Atallah *et al.*
Egyptian Journal of Neurosurgery (2023) 38:59
https://doi.org/10.1186/s41984-023-00228-7

Egyptian Journal of Neurosurgery

REVIEW

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Recurrent artery of Heubner infarction: a complication after clipping of anterior communicating artery aneurysm

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Abstract

Recurrent artery of Heubner (RAH) infarction is a potential complication following the surgical clipping of anterior communicating artery (A-comm) aneurysms. RAH plays a crucial role in supplying blood to the basal ganglia and anterior limb of the internal capsule. Understanding the pathogenesis, prognosis, and surgical result of RAH infarction is critical for providing the best care for patients. The literature study produced case reports and retrospective research on topics including the RAH infarct and A-comm aneurysm clipping. The importance of recognizing and controlling the risk of a RAH infarction in relation to A-comm aneurysm clipping is emphasized in this research. RAH infarction following clipping of an A-comm aneurysm has a complex pathophysiology, and by learning more about its causes, prognosis, and surgical results, medical personnel may better assist their patients. While further study is needed to overcome the obstacles highlighted here, the information presented here lays the groundwork for future research and adds to what is already known about the topic.

Keywords Recurrent artery of Huebner, Clipping of A-comm aneurysm, Infarction

Introduction

Surgical clipping is a common method used to treat A-comm aneurysms to prevent rupture and related effects. However, the development of a RAH infarction is one possible complication that can emerge after A-comm aneurysm clipping. The recurrent artery of Heubner (RAH), also known as the medial lenticulostriate artery, is a small branch of the anterior cerebral artery that provides critical blood supply to the basal ganglia and anterior limb of the internal capsule. Significant neurological abnormalities and functional impairments may result from interruption of blood flow through this artery. RAH infarction following clipping of an A-comm aneurysm is not common, but it is still an important clinical consideration. To effectively manage A-comm aneurysms, surgeons must have an in-depth comprehension of RAH infarction's pathophysiology, risk factors, prognosis, and outcome of the surgical intervention. The present work reviews the body of information and research on RAH infarction following A-comm aneurysm clipping. In this work, the relevance of understanding the causes and consequences of RAH infarction after A-comm aneurysm clipping is discussed.

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Anatomy and function of RAH

The RAH, also known as the medial striate artery, is a tiny blood artery that is vital to the blood supply of specific brain areas. A German pediatrician named Johann Heubner initially identified it. The RAH usually arises from the anterior cerebri artery (ACA). Majority (80%-90%) of the times it arises within 4 mm distal to A- comm (Fig. 1). It may arise from the distal part of A1 as well as from A- comm proper with a frequency of about 5%-10%. It gives the structures involved in motor and cognitive functioning with vital circulatory support. The Heubner artery mainly supplies the caudate nucleus, anterior limb of the internal capsule, anterior hypothalamus, nucleus accumbens, portions of the uncinate fasciculus, and basal nucleus of Meynert [1].

Symptoms and diagnosis of RAH infarction

RAH infarction can result in damage to the structures it supplies, primarily the caudate nucleus and the anterior limb of the internal capsule. After the clipping of an A-comm artery aneurysm, the specific signs and symptoms of a RAH infarction can vary depending on the location and extent of the infarction. However, the following signs and symptoms may be associated with this condition: contralateral hemiparesis, loss of sensation, dysarthria, cognitive and behavioral changes, and apraxia [2–6]. The diagnosis of a RAH infarction can be corroborated by imaging investigations such as a CT scan, MRI and digital subtraction angiography to look for possibility of vasospasm. To analyze the vascular architecture and consequences following aneurysm clipping, such as occlusions or stenosis in the relevant arteries, magnetic resonance angiography (MRA) can be carried out as part of an MRI. The digital subtraction angiography is the preferred modality, to detect vasospasm (narrowing in intracranial vessels), which also has the therapeutic value.

