วารสารวิชาการสาธารณสุข
ปีที่ 31 ฉบับที่ 3 พฤษภาคม - มิถุนายน 2565

Journal of Health Science
Vol. 31 No. 3, May - June 2022

นิพนธ์ต้นฉบับ

Original article

Packing Cavernous Sinus: an Alternative Treatment for Traumatic Carotid-Cavernous Fistula

Date received: 2021 Oct 28
Date revised: 2022 Mar 10
Date accpeted: 2022 Mar 25

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Abstract Traumatic carotid-cavernous fistula (CCF) is a possible sequelae of head injury. Urgent treatment is always needed to prevent progression and severe complications. Accessibility to neurovascular intervention, the treatment of choice, is quite limited in Thailand because of few neuro-interventionists. The objective of this study was to evaluate the clinical outcomes of surgical treatment which aimed to induce progressive thrombosis of cavernous sinus in traumatic CCF patients. The present study was a retrospective study using medical records of traumatic CCF patients treated with surgical procedures in Ratchaburi hospital from 2010 to 2019. The goal of surgery was selective packing the sinus to induce thrombosis which leading to obliterate the fistula. Both preoperative and postoperative clinical features and imaging studies were observed within two years of the follow-up period. Twelve traumatic CCF patients were surgically treated between 2010 and 2019. Two cases were excluded from the study due to loss to follow-up. One patient had bilateral CCF. All had clinical triad and some suffered from neurological deficits or visual impairment. Selective packing the sinus resulting in immediate closure of the fistula in 4 cases and progressive thrombosis of the sinus leading to occlusion the fistula in 7 cases. External eye signs were recovered mostly within a week after surgery. Neurological deficits reversed in between 3 and 17 weeks. Two patients had remained some visual impairment. Patency of internal carotid artery was demonstrated in all cases. No new deficits or major complications were detected over the follow-up period. In patient with traumatic CCF, surgical treatment by selective packing cavernous sinus is effective and safe which may be considered in the status that endovascular management is inaccessible or failed.

Keywords: traumatic; carotid-cavernous fistulas; packing cavernous sinus; surgical treatment

Introduction

Carotid-cavernous fistulas recently are classified into direct and indirect types depending on connection between internal carotid artery (ICA) or branches of the artery and cavernous sinus[1]. Carotid-cavernous fistula (CCF) following head injury is mostly direct type (type A) which created high flow shunting of arterial blood from internal carotid artery into cavernous sinus. Clinical features from high pressure in orbital and cerebral venous systems may be developed

rapidly leading to morbidity or even mortality. Urgent management with neurovascular intervention is the first line treatment to occlude the fistula and maintain the patency of ICA. Surgery is always necessary in the situation that neurointervention is unavailable or not successful. Many surgical procedures have been used to treat this conditions with varied results[2]. The objective of this study was to evaluate the results of surgery aimed to progressive thrombosis of the sinus.

Material and Method

From medical records, the patients with traumatic CCF treated with surgery between 2010 to 2019 in Ratchaburi hospital were enrolled in the present retrospective study. Preoperative and postoperative clinical features and imaging studies were collected and analyzed.

The surgical procedures used in these patients sequentially included extradural approach to the foramen rotundum, identifying ophthalmic vein, incision on the junction of cavernous sinus and ophthalmic vein, insertion of thrombotic-induced materials until relatively high resistance to insertion was felt or orbital bruit was absent. If transvenous packing was inadequate or unsuccessful, incision on the dura, just anteromedially to foramen rotundum, to expose the anteromedial (Mullan's) triangle of the cavernous sinus was performed. Then small opening on the wall of cavernous sinus was made and insertion of the thrombotic materials was continued. Necessary monitoring during operation was doppler stethoscope placing over the involved orbit to detect orbital bruits. Thrombotic agents included pieces of Gelfoam, Surgicel and strands of cotton. Postoperative observation of clinical signs was done and CTA after disappearance of orbital bruit was performed. The follow-up duration was 2 years.

Results

There were 12 cases and one had bilateral lesions. Thirteen operations were performed to induce thrombosis of cavernous sinus by selective packing the sinus. There were 2 cases excluded from the study because of loss to follow-up.

