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Stent Angioplasty for Intracranial Vertebral Dissections: Single Stent versus Double Stent Placement

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ABSTRACT

Objective : The reduced stent porosity caused by a double stent may accelerate the intraaneurysmal thrombosis and be helpful in achieving a more rapid complete occlusion compared with that achieved by single stent placement. This study examined the safety and efficacy of stent angioplasty according to two different stent techniques (single versus double stent placement). **Methods** : Twenty two patients who underwent stent angioplasty for vertebral dissections were reviewed retrospectively. **Results** :In the 22 patients, 23 intracranial vertebral artery dissections were treated using stent placement. Among them, 12 dissections were treated with single stent placement. The immediate and follow-up angiography showed a complete occlusion in only one case(8.3%). Eleven dissections were treated using a double stent method. Although an immediate complete occlusion was performed in only one case, the follow-up angiography revealed a complete occlusion in six cases(54.6%). Complications were encountered in only one case (4.3%, acute thrombosis) in the double stent placement group. On the modified Rankin scale applied in the follow-up, all the patients were assessed as being functionally improved or of a stable clinical status in both groups except for one patient with a severe subarachnoid hemorrhage who underwent a double stent placement. **Conclusions** : Intracranial vertebral artery dissections can be treated alternatively using an endovascular method with a stent. Double stent placement is superior to the single stent method. However, there are some limitations and complications associated with stent angioplasty. **(Kor J Cerebrovascular Surgery 9(3):206-11, 2007)**

KEY WORDS : Vertebral artery · Dissecting aneurysm · Stent · Endovascular treatment

Introduction

Intracranial vertebral artery (VA) dissection is a less frequent etiology of brain ischemia or hemorrhage, although increased use of magnetic resonance imaging (MRI) can help to identify more VA lesions. VA dissection can lead to arterial stenosis, occlusion and subarachnoid hemorrhage (SAH). Ischemic symptoms occur in more than 90% of VA dissection patients.[11] Ischemia or infarction due to VA dissection may result from thromboembolic cause rather than hemodynamic origin.[4)12)] Therefore, many neurologists and neurosurgeons use anticoagulation and antiplatelet therapy to prevent brain ischemia or infarction in VA dissection patients. Although some authors insist that unruptured VA dissection usually has a benign feature, its natural course is still poorly understood.[3)14)] However, in case of ruptured VA dissection, the rebleeding rate is very high in acute stage.[10] Therefore, it is necessary to treat ruptured VA dissection as soon as possible.

Recently, stent placement for VA dissections has been increasingly reported in selected patients. The advantages of stent angioplasty include exclusion of plaque and a dissected false lumen from the true vessel lumen, as well as prevention

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of vessel recoil and rupture with preservation of the parent artery.[1)8)13)] However, immediate aneurysm obliteration is often not accomplished.[6)] Some authors advocate using double stent as overlapping or stent-within-a stent technique.[2)9)] In this study we investigated the safety and efficacy of stent angioplasty according to two different stent techniques (single versus double stent placement).

Patients and Methods

Patients

Between 2000 and 2007, in our institution, 22 patients with 23 VA dissections have been treated by stent angioplasty. One patient had two dissections in bilateral vertebral artery involving posterior inferior cerebellar artery (PICA). Catheter induced dissections during angiography were excluded in this study. Indications of stent angioplasty in VA dissection are following in our institution: 1) vertebrobasiliar insufficiency despite anticoagulant or antiplatelet therapy, 2) VA dissection patients whose condition were contraindication to anticoagulant or antiplatelet therapy, or 3) Contralateral VA occlusion or stenosis in a patient who was neurologically unstable or had clinical evidence of hemodynamic insufficiency.

Among patients whose statuses were adequate with these indications, if dissected segments have included important branches, we prefer stent angioplasty to proximal occlusion.

There were 14 male and 8 female patients. Patients' age was ranged from 33 to 71 years, mean age 48.7 years. On admission, six patients had SAH, eleven patients presented brain ischemia or infarctions, four patients had only headache and one patient showed incidental finding. The characteristics and clinical information about patients are shown in (Table 1).

Stent placement and follow-up

Digital subtraction angiography (DSA) was performed in all patients. Angiography was assessed for lesion size, shape, location and relationship to adjacent arterial branches- PICA, anterior inferior cerebellar artery (AICA) and basilar artery. The angiographic features were classified as 1) Pearl and string; corresponding to a fusiform dilatation associated with proximal or distal narrowing, 2) String; corresponding to an isolated irregular narrowing, 3) Fusiform dilatation, and 4) Double lumen.