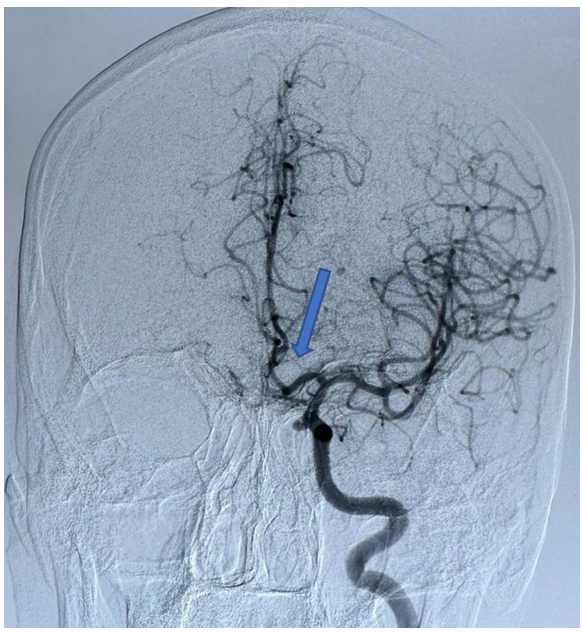

Fig. 1 Digital subtraction angiography image of the left internal carotid artery run in anterior view demonstrates the ipsilateral RAH in the background of medially directed para clinoid aneurysm on the left side

Pathogenesis of RAH infarction after A-comm aneurysm clipping

The pathogenesis of a RAH infarction after clipping of an A-comm aneurysm can involve multiple factors:

a. Surgeon-Caused Occlusion (Iatrogenic Occlusion)

During the surgical clipping procedure, there is a possibility of iatrogenic occlusion, meaning an inadvertent blockage or narrowing of the RAH. The dissection and exposure of the RAH and adjacent perforators should be meticulous to avoid inadvertent injury (Figures 2 and 3). This can occur due to manipulation, compression, or stretching of the blood vessels during the procedure. It can lead to decreased blood flow or complete occlusion, resulting in ischemia and infarction of the structures supplied by the artery.

b Time of Surgery, Surgical Side and Side of Aneurysm, Intraoperative Rupture

The timing of surgery, the side on which the aneurysm is located, and the occurrence of intraoperative rupture can all influence the development of a RAH infarction. The specific details of these factors can determine the extent of surgical manipulation, potential disruption of blood flow, and subsequent ischemic insult.

c. Prolonged duration of Temporary Clips or Repeated Application of Temporary Clips

Prolonged placement of temporary clips or multiple attempts of temporary clip application during the surgery can increase the risk of compromised blood flow to the RAH. Insufficient blood supply during temporary clipping can lead to ischemia and infarction. The attempt for successful clipping of A- comm artery aneurysm (Figure 4) many a time inadvertently involve the RAH of the same or opposite side (Figures 5 and 6).

