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기저동맥 동맥류에 대한 치료 결과

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Treatment Results for Basilar Artery Aneurysms

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Abstract

Objectives: We report our recent treatment results of ruptured and unruptured basilar artery aneurysms during the last 2 years.

Material and Methods: A retrospective analysis was performed on 21 patients with basilar artery aneurysms managed with endovascular and microsurgical treatments from January 2007 to December 2008. Successful embolization was defined as more than 90% occlusion. Clinical outcome was evaluated using the Glasgow Outcome Scale (GOS) at 6 months, and follow-up angiography was obtained at 6 to 12 months.

Results: Based on the Hunt and Hess grading scale, the patient population included 8 patients (38.1%) with unruptured aneurysms, 3 patients with grade II, 6 with grade III, 2 with grade IV, and 2 with grade V. Microsurgical clipping was done in 3 patients with ruptured aneurysms, and the other patients were treated by the endovascular method. Clinical outcome was revealed 5 patients (38.5%) with GOS 5, 1 (7.7%) with GOS 4, 3 (23.1%) with GOS 3, and 2 patients (15.4%) died. Of all the patients that underwent endovascular treatment, 10 patients (55.6%) had successful embolization. On angiographic follow-up, recanalizations developed in 3 patients (17.6%) and these patients were treated by repeat embolizations.

Conclusion: Endovascular coil embolization is a safe and effective method in basilar artery aneurysms although occasionally require repeat embolizations. Surgical treatment was indicated in restricted number of ruptured cases.

Key words : Aneurysm, Basilar artery, Embolization, Retreatment

Introduction

Upper basilar artery aneurysms make up about 50% of aneurysms that occur in the posterior circulation and 5 ~ 8% of all intracranial aneurysms.[1-3] Despite of advances in endovascular treatment, this disease has a high mortality and morbidity among the cerebrovascular diseases.

During the past decade, microsurgical clipping of posterior circulation aneurysms has declined in frequency while endovascular coiling has increased.[4]For cases posing relatively high medical and surgical risk, the alternative treatment modality of endovascular coil embolization may be useful. However, coil embolization has been found to have shortcomings in that it requires further retreatment more frequently than clipping.[5,6]We report here on the results of endovascular coil embolization for basilar artery aneurysms, including additional repeated embolization in 3 cases of recanalized aneurysms.

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Material and Methods

This study was performed on 21 patients who had ruptured (n=13) and unruptured (n=8) basilar artery aneurysms among 421 intracranial aneurysm cases treated between January 2007 and December 2008. The selected study period represents a period during which little operational change occurred in surgical and endovascular techniques. The Hunt and Hess (H & H) grade and Fisher grading scale were presented for all ruptured cases. Treatment methods were decided depending upon aneurysm shape, neck width, relational position between aneurysm and clivus, operator's preference, patient's condition, and patient and family's choices.

According to the location of aneurysms, we classified into the basilar apex, upper basilar trunk (from the superior cerebellar arteries (SCA) to the anterior inferior cerebellar arteries (AICA)), and lower basilar trunk (from the AICA to the vertebrobasilar junction). Aneurysms were measured according to the longest axis seen on selected angiograms. The neck size was estimated using the view showing the widest dimension. Preoperative maximum diameters were categorized as small (< 10 mm), large (10 to 24 mm), or giant (4 mm) by Fernandez' s classification[7]. Complete obliteration of an aneurysm was defined when no filling of the neck, fundus, or body was seen on any angiographic projection. A remnant sac was defined when less than 95% of the aneurysm was obliterated. The follow-up studies consisted of either a magnetic resonance angiogram (MRA) or a conventional angiogram wasobtained at 6 months at first, and then yearly. The follow-up duration varied from 6 to 24 months with a mean of 7 months.

Clinical outcome was evaluated using the Glasgow Outcome Scale (GOS) at 6 months. Patients who returned to work with no neurological deficits (GOS 4 or 5) were determined to have had good outcomes. Patients with any neurological deficits who were unable to work or required some level of assistance in their daily living (GOS 2 or 3) were defined as having poor outcomes.

