Case Report

The Nerve

The Nerve 2022;8(2):126-132
https://doi.org/10.21129/nerve.2022.00185
eISSN 2465-891X

Multiple Stenting without Coils for Traumatic Pseudoaneurysm of Supraclinoid Internal Carotid Artery: Two Case Reports

Dong-Min Seo[1], Yongjae Cho[1,2], Young goo Kim[1,2], Na Rae Yang[1,2]

[1]Department of Neurosurgery, Ewha Womans University Mokdong Hospital, Seoul, Republic of Korea
[2]Department of Neurosurgery, Ewha Womans University College of Medicine, Seoul, Republic of Korea

OPEN ACCESS

Received: August 31, 2022
Revised: September 19, 2022
Accepted: October 5, 2022

Corresponding author:
Na Rae Yang
Department of Neurosurgery, Ewha Womans University Mokdong Hospital, Ewha Womans University College of Medicine, 1071, Anyangcheon-ro, Yangcheon-gu, Seoul 07985, Republic of Korea
Tel: +82-2-2650-2840
Fax: +82-2-2650-2652
E-mail: narae.yang@ewha.ac.kr

Traumatic intracranial pseudoaneurysm (TIPA) is a very rare disease that is difficult to diagnose and treat and has high mortality and morbidity. Various treatment methods, such as microsurgery and endovascular treatment, have been proposed because TIPA accompanies traumatic brain injury. It is necessary to consider the location and characteristics of the TIPA and the patient's condition. According to previous reports regarding the endovascular treatment of TIPA, most cases were treated with stent-assisted coil embolization. Unlike previous studies, however, we would like to share our experience of two cases successfully treated by overlapping three closed-cell self-expandable stents without coils.

Keywords: Aneurysm, false; Intracranial carotid artery injuries; Stents; Stent-within-a-stent; Traumatic pseudoaneurysm; Triple overlapping stents

INTRODUCTION

A traumatic intracranial pseudoaneurysm (TIPA) is a rare disease in approximately 1% of patients with intracranial aneurysms[3,8,13,15)]. Furthermore, the diagnosis and treatment of a TIPA may be difficult, and the disease is associated with high mortality and morbidity[8,10)].

Previous studies on vascular surgical approaches for the treatment of TIPA mostly included stents and coils. Tan et al.[12)] reported the results of 12 cases of stent-assisted coil embolization using a low-profile visualized intraluminal support stent (LVIS). All cases were successfully treated. There were two cases of multiple cerebral infarctions due to the complication from vasospasm, and another two from the remaining ten cases underwent retreatment due to recanalization of the pseudoaneurysm. Mortality and morbidity rates were reported as 25% and 8.3%, respectively, and it showed that LVIS stent-assisted coiling is feasible for the treatment of traumatic internal carotid artery (ICA) pseudoaneurysms.

We hope to share the successful experiences of using tripled overlapping stents (TOS) for supraclinoid ICA traumatic aneurysms, without coils, in two cases of head trauma.

CASE REPORT

1. Ethics Approval

The study conformed to the ethical guidelines of the World Medical Association Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the relevant institution. (IRB no. 2022-07-053)

2. Case 1

A 50-year-old patient suffered head trauma after a collision traffic accident from the posterior with an excavator. His Glasgow Coma Scale grading was E4, V4, and M6. Brain computed tomography (CT) in the emergency room showed subarachnoid hemorrhage (SAH), pneumocephalus, fractures of the left orbital roof, left posterior ethmoid sinus roof, and sphenoid sinus roof, and a facial bone fracture. A left temporal bone fracture was also present

The patient was treated in the intensive care unit, and he continued to be in a confused and irritable state. A vascular evaluation was performed, and CT angiography was conducted on hospital day 1 (Fig. 1A-C). The left temporal contusion increased, and a left supraclinoid ICA aneurysm was found. There was no sign of herniation and coup injury was definitive, as a left temporal bone fracture was present. There was uncertainty regarding the left ICA pseudoaneurysm on the scan; therefore, minimal invasive surgery for the catheterization of the hematoma was performed initially.