Before stent angioplasty, informed consent was obtained from patients or their relatives. Patients scheduled for elective procedures received oral acetylsalicylic acid (100 mg) and oral clopidogrel (75 mg) for 3 days before the stent procedure, and patients undergoing emergency procedures

Table 1. Clinical summary of 22 patients underwent stent angioplasty for vertebral dissections

	Stent angioplasty	
	Single stent placement	Double stent placement
Age (mean, yrs)	45.8	52.1
Sex (male:female)	7:5	7:3
Clinical presentations		
Headache	3	1
Subarachnoid hemorrhage	1	5
Ischemia or infarctions	8	3
Incidental findings	0	1
MRS on admission		
0 (no symptoms)	0	1
1 (no significant disability despite symptoms)	8	3
2 (slight disability)	3	1
3 (moderate disability)	1	3
4 (moderately severe disability)	0	2
5 (severe disability)	0	0
Total (number of patients)	12	10

MRS: modified Rankin scale

for acute SAH underwent combined antiplatelet therapy on the day of surgery.

The patients underwent endovascular intervention in a state of local anesthesia except ventilator care patients or extremely noncooperative patients. Following standard Seldinger puncture, 6- or 7-F introducer sheath was placed in the right femoral artery. After placement of 6- or 7-F guiding catheter (Envoy Max ID Multipurpose 90cm; Cordis, Johnson and Johnson Medical, Miami, FL, USA) in the proximal VA, full systemic heparinization was achieved by administrating 2000-4000 IU bolus followed by hourly boluses of 1000 IU and monitoring of the activated clotting time. Stent were positioned across diseased segments to have overlap on each side of the dissection orifice. For stent placement alone (12 patients), we used balloon-expandable stents currently applied in interventional cardiology such as S670 (Medtronic AVE, Santa Rosa, CA), Driver (Medtronic AVE) and Flexmaster (Jomed Internaltional, Helsinborg, Sweden) to achieve appropriate luminal diameter and sufficiently narrow strut size to occlude dissecting aneurysm. Ten patients underwent double overlapping stent placement in order to minimize the perforation size. After the final check angiogram, the catheter was removed and the sheath was left in the groin. The patient was moved to the neurosurgery intensive care unit for monitoring and received heparin 1,000 IU/hour for the next 24 hours. Heparinization was discontinued after 24 hours post-treatment but not reversed.

Immediate post-treatment angiography was performed in all cases and follow-up angiographies were performed at 6-12 months in fourteen patients. Further examination was obtained yearly if needed. Angiographic outcomes were divided into three grade: complete obliteration (100% occlusion or resolution of stenosis), near complete (>95%), incomplete (<95%).

Follow-up was determined by phone interview or from the most recent office note, and modified Rankin scale (mRS) was assigned. Overall outcomes were defined as excellent,

Table 2. Summary of angiographic findings and treatment outcome according to stent placement method

	Stent angioplasty	
	Single stent placement	Double stent placement
Angiographic findings		
Pearl and string sign	7	8
String sign	2	0
Fusiform dilatation	3	3
Double lumen	0	0
Time to treatment	6.6 days	4.4 days
Immediate outcome		
Incomplete obliteration	9	10
Near complete obliteration	2	0
Complete obliteration	1	1
Follow-up outcome		
Incomplete obliteration	6	2
Stable	1	1
Unstable or regrowing	5	1
Complete obliteration	1	6
Not done	5	3
Clinical outcome at last follow-up		
Excellent (mRS 0-1)	10	5
Good (mRS 2)	2	3
Poor (mRS 3-4)	0	2
Death (mRS 5)	0	1
Complications	None	1 (acute thrombosis)

mRS: modified Rankin scale

mRS 0-1; good, mRS 2; poor, mRS 3-4; or death, mRS 5.

Results

We treated 23 VA dissections by stent placement. The mean interval duration from symptom onset to treatment time was 5.5 days. According to angiographic finding, most common feature of VA dissections was "pearl and string sign" (15 cases). "Fusiform dilatation" was revealed in six cases, "string sign" in only two cases.

Among 23 VA dissections, twelve dissections were treated by single stent placement and the others were treated using double (9 cases) or more (2 cases) stents. We decided which method could be available to each case in consideration of clinical manifestations, size, location and relationship with adjacent artery branches.

Immediate angiography showed one complete obliteration outcome of dissection at each groups. Nine cases of single stent method group and ten cases of double stent method group showed incomplete obliteration in immediate post-treatment angiography. However, comparing two groups about follow-up angiographic outcomes, double stent method group was superior to single stent method group. Follow-up angiography showed six cases (54.6%) of complete obliteration of VA dissections in double stent method group versus only one case (8.3%) in single stent method group. There were two cases of dissecting aneurysm regrowing, one in single stent method group and the other in double stent method group.