All patients had classic triad of chemosis, exophthalmos and orbital bruit and some had neurological deficits. The deficits were total ophthalmoplegia in 2 cases, lateral rectus palsy in 2 cases, visual impairment in 3 cases and 1 patient had an eye pain. In 10 cases, 6 cases were male and 4 were female. The youngest patient was 17 years old and the oldest was 63 years old. Motorcycle accident was the cause of head injury in 9 cases and fall in 1 case. The earliest diagnosis was a week after head injury and the latest was 16 weeks. The involved cavernous sinuses were 7 in the right side and 4 in the left (Table 1).

The success route of packing in 6 operations was through ophthalmic vein and directly through the sinus (Mullan's triangle) in 5 operations. The average number of inserted thrombogenic agents was 6 pieces, each 0.5x3.0 centimeters in size.

The eye signs markedly improved mostly within a week. The deficits were reversed earliest in 3 weeks and latest in 17 weeks and 2 cases remained some visual impairment.

After packing the sinus, no orbital bruit was recorded in 4 operations and in 7 operations the bruits definitely decreased but did not disappeared which indicated that the fistulas were not occluded immediately after surgery. All 7 cases had the bruit disappearance in the follow-up period, most was within 4

Table 1 Clinical features and postoperative results in 12 patients

OR	Sex	Age	Cause	Onset	Deficits	Through	No Bruit	Eye recovery	Deficit recovery
1	M	43	MCA	3W	Total	Venous	Immediate	3D	10W
2	M	17	MCA	1W	Total	Sinus	4W	7D	11W
3	M	53	MCA	7W	Visual (Rt)	Venous	Immediate	4D	Residual
4					Visual (Lt)	Venous	4W	10D	-
5	M	52	MCA	2W	Visual	Sinus	7W	7D	12W
6	M	49	MCA	9W	6^{th} CN	Sinus	3D	3D	17W
7	F	49	MCA	3W	6^{th} CN	Sinus	Immediate	3D	3W
8	M	19	MCA	4W	-	Sinus	3W	5D	-
9	F	63	MCA	5W	Visual	Venous	14W	15D	Residual
10	M	46	MCA	4W	-	Venous	2W	7D	-
11	F	41	Fall	16W	Pain	Venous	Immediate	7D	-

Note: OR = operation (3 and 4 in the same patient with 3-week interval), MCA = motorcycle accident, Total = total ophthalmoplegia, No Bruit = from operative day, Eye (signs) recovery = from operative day, Deficit recovery = from operative day, Residual = some visual impairment, D = days, W = week(s). Eye signs = chemosis/exophthalmos/eye pain, Deficit=ptosis/extraocular muscle palsy/visual impairment.

weeks (5 cases), the earliest was 3 days and the latest was 14 weeks postoperatively. Two patients had some residual visual impairment. Computed tomography angiography (CTA) of all cases after bruit appearance demonstrated decreased bulging cavernous sinus, no fistulas, and patency of ICA. No new clinical signs or deficits developed within the follow-up period in all patients. Images of preoperative and postoperative CTA of a patient in this series is illustrated in Figure 1.

