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Endovascular Management of Superior Cerebellar Artery Aneurysms: Mid and Long-Term Results

Süperior Serebellar Arter Anevrizmalarında Endovasküler Tedavi: Orta ve Uzun Dönem Sonuçlar

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ABSTRACT

AIM: Superior cerebellar artery (SCA) aneurysms are uncommon vascular lesions, thus data about their presentation and clinical management are limited. Our aim was to determine clinical presentation, angiographic findings and mid and long-term clinical and imaging results of endovascular treatment of 49 patients with SCA aneurysm.

MATERIAL and METHODS: Forty-nine patients with SCA aneurysms underwent endovascular treatment (25 female, 24 male; mean age 46.7 years; range, 21-79 years) in our institution. Both aneurysms arising at the origin of SCA and peripheral SCA aneurysms were included to our retrospective study. 73.5% of the patients were presented with subarachnoid hemorrhage. Forty-two of 49 (85.7%) aneurysms were located in the origin of SCA. Mean aneurysm size was 6.5 mm (range 2-16 mm).

RESULTS: Forty-seven (95.9%) of the aneurysms were coiled with detachable coils. In two peripheral aneurysms, liquid embolic agent was used. Overall control angiographic occlusion rates were as follows: 87.5% (34/40) total occlusion and 12.5% (6/40) dog-ear remnant. All peripheral SCA aneurysms were occluded with the parent artery. Procedure related mortality was seen in one patient (2%) due to the rupture of another aneurysm. There was no procedure related permanent morbidity.

CONCLUSION: Endovascular treatment is an effective and safe option in both peripheral and proximal SCA aneurysms.

KEYWORDS: Superior cerebellar artery, Aneurysm, Endovascular, Subarachnoid hemorrhage

ÖZ

AMAÇ: Süperior serebellar arter (SSA) anevrizmaları nadir vasküler lezyonlar olup klinik prezentasyonları ve tedavileri ile ilgili bilgiler sınırlıdır. Amacımız SSA anevrizması nedeniyle endovasküler tedavi uyguladığımız 49 hasta bazında bu anevrizmalarda sıklığı, klinik ve anjiyografik bulguları ve endovasküler tedavi orta ve uzun dönem klinik ve görüntüleme sonuçlarını belirlemektir.

YÖNTEM ve GEREÇLER: SSA anevrizması olan 25'i kadın 24'ü erkek kırkdokuz hastaya endovasküler tedavi uygulandı.Yaş ortalamaları 46,7 (21-79 aralığında) idi. Retrospektif çalışmamıza SSA'nın orijin bölgesi anevrizmaları ve periferik anevrizmaları dahil edildi. Hastaların %73,5'u subaraknoid kanama ile başvurmuştu. Kırkiki anevrizma (%85,7) SSA orijini yerleşimli idi. Ortalama anevrizma boyu 6,5 mm (2-16 mm) idi.

BULGULAR: Kırkyedi anevrizmada (% 95,9) koil embolizasyon uygulandı. İki anevrizma, sıvı embolik ajanlar ile parent arter oklüzyonu ile birlikte tedavi edildi. Kontrol anjiyografilerde; %87,5 (34/40) tam oklüzyon, %12,5 (6/40) kulakçık tarzda boyun dolumu saptandı.Tüm periferik SSA anevrizmaları (n = 7), parent arter oklüzyonu ile embolize edildi. Işleme bağlı mortalite, aynı seansta tedavi edilen başka bir anevrizmanın rüptürü nedeniyle bir hastada (% 2) görüldü. Kalıcı morbidite saptanmadı.

SONUÇ: Endovasküler tedavi gerek periferik ve gerekse proksimal SSA anevrizmalarda etkili ve güvenli bir seçenektir.

ANAHTAR SÖZCÜKLER: Süperior serebellar arter, Anevrizma, Endovasküler, Subaraknoid kanama

INTRODUCTION

Superior cerebellar artery (SCA) aneurysms are uncommon vascular lesions, thus data about their presentation and clinical management are limited (8, 9, 14). Our aim was to determine the incidence, clinical presentation, angiographic findings and long-term clinical and imaging results of endovascular treatment of 49 patients with SCA aneurysm.

