five cases presented with seizure and were all treated by surgical resection.

Conclusion: To the best of our knowledge, this is the second report documenting the features of gyrus rectus AVMs and the first one from Iraq. Further, research into gyrus rectus AVMs is required to help better characterize and enhance our knowledge on the outcomes of such lesions.

Keywords: Arteriovenous malformation, Front-basal arteriovenous malformation, Front-basal hemorrhage, Gyrus rectus, Gyrus rectus arteriovenous malformation

INTRODUCTION

Arteriovenous malformation (AVM) is a congenital lesion consisting of an abnormal single or multiple direct connections between a combination of thin or dilated arteries and veins, classically appearing as a "bag of worms" on magnetic resonance imaging. They lead to arteriovenous shunting of blood and cause surrounding neural tissue to become nonfunctional

or calcified, which may contribute to the development of seizures and another neurological phenomena.[1,3,4,11,16] They represent about 10–15% of all vascular malformations of the central nervous system. In the posterior fossa, the majority of AVMs are located in areas such as the cavernous, sigmoid, or transverse sinus, whereas supratentorially, they can be located in the gyrus rectus region with high predilection for intracerebral hemorrhage (ICH).[9,14]

The gyrus rectus is part of Bormann's area 11 and is considered to be the most anatomically constant cerebral gyri. Located medial to the olfactory sulcus at the frontobasal lobe in the anterior cranial fossa, it gets its arterial supply from the orbitofrontal artery, a branch of the anterior communicating artery. It has two groups of venous drainage: A superficial drain into the superior sagittal sinus (SSS) and a deep drain into the basal vein.[21,25,27] Gyrus rectus AVM is one of the important pathologies that lead to gyrus rectus hematoma (GRH).[12] However, to the best of our knowledge, this is the second report that discusses frontobasal AVMs and its characteristics and the first report from Iraq.

MATERIALS AND METHODS

We enrolled five cases of gyrus rectus AVM that presented to the Neurosurgery Teaching Hospital, which were all ruptured at the time of presentation. Patients with the presence of gyrus rectus AVM were analyzed according to the demographic data, clinical status, radiological imaging, and outcome.

The parameters included were age, gender, Glasgow coma scale (GCS), seizure, and size of AVM in centimeters, whether the AVMs were ruptured or not at the time of presentation, computed tomography (CT) findings, arterial feeders, venous drainage, and method of treatment. The degree of disability of patients postoperative was assessed according to the modified Rankin score (mRS), where a score of 0 is given when there are no symptoms, (1) when there is no significant disability despite symptoms (able to carry out all usual duties and activities), (2) when there is a slight disability (unable to carry out all previous activities, but able to look after own affairs without assistance), (3) when there is a moderate disability (requiring some help, but able to walk without assistance), (4) when there is a moderately severe disability (unable to walk and attend to bodily needs without assistance), (5) when there is a severe disability (bedridden, incontinent, and requiring constant nursing care and attention), and (6) if the patient is dead. To estimate the mortality and morbidity of surgical resection, the AVMs were categorized according to the Spetzler-Martin (SM) AVM grading system, where the grade is equal to the sum of points in three categories: the size of nidus [(1) when it is small (<3 cm), (2) when it is medium (3–6 cm), and (3) when it is large (>6 cm)], location (0 when it is in a noneloquent site, and 1 when it is in an eloquent site), and venous drainage (0 when there are superficial veins, and 1 when there are deep veins), which are all demonstrated in Table 1.

RESULTS

Of the total cases enrolled, all five cases were ruptured at the presentation. Three were male and two were female. Their age ranged from 14 to 28 years, with a mean age of 21 years. Four of the cases of gyrus rectus AVM had a medium-sized nidus, with three of them measuring 3 cm in size and one measuring 4 cm in size. Only one case was of small size, measuring 2 cm. All patients had ICH as demonstrated on the CT scan: Three of them presented with ICH in the right frontal area, while two of them had ICH in the left frontal area. Four (80%) of the AVMs had arterial feeders from the anterior cerebral artery and one had multiple arterial feeders from the anterior and middle cerebral artery. Four cases only had superficial venous drainage through the anterior third of the SSS with no deep venous drainage. However, one case had both deep drainage into the cavernous sinus and superficial drainage to the SSS. With regard to the SM scale, two cases were classified as grade 1 AVMs, two were grade 2, and one was grade 3. With regard to mRS, four of them had a score of 0 after observation for 30, 18, 26, and 12 months, respectively, while one patient had an mRS score of 1 after 28 months of observation. All five cases presented with seizure and were all treated by surgical resection. All these data are shown in Table 1.