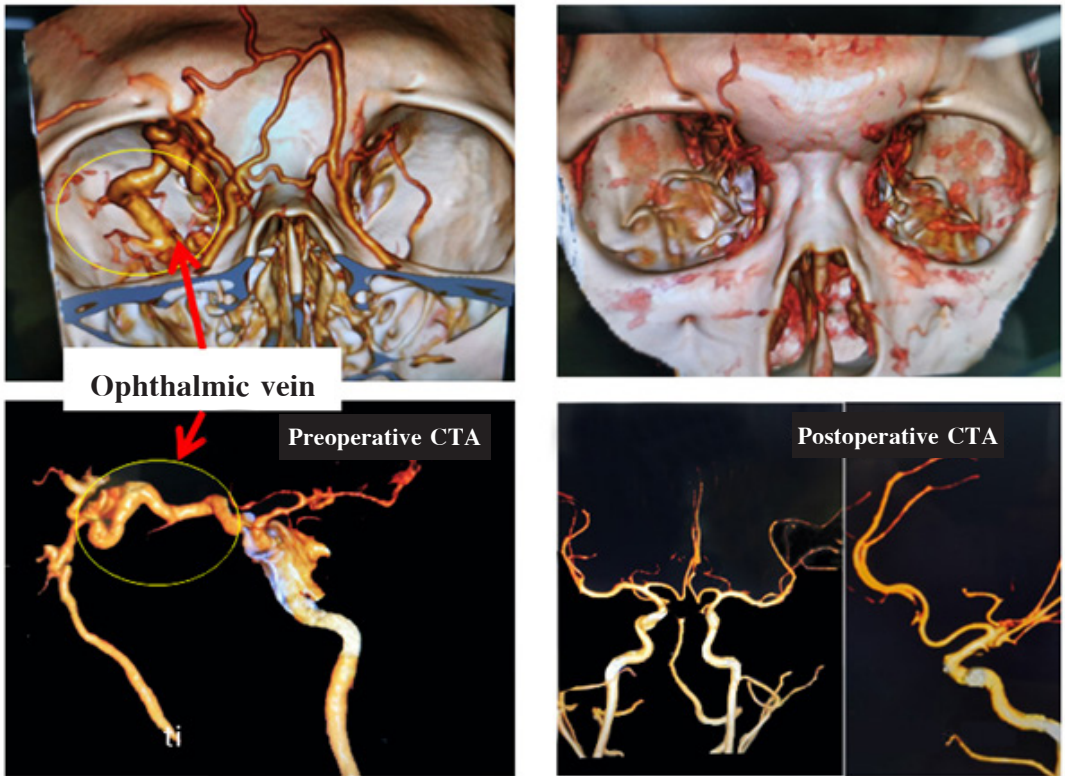
Discussion

Traumatic CCF is a possible sequelae of head injury. There is direct communication between ICA and cavernous sinus which causes pressure effect to the intra-cavernous cranial nerves and raises pressure in the venous tributary draining into cavernous sinus, especially in the orbital venous channels.

Clinical signs may rapidly progress including eyelid edema, chemosis, exophthalmos, orbital bruit, ptosis, ophthalmoplegia, visual loss, increased intraocular pressure, increased intracranial pressure and brain hemorrhage.[3-6] Spontaneous closure of traumatic CCF have been occasionally reported.[7-11] Urgent treatment is always needed to prevent progressive and irreversible deficit. Various surgical procedures have been used to treat this condition.[12-17] With advances in neurovascular intervention techniques, endovascular treatment now is the treatment of choice in the literature.[18-21]

In Thailand, there are not enough neuro-interventionists and few hospitals have facilities to perform neuro-endovascular treatment. In spite of universal health coverage, rather expensive co-payment is usually needed. So accessibility to the first-line treatment is limited for many CCF patients.

Figure 1 Imaging of preoperative and postoperative computed tomography angiography of a patient in this series



Note: The CTA of a CCF patient, preoperative study showed marked dilatation of ophthalmic vein and some degree steal effect on ICA. Postoperative study after orbital bruit disappearance showed normal orbital venous channels and ICA patency.

When neuro-intervention is inaccessible, surgical treatment becomes the necessary choice. Immediate occlusion of the fistula by various surgical procedures can be success with some morbidity and mortality[12-17,22]. The major surgical complications are occlusion of ICA and injury to the cranial nerves.

Avoiding injuries to the intra-cavernous cranial nerves and ICA is a great concern during packing cavernous sinus. When opening the sinus is needed, the area of Mullan's triangle is relatively safe location, it is inferolateral on anterior part of the sinus, while ICA passes superomedially and the cranial nerves (the III, IV, V-1 and VI CN) run above the triangle.

Cavernous sinus composed of venous plexus with connective tissue which creates compartments in the sinus.[23-25] Ophthalmic veins are not valveless[26] and spontaneous closure of the fistula have been occasionally reported. The evidences showed some self-healing potential in CCF patients. In addition to the capacity of thrombogenic material to expand its volume after insertion, selective packing the sinus in order to disconnect orbital venous channels from cavernous sinus, not to immediately close the fistula, showed reversal of clinical signs with no complication. Progressive thrombosis of the sinus leading to complete closure of CCF was demonstrated in the present study.

Conclusion

When endovascular management is impossible or failed to treat patients with traumatic CCF, surgery with the aim to decrease pressure in ophthalmic veins with acceptance of progressive closure of fistula is a safe and effective alternative.

Acknowledgment

The author wishes to acknowledge the assistance provided by Radiology Division, Ratchaburi Hospital.