The hematoma was successfully removed, and the patient stabilized. To check for the presence of a pseudoaneurysm, at postoperative day (POD) 14, follow-up CT angiography was performed (Fig. 2B). Because there was a change in the shape of the aneurysm compared with than on the previous scan, a pseudoaneurysm was diagnosed (Fig. 2A), and the following findings were obtained by transfemoral cerebral angiography (TFCA) regarding the treatment (Fig. 2C).

Dual antiplatelet therapy was administered for 3 days, which was loaded on the day of the procedure. The procedure was performed under general anesthesia. A 6 Fr guiding catheter was placed in the ICA, and stenting was performed with the closed cell stent Enterprise 4 mm/23 mm to include the proximal and distal healthy segments of the lesion, using a Prowler plus 45-degree microcatheter and synchro soft microwire. Using the wire where the stent was loaded, the microcatheter was placed (Fig. 3A), and two additional Enterprise 4 mm/23 mm stents were deployed by repeating the steps to perform the stent-in-a-stent technique for a total of three stents (Fig. 3B). The procedure was successful (Fig. 3C), and the pseudoaneurysm on the left ICA angiogram was stagnated in a delay phase. The patient continued to receive dual antiplatelet therapy and was stable. Follow-up TFCA was performed 2 weeks, 1 month, and 6 months after the procedure. The 2-week follow-up three-dimensional reconstruction image showed a change in the shape of the pseudoaneurysm, but with a decreased neck

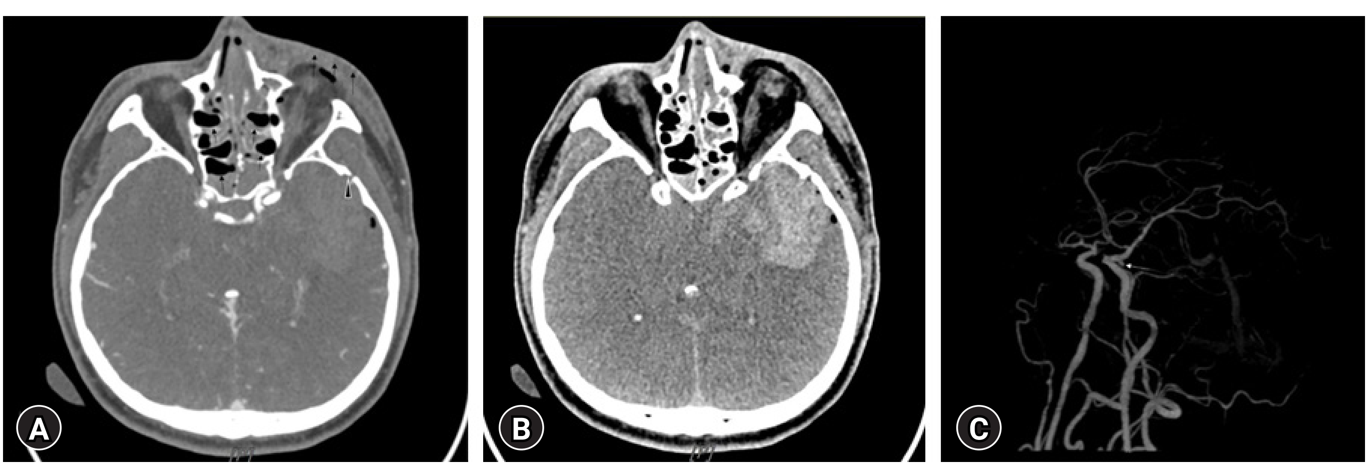

Fig. 1. Computed tomography (CT) angiography was performed on hospital day 1. (A) On CT angiography (bone setting), air-fluid level is observed in the nasal sinus, and soft tissue swelling is observed in the left face (arrow). A temporal bone fracture is also observed (arrowhead). (B) CT angiography shows suspected temporal lobe contusion. (C) On CT angiography (3-dimensional reconstruction view), a left supraclinoid internal carotid artery aneurysm (arrow) is found.