d. Vasospasm

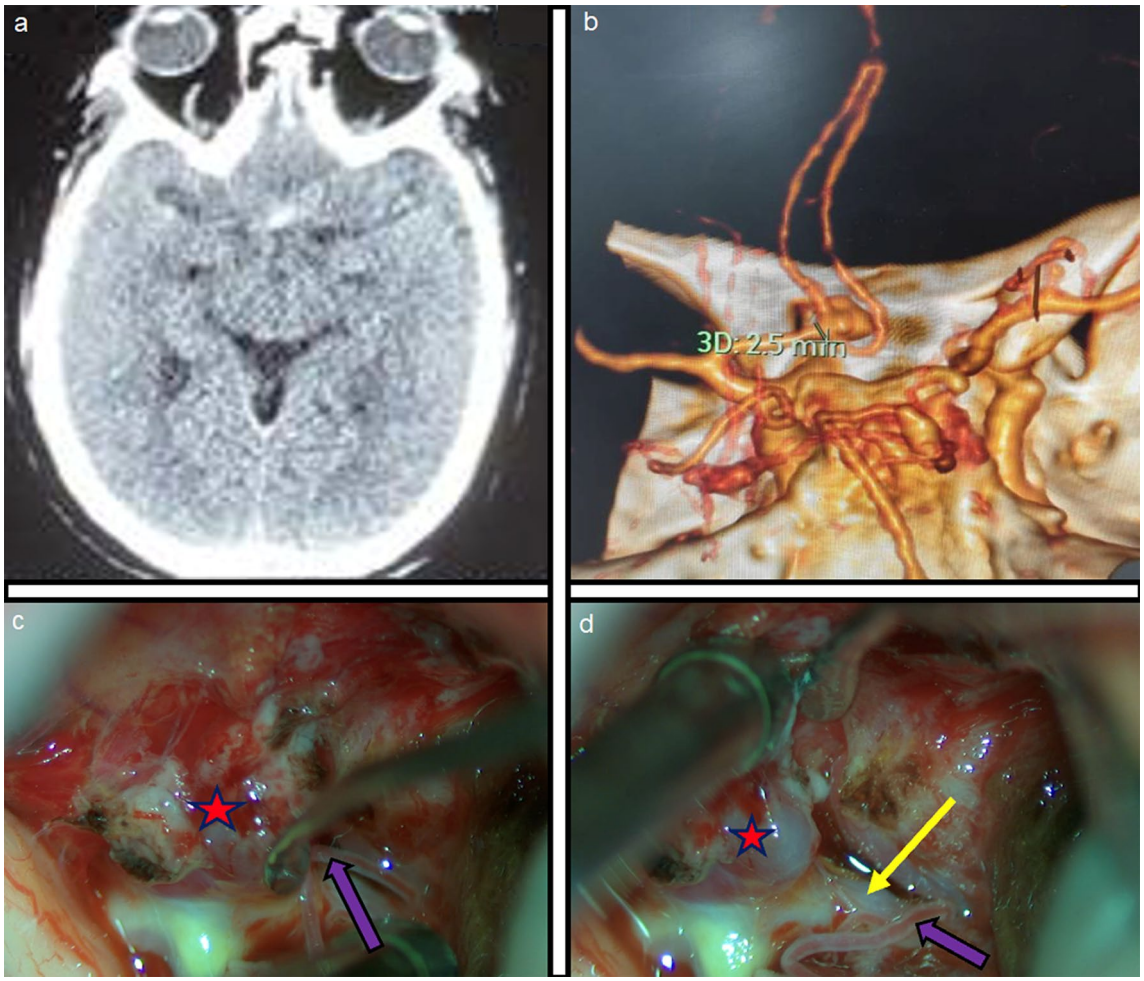

Fig. 2 Plain CT scan head demonstrate small hyper density in the suprasellar cistern **a**. Reconstructed image of CT angiogram demonstrates an anteriorly directed A- comm artery aneurysm with bilobed appearance with dominant left A1 and right A1 is not visible **b**. Intraoperative images after left pterional craniotomy **c** and **d** demonstrates ipsilateral RAH (purple arrow) adhered to the neck of aneurysm (red star). After successful separation of the RAH from aneurysm the ipsilateral A2 (yellow arrow) is seen parallel to the opposite side of A2. In this case, RAH is arising from ipsilateral A2

Vasospasm refers to the narrowing of blood vessels, often occurring several days after aneurysm rupture. It can contribute to reduced blood flow and ischemia in the territory of various cerebral arteries, including the RAH. Vasospasm can exacerbate the risk of infarction in patients who have undergone surgical clipping.

e. Hypotension during Surgery

Intraoperative hypotension, which is a low blood pressure during the surgical procedure, can result in inadequate blood supply to the brain. Hypotension in the presence of underlying increased intracranial pressure results in impaired cerebral perfusion pressure. Insufficient perfusion pressure can compromise the blood flow through the RAH, leading to ischemia and potential risk of cerebral infarction.

f. Relation to comorbid conditions (Hypertension, Diabetes).