DISCUSSION

AVMs can be generally described as vascular developmental deformities consisting of tangles of convoluted arteries and veins that allow single or multiple direct connections and high-flow shunting without interfering with capillary beds.[4] It may present with a wide range of symptoms, including seizures, which tend to occur in alternate cycles of exacerbation and recovery.[22] In our series, anterior cranial fossa AVM was more common in males than females, which is consistent with other reported cases showing a predominance in males. The predilection seen in males may be attributed to the higher rate of trauma in males.[13,17,24]

AVMs can be ruptured or unruptured at the time of presentation. Intracerebral and subarachnoid hemorrhage are the most common clinical presentations for anterior cranial fossa AVMs.[2,13,17] Some studies report that about 50–53% of brain AVMs present with hemorrhage.[6,23] In a case series conducted by Tong *et al*. involving 3299 patients with brain AVM, hemorrhage was the initial presentation for 57.9% of the patients.[24] In another study by Kaplan *et al*. that included 42 patients with AVM in the anterior cranial fossa, 76% presented with massive ICH.[13] However, in our series,

Table 1: Parameters data of five patients with gyrus rectus AVM.

Patient No.	Age	Sex	Rupture at presentation	GCS	Seizure	Size of AVM (max diameter of nidus) cm	CT Findings	Arterial feeder	Venous drainage	SM grade	Method of treatment	Outcome mRS/ duration months
1	23	M	Yes	14	Yes	3	Right frontal ICH	ACA	SSS (Anterior third), no deep drainage	2	Surgery	0/30
2	17	M	Yes	14	Yes	3	Right frontal ICH	ACA	SSS (Anterior third), no deep drainage	1	Surgery	0/18
3	14	F	Yes	14	Yes	2	Left frontal ICH	ACA	SSS (Anterior third), no deep drainage	1	Surgery	0/26
4	21	F	Yes	14	Yes	3	Right frontal ICH	ACA	SSS (Anterior third), no deep drainage	2	Surgery	0/12
5	28	M	Yes	14	Yes	4	Left frontal ICH	ACA + Medial Cerebral Artery	SSS (Anterior third) + Deep drainage into the cavernous sinus	3	Surgery	1/28

**AVM: Arteriovenous malformation, CT: Computed tomography, GCS: Glasgow coma scale, F: Female, ICH: Intracranial hemorrhage, M: Male, mRS: modified Rankin Scale, SM: Spetzler-Martin, SSS: Superior sagittal sinus, ACA: Anterior cerebral artery

100% of the cases of AVM that were enrolled presented with hemorrhage, which might be a specific feature for AVM in the location of the gyrus rectus [Figures 1-3].

Around 30% of patients with AVM have been reported to present with a seizure at initial diagnosis, making it the second most common presentation of AVM. In the study by Tong *et al.*, 20.9% of the patients had seizures as the initial presentation.[24] Martin *et al.* included 99 patients in their study, but only 7 (7%) of them presented with seizures.[17] The low percentage of cases presenting with seizures in their study may be attributed to the location of AVM in noneloquent areas. In our series, all the patients included had seizures at the presentation. Many studies found an association between seizures and the location of the AVM, particularly in the frontal lobe.[7,8,20] AVMs in the frontal lobe were found to have a rate of seizure occurrence of approximately 36.1–37.3% and correspond to the anatomical location of the gyrus rectus in the frontobasal lobe.[5,24] An association has been discovered where the size of the AVM correlates with the occurrence of hemorrhage and seizures. It has been reported that AVMs, particularly those that are 3 cm or larger, tend to have a higher likelihood of resulting in hemorrhage, which is thought to be due to elevated arterial feeding pressure.[19,28]

The anterior cerebral arteries, medial cerebral arteries, and posterior cerebral arteries are common superficial arterial feeders for cortical AVMs of the anterior cranial fossa, while deep feeder arteries for cortical AVMs include the lenticulostriate artery and the anterior and posterior choroidal arteries.[17,28] Other arteries such as the middle meningeal artery and anterior ethmoidal artery have also been shown to play a major role in supplying the AVM in many studies. AVMs of the anterior cranial fossa typically drain through veins of the anterior frontal lobe into the SSS or posteriorly toward the cavernous sinus.[9,13,15,17] In our study, the anterior and medial cerebral arteries were the main arterial feeder systems, and the SSS was the main venous drainage with a case of AVM with drainage into the cavernous sinus.