Results

Frequency of basilar artery aneurysms was 21 (5%) of 421 patients with intracranial aneurysms in the same period. Their median age was 57.3 (range 43 to 71 years old), and the male to female ratio was 1 to 2. These parameters were similar to those of all intracranial aneurysms (M : F = 1 : 1.7, median age, 54.8 years old). Of these 21 patients with basilar artery aneurysms, 13 (61.9%) presented with subarachnoid hemorrhages (SAH) and 8 (38.1%) with unruptured aneurysms. Seventeen (81%) lesions were at the basilar apex and of the rest, 2 (9.5%) were at the upper basilar trunk and 2 (9.5%) were at the lower basilar trunk. Sixteen patients (76.2%) had small aneurysms while there were 5 patients (23.8%) with large aneurysms. Eleven patients (52.4%) had wide neck and 10 (47.6%) had narrow neck lesions (Table 1).

Results of microsurgical clipping

Only three patients underwent direct surgical clipping. Among the three patients, two patients were H & H grade II, and one patient was grade V due to rebleeding. Two patients had broad neck aneurysms (dome to neck ratio 2) with multilobulation or multiple daughter sacs and one patient had a tiny aneurysm (dome size < 2 mm) at the upper basilar artery. It was difficult for these aneurysms to be treated by endovascular coiling for complete obliteration. Two patients developed surgery-related complications (cerebral infarction related to perforator injury and brain retraction in one case, and cerebrospinal fluid (CSF) leakage and transient third nerve palsy in the other case). Finally, two patients did well (as defined by a GOS score of 4 or 5), and one patient died suddenly during the recovery period because of acute myocardial infarction.

Results of endovascular treatment

Eighteen patients underwent endovascular coil embolization, including 10 patients (55.6%) with ruptured

Table 1. Characteristic 21 patients with basilar artery aneurysms: comparison of surgical and endovascular treatment

Case No.	Age(yrs)/Sex	H&H Grade	Fisher Grade	Dimension (mm)*	Obliteration rate†	GOS	Complications	
							Clinical	Angiographic
Surgical treatment								
1(BA)	50/F	Ⅲ	2	8.3 × 5.2 / 4.3	complete	4		
2(BA)	48/F	Ⅴ	4	4.7 × 2.5 / 3.6	complete	1	Cerebral infarction, acute myocardial infarction	
3(UB)	57/F	Ⅱ	2	1.4 × 2.0 / 0.8	complete	5	CSF leakage, Transient 3rd nerve palsy	
Endovascular treatment								
4(BA)	65/F	Ⅲ	3	2.1 × 1.2 / 1.0	complete	3	Rebleeding	
5(LB)	70/M	Ⅱ	1	4.8 × 5.9 / 8.9	complete	5		
6(LB)	70/F	Ⅲ	3	3.9 × 5.7 / 1.6	near total	3	Hydrocephalus	
7(BA)	71/F	Ⅳ	4	14.0 × 19.0 / 5.1	incomplete	3	Hydrocephalus	
8(BA)	44/F	Ⅲ	3	4.2 × 3.7 / 3.0	incomplete	5		
9(BA)	54/M	Ⅲ	4	9.2 × 9.0 / 3.5	near total	5		Residual neck, Coil compaction & regrowth
10(BA)	60/M	Ⅴ	4	8.7 × 4.6 / 3.8	complete	2	Rebleeding, Hydrocephalus	
11(BA)	69/F	Ⅳ	4	4.4 × 7.3 / 3.7	complete	2	Vasospasm	
12(BA)	53/F	Ⅲ	4	18.3 × 20.6 / 5.1	failure	1	Rebleeding	
13(BA)	43/M	Ⅱ	3	17.0 × 12.0 / 10.1	incomplete	5		Residual neck, Coil compaction & loosening
Elective endovascular treatment‡								
14(BA)	65/M			6.3 × 6.7 / 5.0	complete			
15(BA)	47/F			4.2 × 7.1 / 4.0	complete			
16(BA)	50/M			2.4 × 2.7 / 1.6	complete			
17(UB)	48/M			9.1 × 5.0 / 8.6	near total			Residual neck
18(BA)	47/F			12.6 × 13.3 / 4.3	complete			
19(BA)	56/F			3.4 × 3.2 / 3.1	complete			
20(BA)	69/F			5 × 7 / 5	complete			
21(BA)	68/F			10.5 × 11.1 / 9.4	incomplete			Residual neck, Coil compaction & loosening, regrowth