Pre-existing medical conditions like hypertension and diabetes can contribute to the development and progression of cerebrovascular disease. These comorbid conditions lead to the development and rupture of intracranial aneurysms. These conditions can lead to structural changes in blood vessels, making them more susceptible to aneurysm formation and rupture. In the context of a RAH infarction after clipping of an A-comm artery aneurysm, the presence of hypertension and diabetes

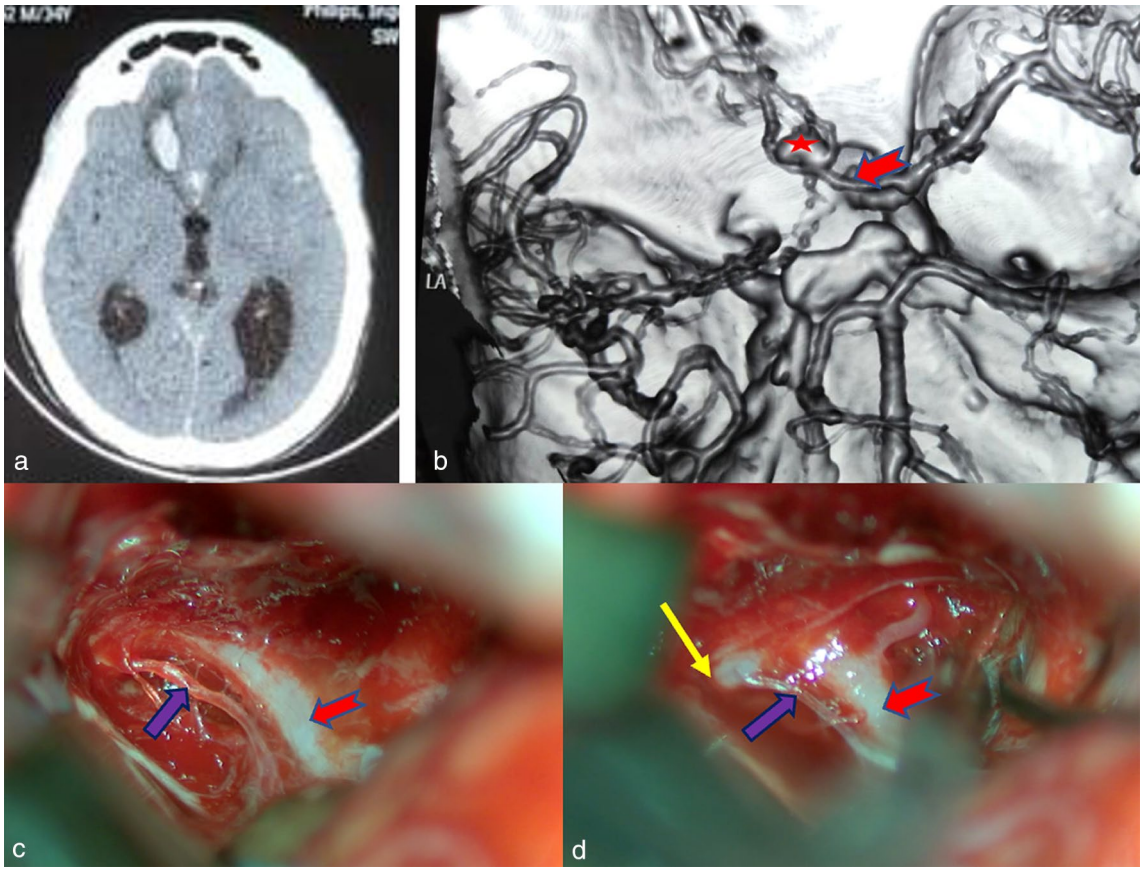

Fig. 3 Plain CT scan head demonstrate hyper density (bleed) in the left gyrus rectus and adjacent basifrontal gyrus with subarachnoid hemorrhage in the interhemispheric fissure **a**. Reconstructed image of CT angiogram demonstrates a superiorly directed A- comm artery aneurysm (red star) with dominant right A1 **b**. Intraoperative images after right pterional craniotomy **c** and **d** demonstrates ipsilateral RAH (purple arrow) running parallel to the ipsilateral A1 (red arrow). After successful micro neurosurgical dissection, the ipsilateral A2 is identified and is well depicted in the image as the source of origin for RAH

may further increase the risk of vascular complications, including perioperative ischemia and compromised blood flow to the RAH.

g. Other Causes

In addition to the factors mentioned above, there can be other causes or contributing factors which lead to the development of a RAH infarction after clipping of an A-comm aneurysm. These may include individual variations in vascular anatomy, presence of other coexisting vascular abnormalities, presence of emboli or clot formation during the surgical procedure, and perioperative complications such as hypoxia, or infection [7–10].