Hartmann *et al.* followed up on 115 patients after AVM hemorrhage with neurological assessment and found that 47% of them had no neurological deficit with an Rankin score (RS) of 0, 7% were assigned an RS score of 4 or 5 after initial or subsequent bleeding, and 37% remained independent in their daily activity with an RS of 1.[4,10] From the five cases that were enrolled in this study, four of the patients (80%) had very good outcomes with an mRS of 0. The one case (20%) with a minor deficit (mRS score of 1) had an AVM in the left dominant side with multiple arterial feeders and venous drainages as well as a SM scale of 3, which may explain its poorer neurologic outcome [Figure 2].

Surgical resection is indicated when the AVM is complicated by hemorrhage and is the treatment of choice for AVMs

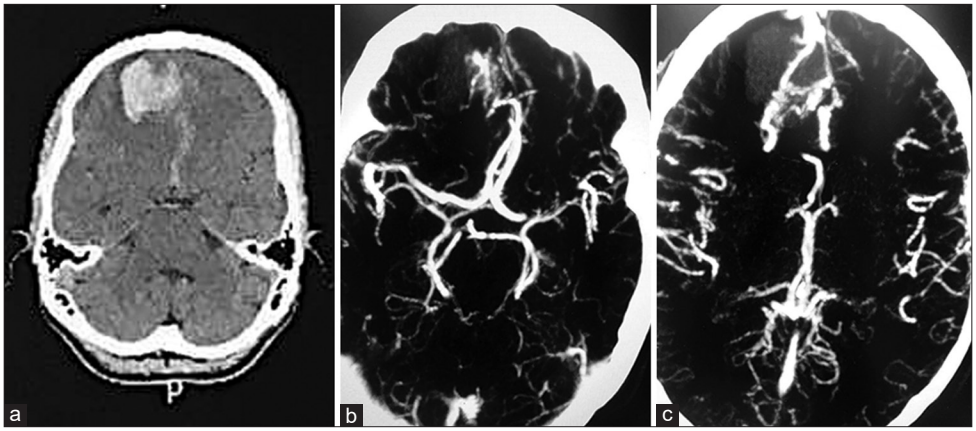

Figure 1: (a) Computed tomography (CT) scan of the head (axial view) showing right intracerebral hemorrhage (ICH) in the frontal lobe within the rectus gyrus with no signs of subarachnoid hemorrhage. (b) CT angiography of the head (axial view) showing the circle of Willis with a tuft of vessels in the right gyrus rectus. (c) CT angiography of the head (axial view) showing a tuft of vessels with ICH in the right gyrus rectus in the frontal lobe.

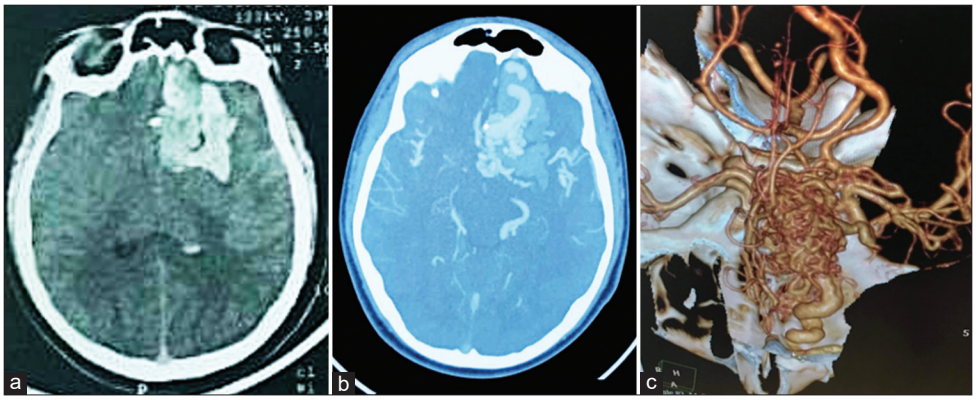

Figure 2: (a) Computed tomography (CT) scan of the head (axial view) showing left intracerebral hemorrhage in the frontal lobe within the rectus gyrus with no signs of subarachnoid hemorrhage. (b) CT angiography of the head (axial view) showing a tuft of vessels in the left rectus gyrus. (c) 3D-constructed angiography showing an arteriovenous malformation with multiple feeders from the anterior circulation.

