Sdü Sağlık Bilimleri Enstitüsü Dergisi / Cilt 9 Sayı 1 / 2018

Endovascular Management of Unruptured Intracranial Aneurysms: Single-Center Report

Rüptüre Olmamış İntrakranyal Anevrizmalarda Endovasküler Tedavi Yaklaşımları: Tek Merkezli Çalışma

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Abstract

Objective: The exact treatment indications and optimal management strategies of patients with intracranial unruptured aneurysms remain controversial.

Material-Method: In this study we present our results and clinical outcomes in a single center of patients with unruptured aneurysms treated with different endovascular techniques. Between April 2008 and October 2014, 106 unruptured aneurysms in 100 consecutive patients were treated with different endovascular techniques in our center. There were 35 male and 65 female patients with a median 53.2 years (range, 15-76 years). Endovascular primary coiling, coiling with balloon remodeling, stent assisted coiling, flow-diversion, intrasaccular flow-diversion or parent artery occlusion were performed according to location, type, complexity and size of the related unruptured aneurysms.

Results: At 6 months follow-up, complete occlusion was achieved in 101 aneurysms (100%) and near-complete occlusion in 5 aneurysms (90%-100%). Four patients had procedure-related complications including thromboembolism in 2 patients and aneurysm perforation during the procedure in 2 patients. Follow-up imaging was performed with angiography in 61 patients, with CT angiography in 16 and with MR angiography in 23. Our median surveillance time was 10.05 months (6-50 months).

Conclusions: Endovascular treatment of unruptured intracranial aneurysms seems to be a safe method in selected patients according to risk-benefit analysis.

Keywords: Unruptured Intracranial Aneurysms, Endovascular Techniques, Embolization

Özet

Amaç: İntrakranyal rüptüre olmamış anevrizmalarda tam tedavi endikasyonları ve optimal tedavi stratejileri tartışmalıdır.

Materyal-Method: Bu çalışmada, tek bir merkezde farklı endovasküler tekniklerle tedavi edilen rüptüre olmamış anevrizma hastalarındaki sonuçlarımızı sunuyoruz. Nisan 2008 - Ekim 2014 tarihleri arasında, 100 ardışık hastada 106 adet rüptüre olmamış anevrizma, merkezimizde farklı endovasküler teknikler ile tedavi edildi. Çalışmada ortalama yaşı 53.2 yıl olup 15-76 yıl arasında dağılım gösteren 35 erkek 65 kadın hasta vardı. Anevrizmaların yeri, tipi, kompleksitesi ve büyüklüğüne göre endovasküler primer koilleme, balon veya stent yardımlı koilleme, intrasakküler akım yönlendiriciler veya parent arter oklüzyonu yapıldı.

Bulgular: 6 aylık izlemde 101 anevrizmada (% 100) tam oklüzyon ve 5 anevrizmada (% 90 -% 100) ise tama yakın oklüzyon sağlandı. Dört hastanın 2'sinde tromboemboli ve 2 hastada ise işlem sırasında anevrizma perforasyonu gibi prosedürle ilgili komplikasyonlar oldu. Takip görüntüleme 61 hastada anjiografi ile, 16 hastada BT anjiyografi ve 23 hastada MR anjiyografi ile yapıldı. Ortalama izlem zamanı 10.05 ay (6-50 ay) idi.

Sonuç: Rüptüre olmamış intrakranyal anevrizmaların endovasküler tedavisi, seçilmiş hastalarda risk-fayda analizine göre güvenli bir yöntem gibi gözükmektedir.

Anahtar kelimeler: Rüptüre olmamış İntrakranyal Anevrizmalar, Endovasküler Teknikler, Embolizasyon

Introduction

Unruptured intracranial aneurysms are found in approximately 3.2% of the adult population worldwide and are determined incidentally, depending on the development of imaging modalities. The best treatment option and exact indications for unruptured aneurysms remain uncertain and still have some controversies. The unruptured aneurysms have an annual 10/100,000 subarachnoid hemorrhage (SAH) incidence due to their rupture and SAH have high morbidity and mortality rate despite current treatment techniques (1). Generally unruptured aneurysms remain asymptomatic until their rupture, nevertheless they can produce some unspecific symptoms such as refractory headache or compression effects to cranial nerves and other structures (1).