Measures to avoid RAH infarction

Clipping of A-comm artery aneurysm requires one of the finest micro-neurosurgical skill and maneuverability to bring out a favorable outcome. The distorted anatomy of A-comm artery aneurysm complex along with necessity to visualize a dozen of vessels around A-comm artery makes it a challenging surgery to perform. The preoperative assessment of CT angiogram along with the relation of perforators with the aneurysm complex has been found to be most useful for successful clipping of the aneurysm. The utilization of a preoperative CT angiography has significant importance in the evaluation of vascular architecture and the detection of possible complications. In the course of the surgical procedure, the neurosurgeon is required to exercise meticulousness in navigating and manipulating the complex array of blood arteries encompassing the aneurysm, so as to prevent any harm to critical perforators. Measurement of the aneurysm neck size on the CT console avoids unnecessary delay in application of permanent clip during surgery. All attempts must be made to decrease the duration as well as the number of temporary clip application before the definitive clipping. After all, a properly selected aneurysm clip having appropriate length and curvature helps to avoid inadvertent injury as well as entrapment of RAH

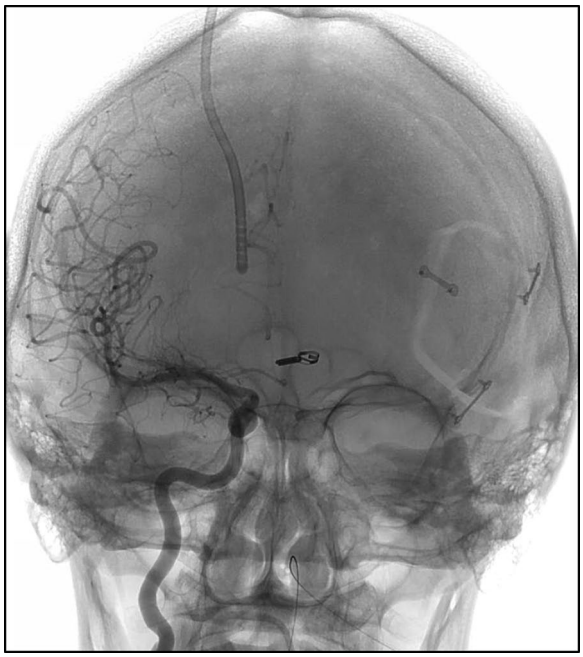

Fig. 4 Postoperative digital subtraction angiography of the right internal carotid artery demonstrating successful exclusion of the A- comm artery aneurysm following microsurgical clipping. The right recurrent artery of Heubner is not visible due to vasospasm or iatrogenic occlusion intraoperatively

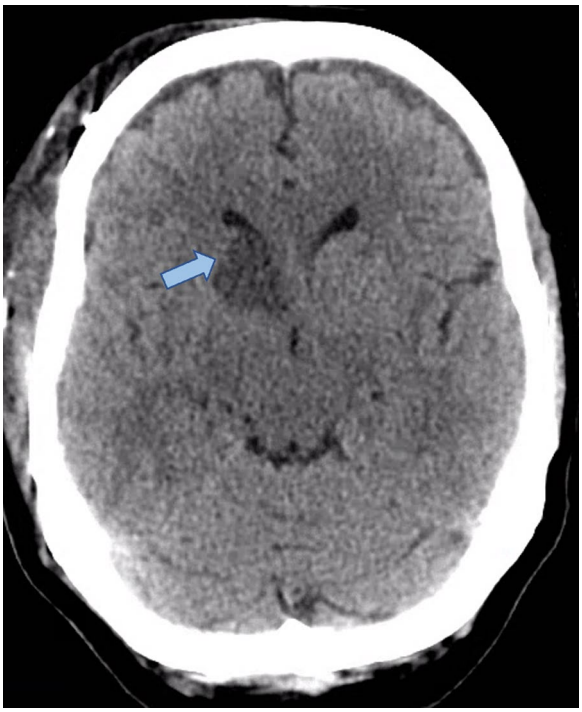

Fig. 6 Axial CT scan results demonstrate RAH distribution as hypodensity at the anterior part of the internal capsule and the head of caudate nucleus on the right, ipsilateral to the side of the craniotomy