Fig. 2. (A) On computed tomography (CT) angiography performed on the day of the injury, a saccular aneurysm is observed in the posterior direction of the supraclinoid internal carotid artery (ICA) segment (arrow). (B) CT angiography performed 2 weeks after the injury. The aneurysm in the supraclinoid ICA segment has changed. It appears to present more of a broad base, and the height is lower (arrow). (C) On the left ICA on a transfemoral cerebral angiogram, a lateral posterior direction pseudoaneurysm is confirmed (arrow).

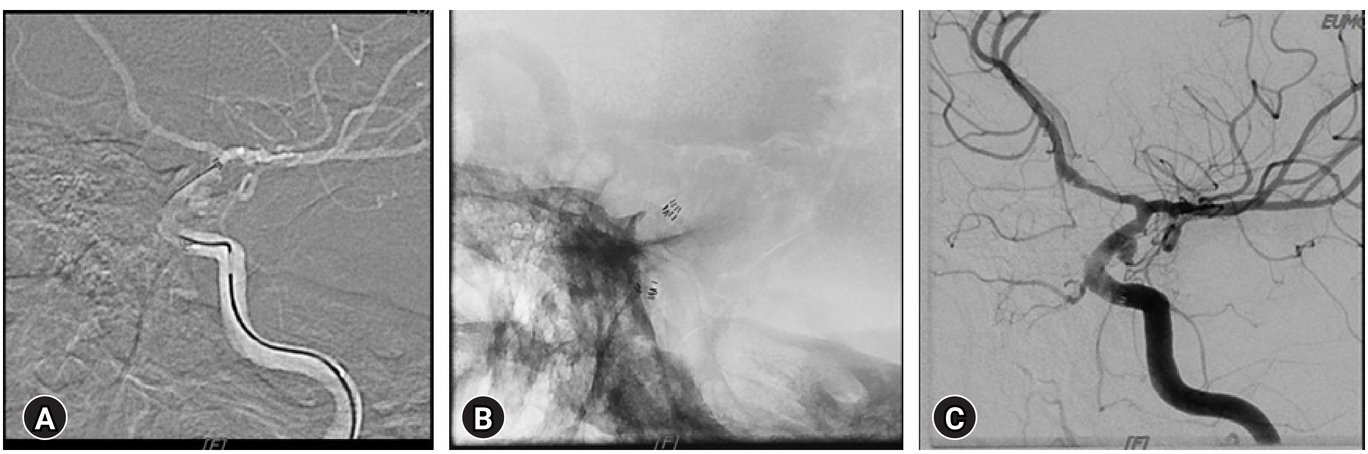

Fig. 3. Under general anesthesia, endovascular treatment was performed for the left supraclinoid internal carotid artery (ICA) pseudoaneurysm. (A) Using the wire where the stent was loaded, a microcatheter was placed through the deployed stent. (B) A native working projection shows the deployment of three stents, using the stent-in-a-stent technique. (C) Left ICA angiogram shows that the procedure was successful.

(Fig. 4A), the 1-month follow-up scan showed a decreased size of pseudoaneurysm (Fig. 4B), and complete healing was confirmed on the 6-month follow-up scan (Fig. 4C). The patient was discharged at 3 months after surgery with a modified Rankin Scale (mRS) score of 1, and the patient returned to a normal lifestyle with a mRS score of 0 at the 6-month follow-up.

3. Case 2

A 57-year-old male individual with decreased consciousness was found next to a motorcycle and was admitted to the emergency room. His mental status was drowsy, and there was a contusion on the left part of the face. Brain CT showed diffuse SAH and intraventricular hemorrhage (Fig. 5A), as well as a left lateral orbital wall fracture (Fig. 5B), accompanied by multiple rib fractures. CT angiography showed a suspicious lesion (Fig. 5C); therefore, TFCA was performed (Fig. 6A, B).