In this report we presented our unruptured aneurysm series including 100 patients and 106 aneurysms which were treated with different endovascular management techniques and discussed main indications, outcome and complications.

DOI: 10.22312/sdusbed.337436
Müracaat tarihi: 11.09.2017
Kabul tarihi: 07.12.2017

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Material-Methods

This study was approved by the ethics and research committee of the hospital, and the patients' written informed consent before endoscopic interventions was obtained.

Between April 2008 and October 2014, 106 unruptured aneurysms in 100 patients were treated with different endovascular techniques in our center. There were 35 male and 65 female patients with a median 53.2 years (range, 15-76 years). Of these 106 aneurysms, four was diagnosed during endovascular management of ruptured aneurysms. A total of 90 aneurysms were detected incidentally on imaging studies performed for an unrelated medical reason, 12 aneurysms presented with symptoms due to the mass effect. The location and the mean size of the aneurysms during admission were presented in Table 1.

Table 1. Clinical presentation of patients and characteristics of unruptured aneurysms.

Presentation	**Number**
Diagnosed during investigations for ruptured aneurysm	4
Incidental	80
Symptoms of mass effects	12
Cranial Nerve Compression	10
Location	
Anterior cerebral artery (ACA)	10
Middle cerebral artery (MCA)	37
Internal Carotid Artery (ICA)	47
Cervical segment	*3*
Petrous segment	*3*
Cavernous segment	*6*
Clinoid segment	*7*
Ophthalmic segment	*28*
Vertebral Artery	1
Basilar Artery	8
Posterior Cerebral Artery (PCA)	3
Size	
<10mm	50
10-25mm	38
>25mm	18

Table 2. Endovascular Techniques.

Endovascular Techniques	**Number**
Primary Coiling	3
Coiling with Baloon Remodelling	29
Stent Assisted Coiling	28
Flow-Diversion	38
Intrasaccular Flow Diversion	3
Parent Artery Occlusion	5

Table 3. Post-procedural immediate and follow-up results.

Contrast Stasis During Procedure*		
Flow-Diverters	None	1
	Mild stasis	2
	Moderate stasis	5
	Pronounced stasis	28
	Complete occlusion	5
Others[¢]	Completely Occluded	60
	Near Completely Occluded	5
	Incompletely Occluded	-
Method For Follow-up Imaging		
Angiography		61patient
CT angiography		16 patient
MR angiography		23 patient
Occlusion Status		
Completely Occluded		101 aneurysms
Near Completely Occluded		5 aneurysms
Incompletely Occluded		-

Endovascular Management

Under general anesthesia, endovascular treatment of aneurysms was performed with heparinization to maintain an activated clotting time between 250 and 300 s. Endovascular primary coiling, coiling with balloon remodeling (Figure 1, A-E), stent assisted coiling (Figure 2, A-D), flow-diversion (Figure 3, A-C), intrasaccular flow-diversion or parent artery occlusion (Figure 4, A-E) were performed according to location, type, complexity and size of the related unruptured aneurysms. The details for endovascular management techniques were presented in Table 2. Complications of endovascular management were recorded and presented. The initial post-procedural and at least six-month follow-up outcome were recorded and evaluated (Table 3).

Premedication with clopidogrel 75 mg (Plavix; Sanofiaventis, Istanbul, Turkey) and 100 mg of aspirin was started 5-7 days prior to the procedure in the stent assisted coiling and flow-diverter groups. If antiplatelet premedication was not given the day before the treatment, the patient was administered a dose of aspirin (100 mg) and clopidogrel (300 mg). Overall 69 patients received antiplatelet therapy. Dual antiplatelet therapy is continued for at least 6 months after the procedure in these patients.

Device description and adjunct management

Coiling was performed with Microplex coils (Microplex, Microv- ention, Aliso Viejo, CA, USA). Stent assisted coiling was performed with Enterprise stents (Cordis, Miami Lakes, FL, USA) Leo stents (Balt, Montmorency, FR) and LVIS™ (Microvention, Tustin, CA, USA). Coiling with balloon remodeling was performed with Hyperglide and Hyperform balloon (M.T.I.-ev3, CA, USA). Flow-diversion was performed with the pipeline embolization device (PED) (ev3, Neurovascular, Irvine, CA, USA) and Flow-Redirection Endoluminal Device (FRED) (MicroVention, Tustin, CA). Intrasaccular flow-diversion was performed with the Woven Endobridge (WEB; Sequent Medical Inc., Aliso Viejo, CA, USA). Parent artery occlusion was performed in 5 aneurysms after balloon occlusion test in awake patients. After successful