MATERIAL and METHODS

Patient Population

Between May 1995 and June 2011, 49 patients with SCA aneurysms underwent endovascular treatment (25 female, 24 male; mean age 46.7 years; range, 21-79 years) in our institution. Both aneurysms arising at the origin of SCA from the basilar artery (BA) and peripheral SCA aneurysms were included to our retrospective study.

Clinical Presentation

Patients were classified into three groups according their clinical presentations.

Group 1 included 25 patients (51.1%) who presented with acute subarachnoid hemorrhage (SAH) and were treated within the first two weeks after hemorrhage (mean procedure day is 2.4). The clinical condition of these patients at the time of treatment was Hunt-Hess Grade I in 18, Grade II in six and Grade III in one.

Group 2 included 11 patients (22.4%) who presented with SAH but the procedure had not been performed within two weeks. These patients were referred to our hospital from other centers after initial SAH. Their modified Rankin Scale was '0' in five patients, '1' in four patients and '2' in two patients.

Group 3 included remaining 13 patients (26.5%) who had unruptured SCA aneurysms. One of them was incidentally discovered during angiography performed for an intracranial arterio-venous malformation (AVM). One was a de novo aneurysm, which was found during routine follow-up of previously treated aneurysm of patient with known Behçet's disease. In two patients, vertigo and in one patient, diplopia due to possible mass effect of aneurysm and in four patients, headaches were the symptoms of patients whom aneurysms detected with cranial magnetic resonance imaging.

Description of Aneurysms

Forty-two of 49 (85.7%) aneurysms were located in the origin of SCA that were encountered as SCA-BA aneurysm and seven of 49 (14.3%) were peripheral aneurysms of the SCA. Among seven of peripheral aneurysms five of them were fusiform in shape and all other aneurysms were saccular. Twenty-seven of the 49 (55.1%) aneurysms were on the right side and 22 (44.9%) were on the left side.

Mean aneurysm size was 6.5 mm (range 2-16 mm). Small aneurysms (measuring ≤5 mm) represented 36.7% (n=18) of all cases. There were 21 (42.8%) aneurysms measuring 5-9 mm, eight (16.3%) aneurysms measuring 10-15 mm and two (4,2%) aneurysms larger than 15 mm. Fourteen (28.6%) patients had multiple aneurysms; nine had one, three had two and two patients had three additional aneurysms. The incidence of SCA aneurysms were 1.7% of all treated intracranial aneurysms and 11.1% of treated posterior circulation aneurysms at our institution.

Dome-to-neck ratios were not calculated for all aneurysms, but the balloon remodeling technique was used in the treatment of 21 aneurysms (42.8%).

Treatment Procedure

Endovascular treatment was performed on monoplane or biplane digital subtraction units (Integris V 3000 and Allura Xper 20/20; Philips Healthcare, Best, The Netherlands). All procedures were performed under general anesthesia, and heparin was given after insertion of the femoral sheath. The adequacy of systemic anti-coagulation was monitored by frequent measurement of the activated clotting time. A baseline activated clotting time was obtained before the bolus infusion of 5,000 IU heparin and hourly thereafter. The bolus infusion of heparin was followed by a continuous drip (1,000–1,500 IU/h) to double the baseline activated clotting time. Reversal of the heparinization was not performed and also continued intravenously for 24 hours after the procedure in some cases.

Right or bilateral femoral access was used depending upon the anatomy of the vertebral arteries and on the adjunctive technique applied. Under high-resolution digital fluoroscopy and road mapping appropriate micro-catheter was positioned in the sac of aneurysm. Coils were delivered sequentially and deployed into the aneurysm until tight coil packing was achieved. The balloon-remodeling technique described by Moret et al. was used to treat wide necked aneurysms during coil deposition (12).

When the glue embolization was considered a flow-guided micro-catheter was closely placed to the aneurysm sac. The glue solution (mixture of 1 ml n-butyl cyanoacrylate (NBCA) (Histoacryl-Blue; Braun, Melsungen, Germany) and 2 ml Lipiodol (Laboratoire Guerbet, Roissy, France)) was injected very slowly with a luer-lock syringe, resulting complete occlusion of aneurysm and parent artery.