A supraclioid ICA dorsolateral area pseudoaneurysm was confirmed (Fig. 6A, B), and endovascular treatment was performed. A 6 Fr Envoy catheter was placed in the ICA. Using a Prowler plus 45-degree microcatheter and synchro 2 mi-

Fig. 4. (A) A 3-dimensional (3D) reconstruction image at a 2-week follow-up after the procedure shows a change in the shape and size of the pseudoaneurysm, although the neck is narrower (arrow). (B) A 1-month follow-up 3D reconstruction image shows a slight decrease in the size of the pseudoaneurysm (arrow). (C) A 6-month follow-up 3D reconstruction image shows complete healing (arrow).

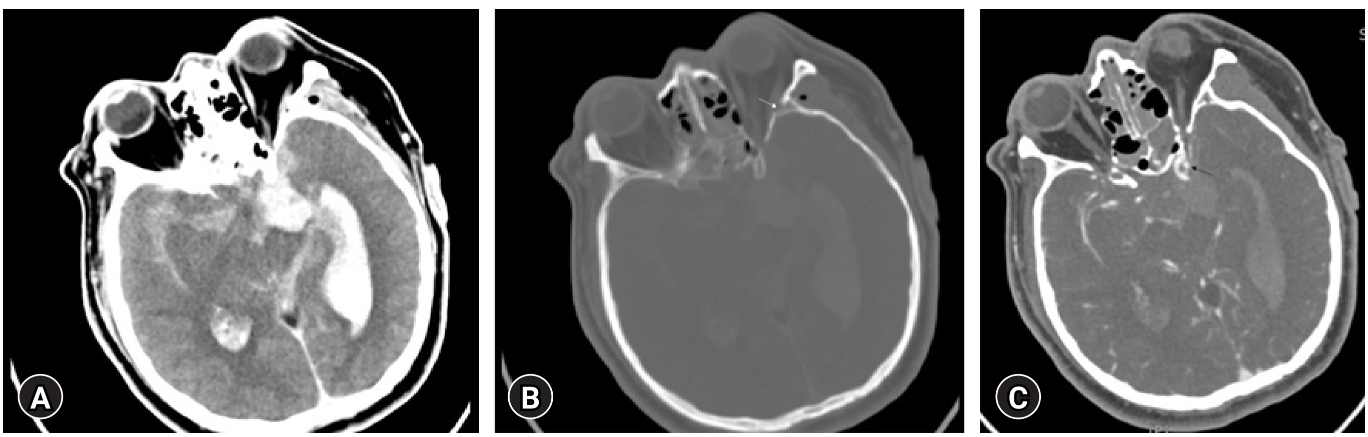

Fig. 5. (A) Non-contrast brain computed tomography (CT) shows diffuse subarachnoid hemorrhage and intraventricular hemorrhage, and there is swelling of the left facial soft tissue. (B) Bone setting brain CT shows a left lateral orbital wall fracture (arrow). (C) CT angiography performed for the suspected vascular injury shows a questionable lesion in the left distal internal carotid artery (arrow).

crowire, the microcatheter was placed with the wire where the Enterprise stent 4 mm/16 mm, 4 mm/20 mm, 4 mm/30 mm, which is a closed cell stent, was loaded. Then, by deploying a stent within a stent, three stents were deployed together.

There were no complications from the surgery. Dual antiplatelet drugs were administered loading dose(clopidogrel 300 mg and aspirin 300 mg) on the day of the procedure, followed by clopidogrel 75 mg and aspirin 100 mg daily.

TFCA performed on a POD #24 showed only a very small sac (Fig. 7A), and total obliteration was confirmed on TFCA performed on POD #65 (Fig. 7B).

DISCUSSION

A traumatic brain aneurysm is a rare disease[3,8,13,15]. The prognosis of a traumatic aneurysm is determined by the severity of the initial brain injury, treatment of the aneurysm, and the timing of the treatment. There are primarily two treatment methods reported, which are the surgical approach and endovascular treatment.