Fig. 5 Axial CT findings reveal a hypodensity at the putamen, the head of nucleus caudate and anterior part of the internal capsule on the left, contralateral to the side of craniotomy

and other surrounding perforators. The optimal application of aneurysm clips significantly impacts the efficacy of the surgical intervention and the subsequent prognosis of the individual. RAH of both the sides are at equal risk with inadequate microsurgical dissection and disproportionate clip size. Following surgical clipping of A-comm artery aneurysm, adequate hydration and elevated blood pressure have been found to be the best medical measure to combat vasospasm and prevent ischemic injury to the surrounding brain tissue. Furthermore, it is imperative to closely monitor the patient's neurological condition and do regular imaging investigations in order to identify any indications of vasospasm or rebleeding. The use of nimodipine, a calcium channel blocker, can be an effective intervention in preventing vasospasm and enhancing the patient's prognosis.

Prognosis and surgical outcome

Various factors affect the surgical outcome and prognosis following infarction in the territory of RAH. These variables include the size and location of the infarct, the length and severity of the ischemia, the existence of comorbid conditions, the general health of the patient, and the effectiveness of postoperative care. In general, more severe, and pervasive neurological impairments

may follow bigger infarctions involving vital areas like the caudate nucleus or anterior limb of the internal capsule. Depending on the deficiencies, recovery may be a gradual process requiring rehabilitation involving physical treatment, occupational therapy, and speech therapy [11–13].

Limitations

The lack of specialized research may limit the availability of reliable data and evidence, which would restrict the scope of analysis and conclusions that may be formed. RAH infarction following A-comm aneurysm clipping may not have universally agreed-upon definitions, diagnostic criteria, or outcome metrics. Due to this, it may be challenging to compare and combine data from several research, which might jeopardize the paper's overall coherence and dependability. It would be beneficial to include studies with extended follow-up periods to better understand the persistence, improvement, or decline of neurological deficits over time. Some further contexts might be gained by contrasting this infarct with others, or by looking at the potential side effects of treating A-comm aneurysms. It is crucial to conduct further research into the best management techniques to reduce the risk of RAH's infarction and enhance patient outcomes. Numerous variables, including surgical technique, patient characteristics, comorbidities, and postoperative treatment, might affect the RAH infarction following clipping of the A-comm aneurysm. RAH infarction can be better understood by looking at the role each of these elements plays in the disease and how they interact with one another.

Conclusion

This study emphasizes how crucial it is to identify and mitigate the risk of RAH infarction during A-comm artery aneurysm clipping. RAH infarction is a devastating condition, but by learning more about its causes, prognosis, and surgical results, the operating neurosurgeons may better serve their patients. While further study is required to address the limitations revealed, this publication serve as a starting point for more research, and this may add to the body of knowledge in this focused yet a very crucial topic. We may expand our understanding of RAH infarction following clipping of A-comm artery aneurysm and work toward better outcomes and quality of life for afflicted patients through sustained efforts, collaborative research, and standardized techniques.

Abbreviation

RAH	Recurrent artery of Heubner
A-comm	Anterior communicating artery
ACA	Anterior cerebri artery
MRA	Magnetic resonance angiography

Acknowledgements

We are deeply grateful to all those who contributed to the success of this research project.

Author contributions

OA: Conceptualization, Methodology, Writing – Original Draft Preparation, Writing, Review & Editing. YFA: Writing, Review & Editing. OW: Writing Review & Editing. VM: Writing, Review & Editing.MMR: Writing, Review & Editing. AA: Writing, Review & Editing. All authors read and approved the final manuscript.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Availability of data and materials

The authors confirm that the data supporting the findings of this study are available within the article.

Declarations

Ethics approval and Consent to participate

As this is a review, ethics approval is not applicable. Written informed consent was obtained from legally authorized representatives before the study.

Consent for publication

Written informed consent was obtained from legally authorized representatives before the study.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Received: 8 August 2023 Accepted: 5 September 2023
Published online: 09 November 2023

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