In all cases coil size, coil type, total number of coils and procedural complications were recorded. All patients were kept in the neurosurgical intensive care unit (ICU) after the procedure at least one day. The patients in Group 2 and 3 were discharged on the second day of procedure if no complication occurred. In Group 1, patients were observed in ICU until stabilization of hemodynamic parameters.

Post-embolization angiographic results of coiling were classified as Roy et al. described (17). Embolization was considered; 'complete' if no filling of contrast medium in the dome, body or neck occurred, 'dog ear' if unilateral residual neck filling, 'residual neck' if bilateral contrast medium in the neck but not in the body and 'aneurysmal filling' if there is contrast filling in the body.

RESULTS

There were no unsuccessful attempts. Forty-seven (95.9%) of the aneurysms were coiled with Guglielmi detachable coils (GDC, Boston Scientific, Fremont, CA, USA). In the remaining two, which were peripheral aneurysms, NBCA was used for parent artery occlusion. Twelve of 14 patients with multiple aneurysms were treated at the same procedure.

Immediate Post-Procedural Angiographic Results

Angiographic results revealed complete occlusion in 46 (93.8%) of 49 aneurysm, dog ear remnant in two (4.1%) and residual neck in one (2.1%). All peripheral SCA aneurysms (n=7) were occluded with the parent artery.

Procedural Complications

Procedure related mortality was seen in one patient (2%) due

to the rupture of left posterior inferior cerebellar artery (PICA) aneurysm, which was treated at the same session after the treatment of SCA aneurysm. There was no procedure related permanent morbidity. There was one patient with transient morbidity. This was a patient with peripheral SCA aneurysm who was treated with parent artery occlusion and after operation diplopia and nystagmus occurred due to a small infarction in the SCA territory. On the second postoperative day the symptoms regressed and on the fifth day the patient recovered totally.

There were two intra-procedural complications, which did not lead to any clinical problem. One local vasospasm of basilar artery and one non-occlusive thrombus formation near the neck of aneurysm was medically treated in the procedure.

Follow-Up Studies

Each patient was scheduled for follow-up at first week, one month, 3-6th month, 12 months and subsequent annual examinations. At first visit clinical examination and craniographies were performed. Control angiographies were scheduled in the first, and fifth years of therapy. Additional angiography examinations were performed if needed. Early angiographic examination was performed (3-6 month) for the patients with residual neck or aneurysmal filling.

Clinical Follow-Up

Clinical follow-up was available for all 47 patients. One patient died of a procedural rupture and another patient died of severe vasospasm. This was a 60 years old female patient, who presented with Hunt-Hess Grade III SAH, died at the 5th day after the procedure secondary to severe vasospasm despite having stable neurological status after the intervention. Outcome at 12 months follow-up in surviving 47 patients was GOS 5 in 42 and GOS 4 in 5 patients. No re-bleeding occurred during the follow-up period.

Angiographic Follow-Up

Control angiography was performed in 40 of surviving 47 patients. No control angiography was planned for the 7 patients who were treated with parent artery occlusion (Figure 1A-D). All 40 patients had 12 months follow-up angiography and 12 of them had also 60 months control angiography. We did not perform any more angiographies if there is stable