H&H : Hunt and Hess, GOS : Glasgow Outcome Scale, CSF : cerebrospinal fluid
BA : basilar apex, UB : upper basilar trunk, LB : lower basilar trunk
*Aneurysm dimensions are given as Width × Height / Neck.
†Obliteration rate is defined as complete (≧ 95% obliteration), near total (90 - 94%), incomplete (< 90%).
‡"Elective" is defined as unruptured or more than 14 days post-SAH.

Table 2. Clinical outcome of patients with ruptured basilar artery aneurysms by clipping or coiling

GOS	H & H Grade, no of patients(%)					
	Clipping group(n=3)			Coiling group(n=10)		
	Ⅰ & Ⅱ	Ⅲ	Ⅳ & Ⅴ	Ⅰ & Ⅱ	Ⅲ	Ⅳ & Ⅴ
5	1(7.7)	0	0	2(15.4)	2(15.4)	0
4	0	1(7.7)	0	0	0	0
3	0	0	0	0	2(15.4)	1(7.7)
2	0	0	0	0	0	2(15.4)
1	0	0	1(7.7)	0	1(7.7)	0

H&H : Hunt and Hess, GOS : Glasgow Outcome Scale

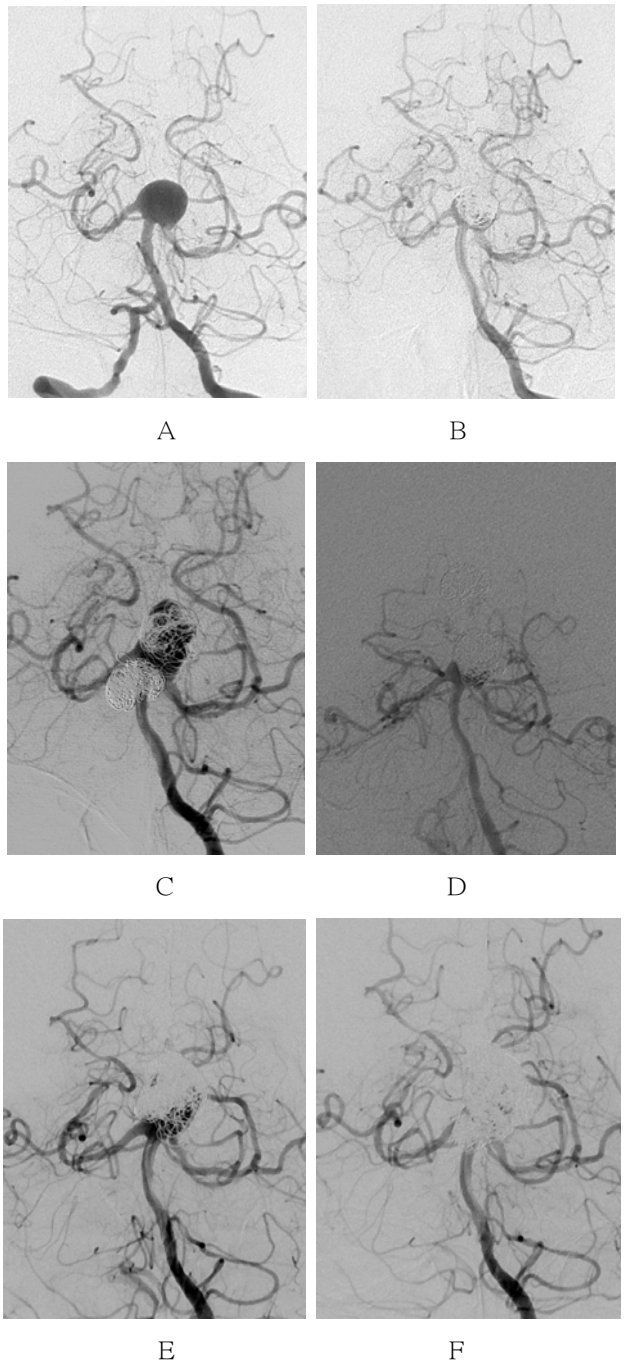

Fig. 1. A 68-year-old woman presented with headache, but without evidence of SAH. A,pre-embolization angiogram showing a basilar apex aneurysm with both PCA encroachment. B, post-embolization angiogram showing incomplete occlusion and residual neck. C, angiogram obtained at 2 years after coil embolization reveals severe coil loosening and compaction and aneurysmal regrowth. D, angiogram taken after repeat embolization showing near total occlusion. E, angiogram after 22 months showing extensive recanalized aneurysm again. F, post-third embolization angiogram showing incomplete occlusion.

aneurysms treated in the acute phase and 8 patients (44.4%) with unruptured aneurysms treatedelectively. Of the 10 patients with SAH, H & H grade was II for two (20%), III for five (50%), IV for two (20%), and V for one (10%) on admission. Clinically, four patients (40%) attained a good outcome (GOS 4 and 5), and three (30%) had GOS 3, two (20%) had GOS 2, and one patient (10%) died because of serious rebleeding after a trial of coil embolization (Table 2). This patient failed endovascular management because of having a severely tortuous vertebral artery, left ICA occlusion, aneurysm size of closing to giant (18.3 20.6 mm), and multiple large aneurysms (including left P1 segment, right SCA, and upper basilar trunk). Complications included 3 patients with hydrocephalus requiring shunt operation, and 1 patient with vasospasm. All 8 patients who were treated by elective coil embolization had good outcomes and serious complications did not occur.

Retreatment