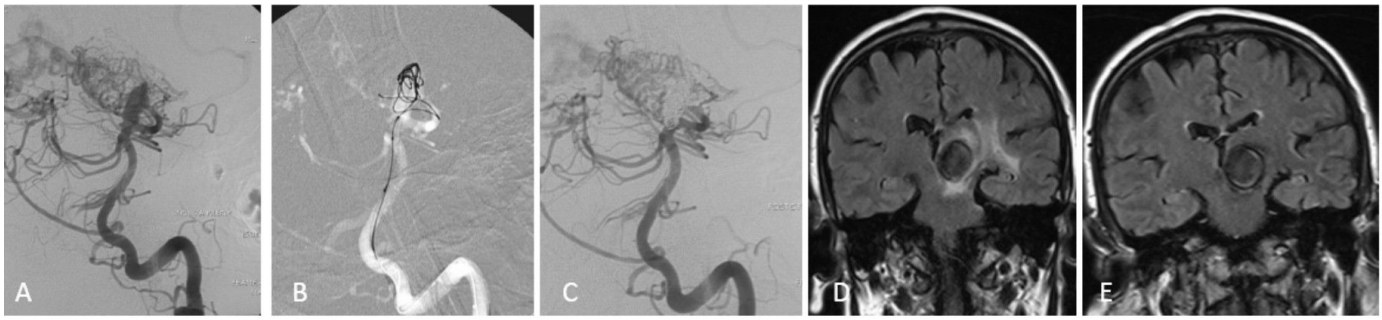

Figure 1. Partially thrombosed flow-related aneurysm in p1 segment of posterior cerebral artery which was associated with an arteriovenous malformation (A). Coiling with balloon remodeling was performed (B). Immediately after procedure total occlusion of the aneurysm can be seen (C). Preprocedural evaluation of perianeurysmal edema on FLAIR sequence of the brain at magnetic resonance imaging (D). Control magnetic resonance imaging at 6- month shows markedly resolution of perianeurysmal edema on FLAIR sequence (E).

balloon occlusion tolerance was determined, the parent artery was permanently occluded with detachable balloon by using Goldvalve (Nycomed, Paris, FR) or Goldball (Balt, Montmorency, FR) balloons.

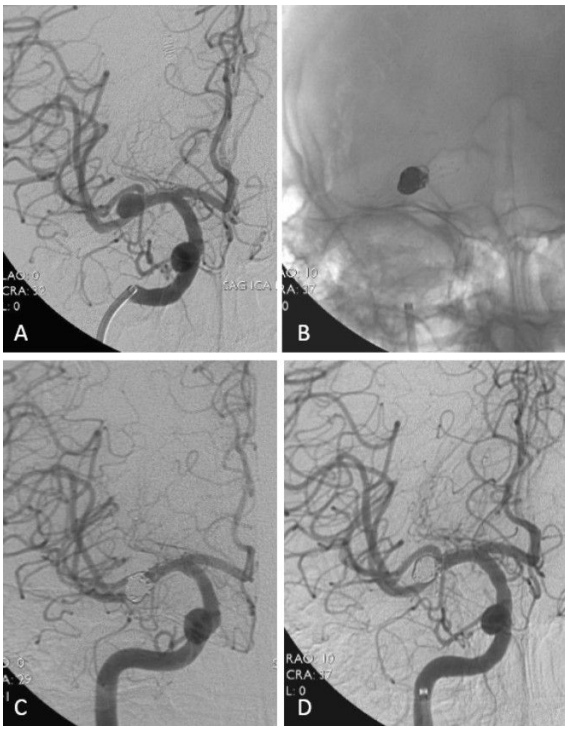

Figure 2. Preoperative angiography of a wide-necked right MCA bifurcation anuerysm (A). Stent assisted coiling was performed (B). Postoperative angiography (immediately after C, six-month control D) shows total occlusion of the aneurysm.

Results

Immediate Results

The immediate angiographic results in the flow diverters are graded using the criteria described elsewhere (2) as according to the degree of stasis of contrast material which is determined by the timing of contrast clearance from the aneurysm sac as defined by the phases of the angiogram: Moderate stasis (clearance prior to the venous phase); Prominent stasis (contrast persists in aneurysm into the venous phase).