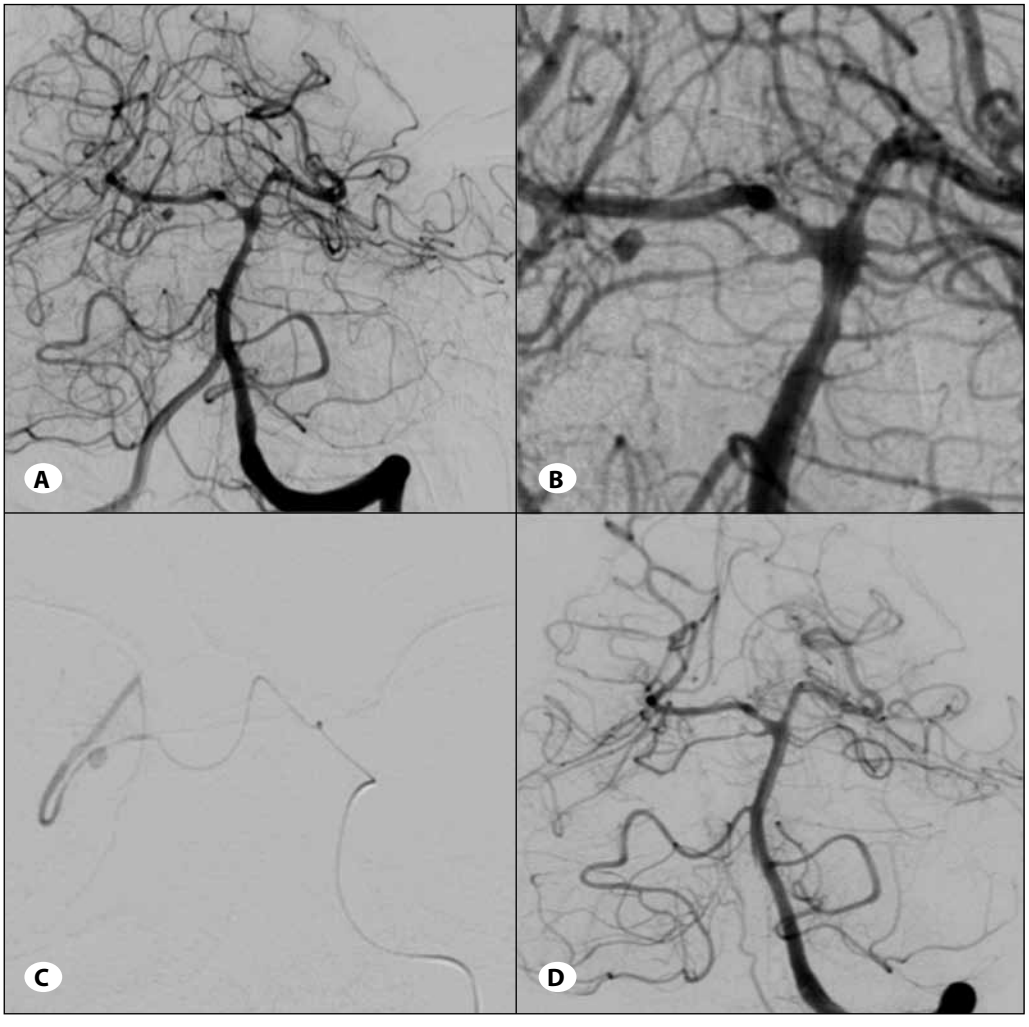

Figure 1: Subtracted angiography image **(A)** and its magnification view **(B)** of a 32 year-old female patient with subarachnoid hemorrhage reveals early bifurcation of right SCA and a small aneurysm probable due to dissection. Angiogram after super-selective catheterization of medial brunch of SCA **(C)** shows aneurysm and peri-aneurysmal parent artery narrowing. Subtracted image of the posterior circulation **(D)** after medial brunch occlusion with coil shows the occlusion of aneurysm with medial brunch of right SCA.

occlusion on the fifth year controls (Figure 2A-D). The mean angiographic follow-up time was 26.7 (range, 12–60) months.

There were neither recurrence nor reduction of occlusion status in the 30 of 37 completely occluded aneurysms (81.1%). There were five patients with dog-ear filling in the 12 months control angiography, which were remained stable in further follow-ups. There were two patients with initially with complete occlusion and showed aneurysmal filling in the first year control angiography. These two patients were treated again with endovascular way with total occlusion. One patient with dog-ear remnant after operation is staying stable on the 24-month control angiography. Other patient with dog-ear remnant after initial operation had recurrence at 6 month and operated on again. At the third month control after second operation there was a recurrence again. This time, stent assistant (Neuroform stent, Boston Scientific, Natick, MA, USA) coiling was performed and total occlusion was achieved. Twelve-month control after third operation showed stable total occlusion. In the patient with residual neck filling after initial operation, regrowth was detected in follow-up and the procedure was repeated with achieving total occlusion. Overall control angiographic occlusion rates were as follows: 87.5 % (34/40) total occlusion and 12.5% (6/40) dog-ear remnant.