Among 17 patients who underwent endovascular treatment (except 1 failed case), 7 (41.2%) were left with an aneurysm remnant (< 95% obliteration). During the follow-up period, 2 of these patients showed aneurysm regrowth on follow-up studies. Recanalization was found in three patients (17.6%), including two regrowth cases, which necessitated repeat coil embolization. Two patients showed residual neck size increase due to coil compaction. In 3 patients, the size of the original aneurysms was usually large, ranging from 9 mm to 17 mm in maximum diameter. One patient showing only coil compaction had a large aneurysm and narrow neck. However, 2 patients showing coil loosening and compaction had larger aneurysms and wider necks. Repeat coil embolizations were necessary to reduce the risk for delayed aneurysm rupture and neurological complications in patients with recanalized aneurysms. Consequently, 2 recanalized aneurysms were retreated at 7 months after initial embolization and 1 aneurysm at 21 months. In the latter

case, the third coil embolization was performed at 22 months after the second embolization, owing to repeat coil loosening and compaction (Fig. 1). All repeat coil embolization procedures were successful and achieved 90% or better occlusion, without procedure related morbidity or mortality.

Discussion

Surgical neck clipping remains a preferred treatment for ruptured and unruptured cerebral aneurysms, with operative morbidity and mortality approaching 3% in experienced hands for non-giant lesions of the anterior circulation.[8,9)]In general, the cases of non-surgical endovascular treatment included cases with a difficult surgical approach or an impossibility of neck clipping with consideration to size, shape and position of the intracranial aneurysm. In addition, several conditions were included such as cases with old age over 65 or high risk of operation from poor general conditions, cases who refused surgery by patients and their family and cases with the failure of clipping.[2,10,11)] The major advantage of endovascular coiling is that a craniotomy can be avoided and the recovery period is short. Endovascular coiling has becoming increasingly common as the treatment of choice in many institutes. In our series, endovascular coiling was the more favorable treatment compared with microsurgical clipping. Three microsurgical clippings (14.3%) were done because of a broad neck with multiple daughter sacs or multilobulation.