In other groups, the aneurysm was considered completely occluded as described by Ron et al. “when the sac and the neck were densely packed; near-completely occluded when the sac was packed, but a small neck remained; and incompletely occluded in case of a persistently opacified sac” (3).

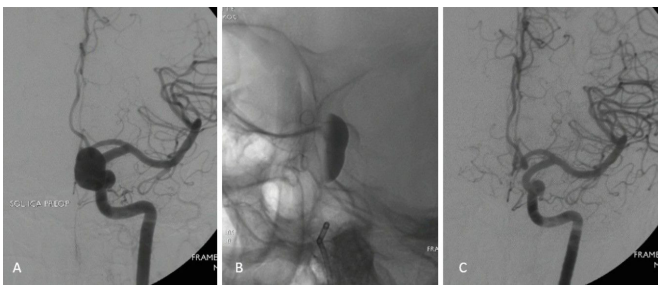

Figure 3. Preoperative angiography depicts an aneurysm originating from the left ICA ophthalmic segment (A). Immediately after flow-diversion, contrast stasis within the aneurysm can be seen (B). Control angiography at six month shows total occlusion of the aneurysm (C).

Follow-up Results

At least six month follow-up results were obtained and the occlusion status of the aneurysms was categorized. If the patient refused follow-up angiography, the occlusion status was evaluated by computed tomography (CT) or magnetic resonance (MR) angiography. The overall occlusion status was presented in Table 3 in detail.

Follow-up imaging was performed with angiography in 61

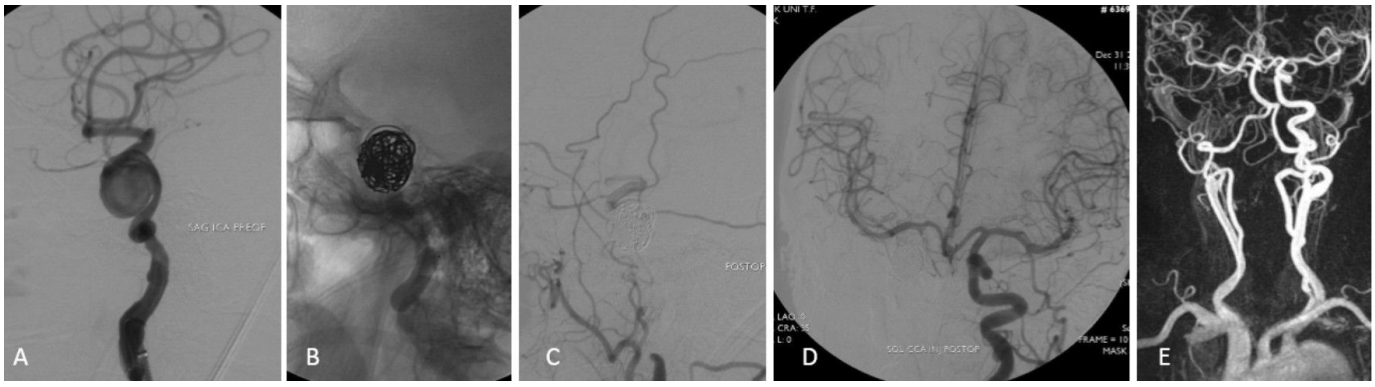

Figure 4. Preoperative angiography shows a giant unruptured aneurysm originating from the right ICA ophthalmic segment (A). Parent artery occlusion with detachable balloon and occlusion of the aneurysm with coiling (B-C). Preserved blood flow from left ICA and posterior circulation (D). Control magnetic resonance imaging at 6-month shows completely occlusion of the parent artery (right ICA) and aneurysm (E).

patients, with CT angiography in 16 patients and with MR angiography in 23 patients. Our median follow-up time was 10.05 months (6-50 months).

At sixth month complete (100%) occlusion was achieved in 101 aneurysms while near complete (90-100%) occlusion was achieved in 5 aneurysms. These aneurysms were initially near complete occluded aneurysms. In near complete occluded aneurysms, any additional procedure was not performed and during the follow-up period aneurysmal regrowth was not observed.