DISCUSSION

Superior cerebellar artery aneurysms are rare vascular lesions accounting for about 15% of posterior circulation aneurysms (10, 13). There are two types of SCA aneurysms; basilar artery-SCA junction aneurysms and peripheral SCA aneurysms. The later one is extremely rare with an incidence of less than 1% of all aneurysms (15).

The proximal SCA has an intimate relation with cranial nerves III, IV and V (17). Aneurysms on the BA-SCA junction may therefore present with palsies of these nerves, but despite this close neighborhood it is a rare type of clinical presentation (1, 6). The subarachnoid hemorrhage is the most common clinical presentation of SCA aneurysms with an incidence of 65% (9, 14). In our series, the incidence was higher (36/49, 73.4%). Fortunately, despite the SAH, outcome of the SCA aneurysms is promising. When we analyze the above-mentioned SCA aneurysm series and our study, the outcomes were GOS 5 in

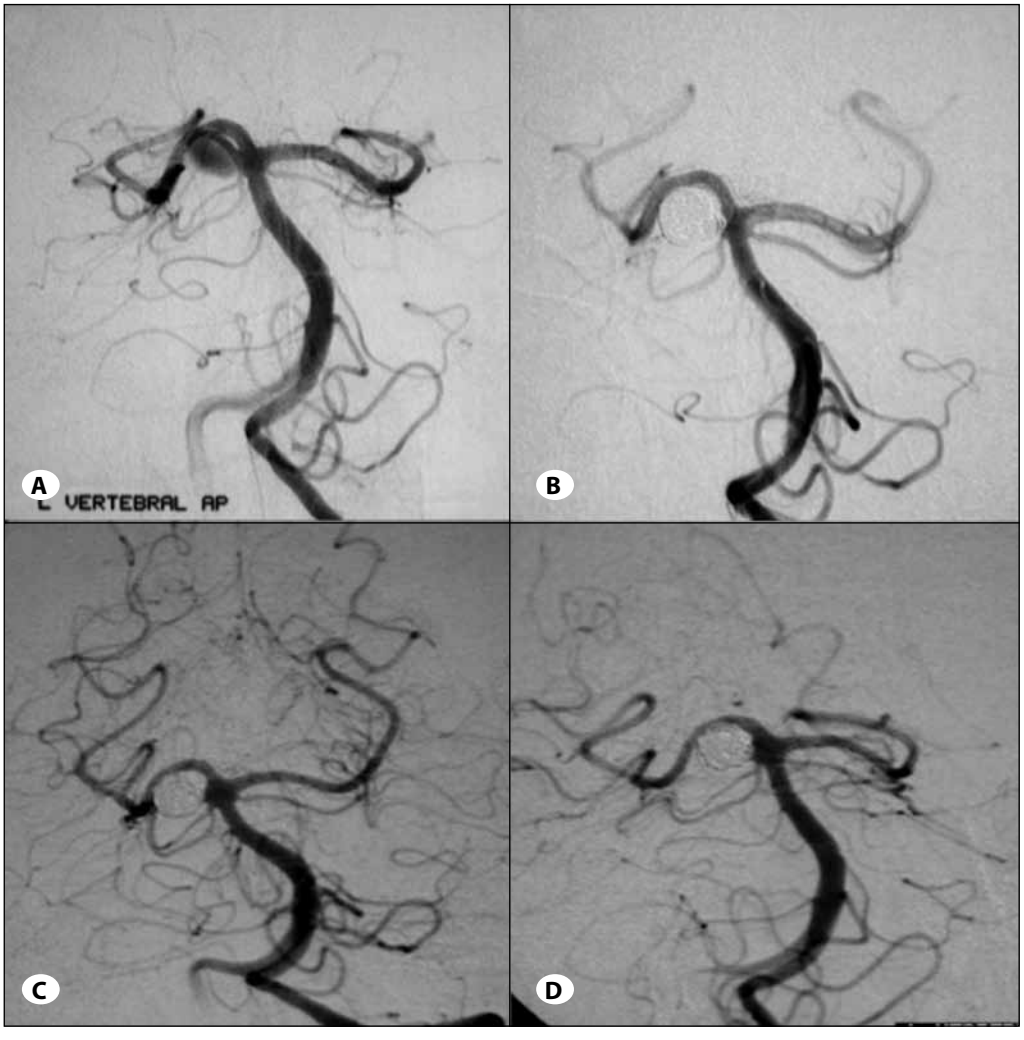

Figure 2: Subtracted angiography image **(A)** of posterior circulation shows right sided aneurysm arising at the origin of SCA from the basilar artery. Immediate post embolization image **(B)** shows total occlusion of the aneurysm with preservation of parent artery. First year **(C)** and 5th year **(D)** control angiograms show stable total occlusion.

89, GOS 4 in 16 and GOS 3 in 4 patients in a total 111 patients with ruptured SCA aneurysms (8, 9, 14).

The outcome of parent artery occlusion for SCA aneurysms is also acceptable. In our series there was only one patient with transient morbidity due to parent artery occlusion. In the literature it was reported as a well-tolerated option if it is not possible to prevent parent artery (4, 5). The collateral blood flow and existence of very limited perforators from SCA usually limit the infarctions resulting in good outcomes.

One interesting point is the high incidence of accompanying aneurysms in SCA aneurysm patients. In the International Subarachnoid Aneurysm Trial (ISAT) data multiple aneurysms were detected in 20-22% of patients (11). In our series of SCA aneurysms we found 14 patients (28.6%) with multiple aneurysms. The incidence was both 42.4% (14/33) in Peluso and Jin et al. series (9, 14). We don't have an explanation for this finding but we recommend searching for other aneurysms if there is one in SCA.