in the anterior cranial fossa due to its high efficacy and low postoperative morbidity.[13,17] The aim is the occlusion of vascular connections to avoid rebleeding.[9,17] For AVM lesions in the frontobasal or frontoparietal area of the frontal lobe, pterional craniotomy is the preferred approach.[28] The frontal craniotomy approach is another option for the resection of anterior cranial fossa AVMs.[9] With this approach, risks include frontal sinus opening and retraction damage to the frontal lobe and olfactory nerves.[29] For AVMs supplied by anterior ethmoidal artery feeders, the fronto-orbital craniotomy has been shown to allow excellent access for proximal control.[26] The use of a keyhole supraorbital craniotomy as a minimally invasive technique for resection of anterior cranial fossa AVMs has also been introduced as an alternative to traditional exposure, enabling quicker recovery, and shorter hospital stays.[18] Besides surgery, other management options for AVMs available to the clinician include stereotactic radiosurgery, endovascular embolization, a combination of two or more of these methods, and in complicated cases, conservative treatment.[4] While stereotactic radiosurgery requires an extended period of time for treatment, endovascular embolization can present a challenge in selectively catheterizing small vessels and has a high risk of central retinal artery occlusion leading to visual impairment.[9]

Limitations

One of the major limitations of this study is that we have a very limited number of patients. However, we intended to highlight this location of AVM as potentially different and perhaps a special form of AVM. We suggest that future

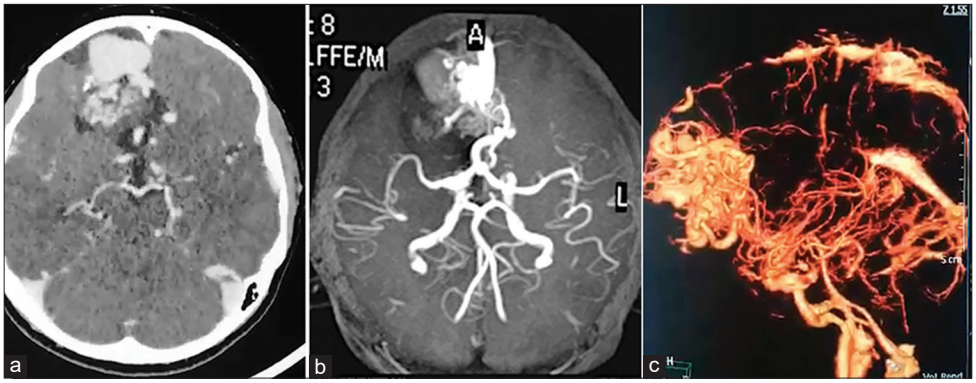

Figure 3: (a) Computed tomography (CT) scan (axial view) showing right intracerebral hemorrhage in the frontal lobe within the rectus gyrus with no signs of subarachnoid hemorrhage. (b) CT angiography of the head (axial view) showing a tuft of vessels in the right rectus gyrus. (c) 3D-constructed angiography showing an arteriovenous malformation with multiple feeders from the anterior circulation in the frontal lobe.

studies may include international collaboration to allow for the recruitment of more cases to have a better understanding of the characteristics of gyrus rectus AVM.

CONCLUSION

Our study offers rare insight into the characteristics of frontobasal AVMs, which is an important pathology that can lead to the development of GRH. To the best of our knowledge, this is the second report documenting the features of gyrus rectus AVMs and the first one from Iraq. The study identified the presence of gender predilection, seizure, and rupture at presentation among the enrolled patients. We also identified the GCS, location of the AVM, SM grade, and mRS of the patients, in addition to describing the arterial supply and venous drainage of each of the cases. Further, research into gyrus rectus AVMs is required to help better characterize and enhance our knowledge on the outcomes of such lesions.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Daily SK, Ismail M, Abdulmajeed AA, Aynona AM, Delawan M, Algabri MH, *et al.* A case series of gyrus rectus arteriovenous malformation: Clinical characteristics, angioarchitecture, microsurgical treatment, and outcome. Surg Neurol Int 2023;14:219.