Surgical treatments include direct clipping and parent artery occlusion with or without bypass. However, appropriate treatment should be determined for each case, as direct clipping of pseudoaneurysms may not be feasible due to

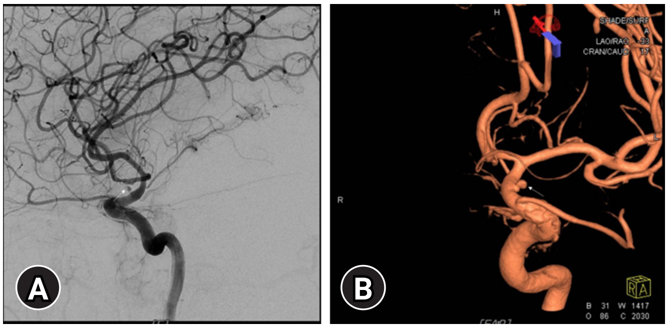

Fig. 6. (A) Transfemoral cerebral angiography. A left internal carotid artery (ICA) angiogram (lateral projection) shows the pseudoaneurysm in the dorsal wall of the supraclinoid segment of the ICA (arrow). (B) Findings are observed in a 3-dimensional reconstruction (arrow).

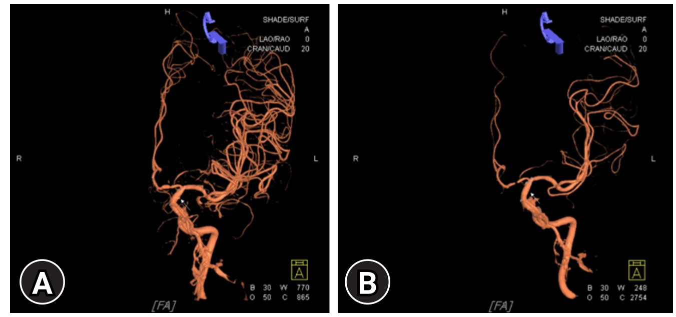

Fig. 7. (A) A very small sac is observed (arrow) on 3-dimensional reconstruction transfemoral cerebral angiography (TFCA, performed on day 24 after the procedure) of the left internal carotid artery. (B) Complete obliteration of the pseudoaneurysm is observed (arrow) on TFCA performed on day 65 of the procedure.

the absence of a vascular wall[1,4]. Bleeding may occur during surgery from the vulnerability of the pseudowall[6], which may involve surgical repair with microsurgical suturing[4], and wrapping and clipping are sometimes performed[4]. Trapping is a definitive treatment for removing pseudoaneurysms, although to prevent issues with hypoperfusion, low-flow bypass is recommended for distal pseudoaneurysm[13] and high-flow bypass is recommended for ICA pseudoaneurysms[7]. However, for a traumatic injury, it is difficult to be certain that bypass treatments are appropriate due to the edema from traumatic brain injury itself. We reviewed 21 cases of microsurgeries for intracranial pseudoaneurysms, excluding middle cerebral artery pseudoaneurysm cases, from the literature review by Zheng et al.[16]. Of these, four cases involved the supraclinoid ICA, one case had a mRS score of 3, and the rest had good outcomes. Among all the microsurgery cases, seven had mRS scores of 3 to 6 (33.33%), and there was one case of mortality (4.76%)[16].

Zheng et al.[16] summarized a total of 63 cases of endovascular treatment. Treatments included internal trapping or reconstructive treatment. Twenty-four cases were treated with coils, 14 with covered stents, and 14 with flow diverters. Of these, there was only one case treated with an overlapping stent without a coil, similar to the two we have described. There has been an increasing number of cases being treated with flow diverters after the introduction of this method, although its limitations include a rather short history of use and an increased burden for the use of antiplatelet agents compared with the use of a typical stent. Moreover, a flow diverter is being used only for an unruptured aneurysm in South Korea, and therefore, it is unlikely to be used in cases where bleeding is occurring.