Size is one of the important factors in the management of aneurysms. It is generally recommended that unruptured aneurysm ≤ 7 mm with no associated symptoms be managed conservatively (2). However, in the ISAT data, 52% of the ruptured aneurysms were ≤5 mm (11). In the SCA series, 39.1% to 42.8% of the ruptured aneurysms were ≤5 mm (8, 9). In our study 36 of the 49 aneurysms were ruptured and 15 (41.7%) of them were ≤5. We believe that studies dealing with detailed natural histories and outcomes for aneurysms in different localizations may change our strategies for the management.

Recurrence is the major concern about coiling. It has been reported to occur at an average of 20 % in a large series (3). Re-treatment rates also can be high as 14.5% in large series (7). Haw et al. reported two reductions in the occlusion status and one retreatment (20% and 10% respectively) in their 10 patients (8). Jin et al. reported 33% occlusion status reduction and 25% retreatment in their 12 follow-up patients, which were coiled (9). On the other hand, Peluso et al. reported neither reduction in occlusion status nor retreatment (14). In our series there nine patients (9/40, 22.5%) with reduction in occlusion status and four of them (4/40, 10%) were operated on again. We think that this is because the lateral wall aneurysms of the basilar artery-SCA junction have wide neck and prone to recur after total occlusion as a result of local hemodynamic stresses. In one of these cases we need to more than one endovascular treatment and in the last session we had to put a stent in addition to coil embolization, to change flow dynamics and during follow-up we have seen durable occlusion. In cases that have peripheral aneurysm of the SCA and embolized with parent artery occlusion, there is no need for imaging follow-up.

As a conclusion, SCA aneurysms are uncommon aneurysms with a high incidence of accompanying aneurysms in other localizations. Most patients present with SAH but outcome is generally good after treatment. Despite close relation to cranial nerves, mass effect and nerve palsies are rare. Parent artery occlusion is an effective and a well-tolerated option if it is not possible to prevent it. Endovascular occlusion with detachable coils is feasible with good angiographic and clinical results. Follow-up imaging is mandatory especially in SCA-BA junction aneurysms with wide-neck to detect early possible recanalization.

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