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บทคัดย่อ: การประเมินผลการเลือกใช้การผ่าตัดในการรักษา carotid-cavernous fistula ที่เกิดจากอุบัติเหตุ

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การมีช่องเชื่อมต่อระหว่างหลอดเลือดแดงคาโรติดกับคาเวอร์นัสไซนัส (carotid-cavernous fistula) ที่เกิดจากอุบัติเหตุ เกิดขึ้นได้ภายหลังจากได้รับการบาดเจ็บที่ศีรษะ การรักษาโดยเร็วมีความจำเป็นเพื่อป้องกันไม่ให้อาการเป็นมากขึ้น และป้องกันภาวะแทรกซ้อนที่อาจเป็นอันตรายร้ายแรง การเข้าถึงการรักษาโดย neurovascular intervention ซึ่งเป็นการรักษาที่แนะนำให้เลือกเป็นอันดับแรก ยังจำกัดมาก เนื่องจากประเทศไทยยังมีแพทย์ผู้เชี่ยวชาญด้านนี้น้อยอยู่ การศึกษานี้มีวัตถุประสงค์เพื่อประเมินผลการรักษาผู้ป่วย carotid-cavernous fistula ที่เกิดจากอุบัติเหตุด้วยวิธีการผ่าตัดที่มีเป้าหมายให้เกิดลิ่มเลือดแบบสะสมขึ้นใน cavernous sinus โดยศึกษาจากข้อมูลจากเวชระเบียนของผู้ป่วยที่มี carotid-cavernous fistula ที่เกิดจากอุบัติเหตุ และได้รับการรักษาด้วยวิธีการผ่าตัดในโรงพยาบาลราชบุรี ในช่วงเวลาปี พ.ศ. 2553 ถึง 2562 การผ่าตัดโดยการเลือกบริเวณอัด cavernous sinus ให้แน่น มีเป้าหมายชักนำให้เกิดลิ่มเลือดและมีอุดกั้น carotid-cavernous fistula ตามมา มีการประเมินอาการแสดงทางด้านคลินิก และวินิจฉัยทางด้านภาพรังสี ทั้งก่อนและหลังการผ่าตัด โดยมีระยะการเฝ้าติดตามผู้ป่วยอย่างน้อยสองปี ในช่วงปี พ.ศ. 2553 ถึง 2562 มีผู้ป่วย carotid-cavernous fistula ที่เกิดจากอุบัติเหตุ จำนวน 12 ราย ที่ได้รับการรักษาด้วยการผ่าตัดในโรงพยาบาลราชบุรี ผู้ป่วย 2 รายไม่ได้รับการนับรวมในการศึกษานี้เนื่องจากระยะการเฝ้าติดตามไม่ครบ 2 ปี ผู้ป่วย 1 ราย มีพยาธิสภาพ carotid-cavernous fistula ทั้ง 2 ข้าง ผู้ป่วยทุกรายมีอาการแสดงเฉพาะ 3 อย่าง คือ เยื่อบุตาบวม ตาโปน และมีเสียงฟู่ที่เบ้าตา บางรายมีอาการสูญเสียการเคลื่อนไหวลูกตา หรือมีการมองเห็นบกพร่องร่วมด้วย การผ่าตัดทำให้เกิดการปิดกั้น carotid-cavernous fistula ได้ทันทีหลังผ่าตัดจำนวน 4 ราย และมีการปิดกั้นในภายหลังจำนวน 7 ราย โดยที่อาการทางตาภายนอกส่วนใหญ่หายไปภายใน 1 สัปดาห์ การสูญเสียการเคลื่อนไหวของลูกตากลับมาเป็นปกติในช่วง 3 ถึง 17 สัปดาห์หลังการผ่าตัด ผู้ป่วย 2 รายยังมีการมองเห็นที่บกพร่องบางส่วน ทุกรายหลอดเลือดแดง internal carotid ยังคงปกติ ไม่มีการตีบตัน และไม่มีภาวะแทรกซ้อนอื่น ๆ การผ่าตัดเลือกบริเวณอัด cavernous sinus ให้แน่นในผู้ป่วยcarotid-cavernous fistula ที่เกิดจากอุบัติเหตุได้ผลดี และปลอดภัย ควรพิจารณาเป็นการรักษาทางเลือกในกรณีที่การรักษาด้วย neurovascular intervention ไม่สามารถทำได้ หรือผู้ป่วยไม่สามารถเข้าถึงได้

***คำสำคัญ*: การผ่าตัดอัดคาเวอร์นัสไซนัส; อุบัติเหตุ; ช่องเชื่อมต่อระหว่างหลอดเลือดแดงคาโรติดกับคาเวอร์นัสไซนัส**