Clinical outcomes of endovascular treatment

Hillman et al.[12)] reported that the neurological state of patients (H & H grade) on admission was the most important factor affecting prognosis of posterior circulation aneurysms. Also, they reported that total prognosis was improved with introduction of nonsurgical endovascular treatment and it was considered an important factor affecting total prognosis compared to only surgical neck clipping. In our study, nine patients with H & H grade I - III showed good outcomes with GOS 4 - 5. Though the number of surgical cases are small, both the surgical group and endovascular coil embolization group with good H & H grades showed favorable outcomes.

Raymond et al.[13)] reported on a series of 23 patients treated with GDCs following SAH and 8 patients treated for incidental basilar bifurcation aneurysms. They reported that the treatment-related morbidity rate was 3% and the mortality rate was 3% (incidental and acutely ruptured groups combined).[13,14)] Gruber et al.[14)] reported on 21 patients, 11 of whom had ruptured aneurysms at the basilar apex that had been treated with GDCs and who were followed for a mean of 26 months after GDC embolization. The authors noted 0.09% morbidity and no mortality rates. They explained that coil embolization demonstrated better outcomes and shorter hospital stays than microsurgical clipping.[14)] In our study, we obtained complete obliteration in 10 (55.6%) of 18 endovascular coiling cases. Of the complete obliteration cases, patients with ruptured aneurysm were 4 (40%) of 10 cases. Overall, these results demonstrated a better outcome in patients with unruptured aneurysms than in patients with ruptured aneurysms.

Angiographic outcomes of endovascular treatment

Aneurysmal architecture plays a significant role in the success of endovascular therapy because aneurysms with a narrow inflow zone are more favorable for coiling.[9)] Most basilar apex aneurysms have wide necks. It is necessary for these aneurysms to be made more suitable for coiling with various supporting materials, devices, and techniques. In our study, the aneurysm diameter and the width of the aneurysm neck were significantly associated with the radiological outcomes of basilar artery aneurysms treated by coil embolization. Of 10 patients with aneurysm neck size 4 mm, only 5 cases (50%) achieved complete obliteration. Also, of 5 patients with aneurysm diameter 10 mm, only 1 patient (20%) presented with complete

obliteration. Overall, the larger the aneurysm diameter and neck size, the higher the incomplete obliteration and recanalization rates (Table 3).

Table 3. Angiographical outcome of patients with ruptured or unruptured basilar artery aneurysms treated by coiling

Occlusion rate*	Neck size, no of patients(%)		Aneurysm size†, no of patients(%)	
	<4mm	≥4mm	small	large
Complete	5(27.8)	5(27.8)	9(50.0)	1(5.6)
Near total	1(5.6)	1(5.6)	3(16.7)	0
Incomplete	2(11.1)	4(22.2)	1(5.6)	4(22.2)

*Obliteration rate is defined as complete (≧ 95% obliteration), near total (90 - 94%), incomplete (< 90%).

Endovascular therapy of basilar apex region aneurysms has proven its safety. Although endovascular therapy leads to approximately 90% of patients achieving independence, the durability of the treatment remains in question.[9)]This is best reflected in the high rate of recanalization and regrowth of coiled aneurysms. Basilar apex aneurysms are more prone to recanalization, regrowth, and coil compaction owing to a hemodynamic disadvantage created by their anatomic location in relation to the direction of blood flow. In addition, coiled basilar aneurysms have a persistent risk for future bleeding, which has been reported at an annual rupture rate of as high as 1.3% per year, with the annual risk of bleeding in partially coiled aneurysms reaching as high as 2.1%.[15,16)]Despite advances in microsurgical techniques for basilar artery aneurysms, endovascular treatment is becoming a common, alternative owing to the difficulty of microsurgery. However, this procedure has the aforementioned problems. The only significant predictor for recanalization and retreatment is large aneurysm size.[17)] It is becoming clear that ideal dome-to-neck ratio. Large and giant aneurysms and/or wide-neck aneurysms have a high rate of recanalization and growth.[1,13,15,16,18)] The location of the aneurysm is another important factor in terms of recanalization and growth as it relates to the direction of blood flow.[12)]