Complications

There were 2 aneurysmal rupture during the procedure. After successful occlusion of their aneurysms, these patients extubated well in 24 hours without any neurological deterioration. In two patients thromboembolism occurred after the procedure. One of the patients was a 41-year-old female patient with a wide-necked left MCA bifurcation aneurysm. The aneurysm was occluded with an intrasaccular flow diverter. The patient developed neurological deterioration and left hemiparalysis six hours later. After adequate medical treatment the patient discharged to a physiotherapy facility but her hemiparalysis remains permanent. The other patient was a 55-year-old male with a wide-necked left MCA bifurcation aneurysm in which stent assisted coiling was performed. The patient extubated well but four hours later he developed neurological deterioration and right sided hemiparalysis. Diffusion-weighted magnetic resonance imaging showed multiple subcortical acute ischemic lesions. The patient improved partially after medical treatment and physiotherapy. His hemiparalysis partially recovered.

There was no procedure related mortality or other minor complications occurred in our series.

Discussion

The unruptured intracranial aneurysms are being diagnosed more frequently owing to improvements in imaging techniques. But their management remains controversial due to incomplete and conflicting data about their natural history and the risks associated with treatment (4,5).

Juvela et al. reported the annual SAH incidence related unruptured intracranial aneurysm was 1.1% and the bleeding rate was about 10% at first decade and 23% at two decade after diagnosis (6). Tsukahara et al. reported an annual 3.42% of rupture rate (7). It has been reported that the risk of rupture in aneurysms is related to the size, localization and type of the aneurysm and symptomatic aneurysms or aneurysms greater than 12 mm should be treated with endovascular techniques. (8).

The adverse outcomes after surgical repair or endovascular management of unruptured aneurysms were reported in the range of 25% and 10%, respectively (4).

Komotar et al. (9) recommended all symptomatic unruptured aneurysms should be treated with rare exceptions. In their review, in almost all cases, incidental aneurysms smaller than 5 mm in diameter should be treated conservatively and the treatment of aneurysms greater than 5 mm in patients under 60 years of age should be carefully evaluated.

The International Subarachnoid Aneurysm Trial in a prospective randomized trial for ruptured intracranial aneurysms between surgical clipping and endovascular coil treatment in terms of the risk of death or dependency found statistically significant differences in favor of endovascular coilling (10).

Lin et al. (11) reported that endovascular coiling was widely used for treatment of unruptured aneurysms in the the United States. Although surgical clipping is also preferred for treatment of ruptured aneurysms, there has been a gradually decrease for its use.

The majority of the unruptured aneurysms can be managed by either surgical clipping or endovascular treatment modalities with very low mortality and morbidity, with appropriate patient selection (12). Sharma et al. (12) concluded that both treatment modalities should be employed synergistically. Koźba-Gosztyła et al. (13) suggest that surgery remains the gold standard of MCA aneurysm treatment. However, defining the best treatment modality and full discussion of the surgical and endovascular options for unruptured intracranial

aneurysm management go beyond the scope of this article.

It was reported that the risk of negative outcomes and mortality for endovascular treatment is 4-5% and 1-2% respectively in current literature (8). Naggara et al. (14) reported after 86.1% successful embolization treatment, 24.4% recurrence and 9.1% required retreatment.

In general 0.27-7.7% morbidity, 0-1.7% mortality and 82-96.1% complete or near complete occlusion of the aneurysm were reported with endovascular management (5). However, the worse outcomes were reported in the endovascular treatment of aneurysms, which are larger than 12 mm and localized in the posterior cerebral circulation. (8).

According to our experience wide necked MCA bifurcation aneurysms should be treated more selectively with endovascular techniques due to their risk of creating embolism despite adequate antiplatelet premedication. Eboli et al reported 3.8% thromboembolic complications in their case series of 184 MCA bifurcation aneurysms (15).

Our results are acceptable and appropriate with current literature with no procedure related mortality and four major morbidity with two aneurysmal rupture during procedure and two cerebral ischemia after procedure. This report have also some limitations. Although both CT and MR angiography may be used for follow-up, conventional angiogram remains the gold standard test. The fact that 40% of our patients were followed by other means than angiography is a limitation of the study.

Conclusion

Developments in endovascular techniques have led to safe and effective management of unruptured aneurysms. Endovascular management of unruptured intracranial aneurysms continues its development as an attractive and safe treatment modality with appropriate patient selection.

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