What is the treatment approach rationale for not using a coil in our cases? When assessing the category of a traumatic aneurysm, a pseudoaneurysm is the most common histologically[5]; this occurs when all three vascular walls are defective and form a hematoma[2,5,8]. Next is a mixed type, which starts as a true aneurysm but forms a false lumen from a rupture[2,5,14]. Therefore, the microcatheter used to place a coil or the coil itself may cause a rupture during the procedure due to the vulnerability of the pseudoaneurysm wall. Moreover, recurrence may occur from the flow pulsatility that induces forces through the gap of the coil mass[9]. When using a coil, due to the characteristics of the disease, recurrence was common with reconstructive treatment. We believe that the absence of the immediate obliteration of the pseudoaneurysm, which is the limitation, can offset the advantage of not using a coil. An overlapped stent can change the blood flow in pseudoaneurysms and accelerate thrombosis within the aneurysm, thereby reconstructing the parent artery by inducing the development of a new interior following the stent. Unlike the flow diverter, where the artery is immediately occluded, there is a risk of re-hemorrhage for several weeks until complete occlusion2, and its limitation includes necessitating dual antiplatelet therapy. Therefore, the overlapped stent should be used with caution in cases of hemorrhagic pseudoaneurysms.

The treatment strategy for case 1 was delayed treatment. First, the possibility of a traumatic aneurysm was high, although there was an injury that could cause direct temporal lobe contusion, and bleeding was also increasing. Therefore, it was difficult to take the risk of the immediate treatment and initiating antiplatelet therapy. It was also difficult to predict the impact of the brain edema from the trauma during craniotomy. If bleeding from the pseudoaneurysm was to be suppressed using a tamponade, there was a possibility for uncontrolled bleeding from a rapid reduction in pressure during craniotomy. Therefore, craniotomy could not be considered. Hence, a burr hole catheter was inserted, and when more evidence for a traumatic pseudoaneurysm was obtained from follow-up tests and intracerebral hemorrhage had improved, treatment was initiated. There was no re-bleeding up to this time, bleeding from the brain contusion was reduced, and the peak for brain edema had passed. Therefore, we believed this was a safe time point. We also found evidence that the patient had a traumatic pseudoaneurysm, as the form of the aneurysm changed across the treatment period. The pseudoaneurysm shape changed during the follow-up period, and while it appeared larger at 2 weeks, the neck area was smaller and we determined that it was improving (Fig. 4A). The patient was stable, and therefore, we did not take the risk of performing additional procedures and followed up closely. At 6 months, we confirmed that pseudoaenurysm had healed

(Fig. 4C).

For untreated pseudoaneurysms, the rate of delayed rupture is very high, at approximately 50%[1], and it is important to follow up closely. The average time from the initial trauma to aneurysm hemorrhage is approximately 21 days, and it is reported that the mortality rate is 50%[8,11,14]. We treated the first case within 21 days of the initial trauma.

Unlike the first case, the treatment strategy for the second case was immediate treatment. This was because the trauma was obvious and the characteristics of SAH suggested damage to the vessels. Therefore, we performed cerebral angiography and confirmed the lesion very early. Fortunately, hemorrhage in the intracerebral parenchyma was minimal and the follow-up tests across several hours suggested that hemorrhage did not increase. Therefore, treatment was needed at the current status. Antiplatelet loading was initiated immediately, and while bleeding did not increase, vasospasm and infarction of the left frontal lobe and basal ganglia occurred from diffuse SAH on day 20 post-injury. Cane gait was possible through rehabilitation treatment. The patient was alert and while there was reduced cognitive function, it was improved such that communication was possible.