The regrowth of a GDC-treated aneurysm depends on the degree of obliteration achieved during the initial treatment. In examining surgical remnants, Feuerberg et al.[19)]reported the long-term follow-up results in 28 patients with incompletely clipped aneurysms and revealed that one lesion (4%) had increased in size and subsequently rebled. Lin et al.[20)] examined aneurysm regrowth in individuals with lesions that had been clipped but retained a 1- to 2-mm residual sac.

In our series, we reported 7 remnants (< 95% obliteration) (41.2%) in 17 patients, with 4 large aneurysms and 10 wide neck aneurysms leading to such conditions. The rate of recanalization owing to coil compaction and/or loosening was 17.6%. This condition required repeat endovascular management. In this study, we performed the second coil embolization and these patients had no symptoms, and this result was found at follow-up MRA. All repeat coil embolization procedures were successful and achieved 90% or better obliteration. To reduce complications of wide neck aneurysms, it may be helpful to treat with endovascular materials and techniques including 3D coils, balloon remodeling techniques, double catheter techniques, and self-expandable stents.[21-26)]

In summary, we obtained good outcomes clinically or angiographically. Obliteration greater than 90% was achieved in 13 patients (72.2%) with endovascular treatment, but 3 patients developed recanalization. Most of the angiographic complications such as recanalization was due to coil compaction and loosening, and aneurysm regrowth developed in cases with initial incomplete obliteration.

Conclusion

Endovascular coil embolization of basilar artery aneurysms is relatively safe and effective in preventing recurrent or primary hemorrhage. But, as time has passed, complications have increased. Inthe long term, follow-up

angiography is mandatory to detect recanalization, coil compaction, and regrowth, especially in large and giant aneurysms. In the case of recanalized aneurysms, effective repeat embolizations are mandatory in preventing aneurysm rebleeding in patients.

국문초록

목적 : 우리는 지난 2년간 기저동맥에 발생한 파열성과 비파열성 뇌동맥류의 최신 치료 결과를 보고하고자 한다.

방법 : 2007년 1월부터 2008년 12월까지 혈관내 수술과 미세현미경 수술로 기저동맥 뇌동맥류를 치료받은 21명의 환자를 대상으로 전향적 분석을 하였다. 90% 이상 막힌 경우를 성공적인 색전술로 정의하였다. 임상결과는 6개월에 글라스고우 결과 등급으로 측정하였으며, 추적 혈관촬영은 6 - 12개월에 시행하였다.

결과 : 헌터와 헤스 등급에 기초하여, 환자군은 비파열성 뇌동맥류 환자 8명 (38.1%) 을 포함하여, 2등급 3명, 3등급, 6명, 4등급,2명, 5등급 2명이었다. 미세현미경하 동맥류 결찰술은 3명의 파열성 뇌동맥류 환자들에게 시행되었으며, 나머지 다른 환자는 혈관내 수술방법으로 치료하였다. 임상결과는 글라스고우 결과 등급 5등급이 5명 (38.5%) 이었고, 4등급은 1명 (7.7%), 3등급은 3명 (23.1%) 으로 나타났으며, 2명 (15.4%) 의 환자는 사망하였다. 혈관내 수술을 받은 환자들 중, 10명 (55.6%) 에서 성공적인 색전술을 보였다. 추적 혈관 촬영에서 재교통은 3명 (17.6%) 의 환자에서 발생하였으며 이 환자들은 추가적인 혈관내 수술을 통하여 재치료를 받았다.

결론 : 혈관내 코일 색전술은 기저동맥 동맥류를 치료하는데 있어서 안전하고 효과적인 방법이다. 수술적인 치료 방법은 파열된 뇌동맥류의 제한적인 경우에 사용할 수 있다.

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