CONCLUSION

We report two cases of TIPA that were treated with TOS without coils. We chose delayed or immediate treatment based on the patient's status, the treatments were successful and the prognoses were satisfactory. While these treatment methods are limited by delayed occlusion of the aneurysm, treatment with a coil may also not result in complete obliteration of pseudoaneurysms or could frequently cause recurrence. Taking these into consideration, we believe the outcomes of our cases to be acceptable. Thus, when treating traumatic pseudoaneurysms with TOS, complete obliteration was achieved after from 2 to 6 months.

FUNDING

This work was supported by the Ewha Womans University Research Grant of 2021. This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government(MSIT) (No. 2018R1D1A1B07045764).

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Altali K, Arruza L, López-Ibor L, Aleo E: Effective coil embolization of intracavernous carotid artery pseudoaneurysm with parental artery preservation following severe head trauma in a pediatric patient. Childs Nerv Syst 30:967–970, 2014
2. Amirjamshidi A, Rahmat H, Abbassioun K: Traumatic aneurysms and arteriovenous fistulas of intracranial vessels associated with penetrating head injuries occurring during war: principles and pitfalls in diagnosis and management. A survey of 31 cases and review of the literature. J Neurosurg 84:769–780, 1996
3. Benoit BG, Wortzman G: Traumatic cerebral aneurysms. Clinical features and natural history. J Neurol Neurosurg Psychiatry 36:127–138, 1973
4. Binning MJ, Eskandari R, Couldwell WT: Direct surgical repair of carotid pseudoaneurysm in an infant. Childs Nerv Syst 26:1151–

1153, 2010
5. Buckingham MJ, Crone KR, Ball WS, Tomsick TA, Berger TS, Tew JM: Traumatic intracranial aneurysms in childhood: two cases and a review of the literature. Neurosurgery 22:398–408, 1988
6. Chen Z, Zhang J, Miao H, Niu Y, Feng H, Zhu G: Delayed rupture of iatrogenic cerebral pseudoaneurysms after neurosurgical procedures: report of two cases. Clin Neurol Neurosurg 115:1552–1554, 2013
7. Cikla U, Li Y, Hernandez-Duran S, Kozan A, Baskaya MK: Treatment of supraclinoid internal carotid artery iatrogenic pseudoaneurym with extracranial-to- intracranial bypass and trapping: Demonstration of technique with video presentation. Turk Neurosurg 25:305–309, 2015
8. Holmes B, Harbaugh RE: Traumatic intracranial aneurysms: a contemporary review. J Trauma 35:855–860, 1993
9. Lee CH, Luo CB: Pseudoaneurysm of the basilar artery presenting with epistaxis. Br J Neurosurg 34:475–476, 2020
10. Nerva JD, Morton RP, Levitt MR, Osbun JW, Ferreira MJ, Ghodke BV, et al.: Pipeline embolization device as primary treatment for blister aneurysms and iatrogenic pseudoaneurysms of the internal carotid artery. J Neurointerv Surg 7:210–216, 2015
11. Parkinson D, West M: Traumatic intracranial aneurysms. J Neurosurg 52:11–20, 1980
12. Tan S, Zhou X, Lu Y, Lai L, Huang X, Li B, et al.: Low-profile visualized intraluminal support stent for the endovascular treatment of traumatic intracranial internal carotid artery pseudoaneurysms. Neurosurg Rev 45:2231–2237, 2022
13. Umekawa M, Hasegawa H, Shin M, Kawashima M, Nomura S, Nakatomi H, et al.: Radiosurgery-induced anterior inferior cerebellar artery pseudoaneurysm treated with trapping and bypass. World Neurosurg 116:209–213, 2018
14. Voelker JL, Ortiz O: Delayed deterioration after head trauma due to traumatic aneurysm. W V Med J 93:317–319, 1997
15. Yazbak PA, McComb JG, Raffel C: Pediatric traumatic intracranial aneurysms. Pediatr Neurosurg 22:15–19, 1995
16. Zheng Y, Lu Z, Shen J, Xu F: Intracranial pseudoaneurysms: Evaluation and management. Front Neurol 11:582, 2020