Complication happened in only one case (4.3%, acute thrombosis) of double stent placement group. This patient was presented with SAH (Hunt-Hess grade III, Fisher grade III) due to ruptured right VA dissecting pseudoaneurysm, which was treated using three stents [Neuroform (4.5×20) Flexmaster (3.5×16 and 3.5×23)]. Immediate post-treatment angiography showed acute thrombosis of stent placement site. After intra-arterial injection of urokinase and Tirofiban, thrombosis was resolved and stent lumen was intact (Fig. 1). Endovascular treatment was summarized in (Table 2). On the mRS applied in follow-up, all patients

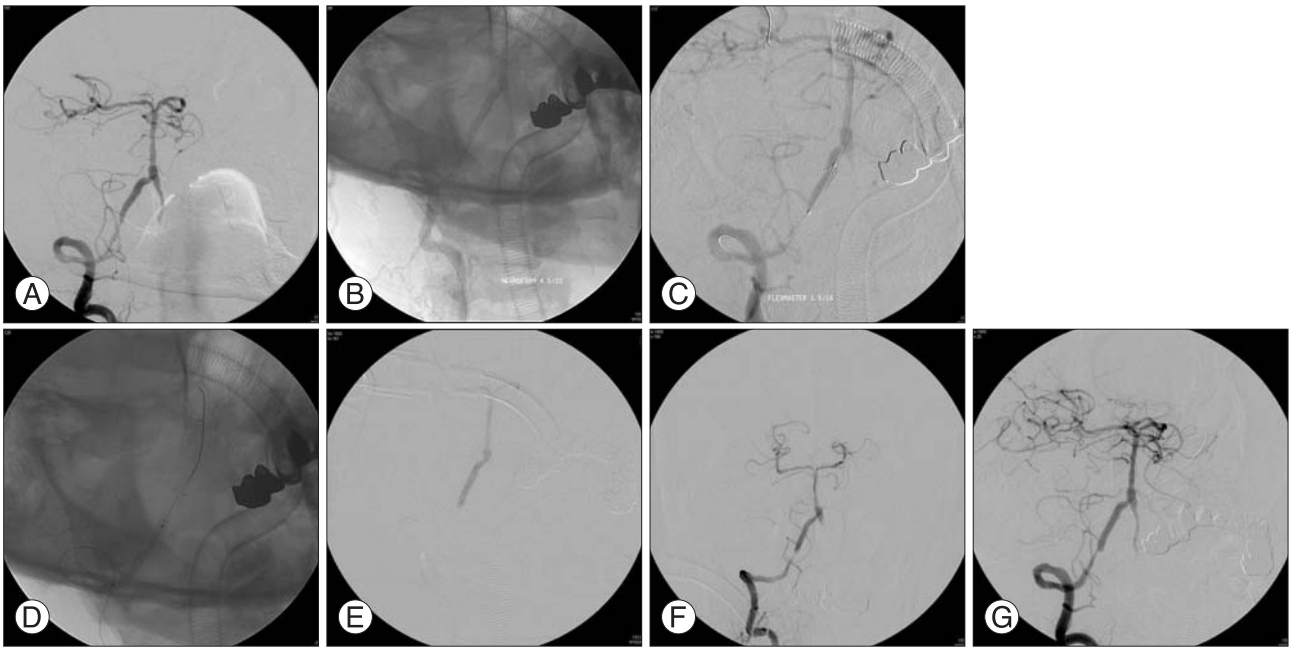

Fig. 1. Angiograms in a 71-year-old man with dissecting aneurysm of the distal intracranial right vertebral artery treated by double stent method. A : Anteroposterior projection shows a fusiform dilatation of the right distal vertebral artery and vertebrobasilar junction with severe stenosis on the free posterior inferior cerebellar artery segment. B : The first stent (Neuroform 4.5×20) is deployed across the vertebrobasilar junction. C : The second stent (Flexmaster 3.5×16) is placed on the proximal side of the first stent in an overlapping manner. D : The third stent (Flexmaster 3.5×23) is placed on the proximal side of the second stent in an overlapping manner. E : Acute thrombosis is developed at the second stent deploying site. F : Angiogram obtained immediately after the intraarterial infusion of urokinase 100,000 U and Tirofivan 2.5 mg demonstrates complete recanalization of the right vertebral artery. G : Angiogram obtained 1 month after stent placement reveals complete healing of the aneurysm.

were assessed as functionally improved or of stable clinical outcome in both method groups except one SAH patient who underwent double stent placement.

Discussion

This study revealed that complete obliteration of the false lumen was not achieved in most of case even though single or double stent placement for VA dissections was undergone. However, double stent method group was superior to single stent method one in follow-up angiography. This study demonstrated that single stent placement was not efficient for VA dissections. Complete obliteration was anticipated in double stent placement group.

In treating VA dissecting aneurysm or other intracranial aneurysm, placement of porous stent can change homodynamic of arterial blood flow and reduce inflow into dissected zone or aneurysmal sac. Double stent method can reduce the porosity and permeability of stent and alter inflow into dissected zone or aneurysmal sac.[7] Finally, stasis and acute thrombosis can be promoted and these processes allow subsequent neointimal endothelial formation.[9] The concept of the placement of a stent within a stent or telescoping stent has been adopted largely from isolated case reports in the cardiology literature.[5]

Stent angioplasty has a limitation related with occlusion of dissecting aneurysm in acute stage. Endovascular treatment is required for prevention of rebleeding by occlusion of dissecting aneurysm in acute stage. Nevertheless, immediate post-treatment angiography showed only two cases of complete obliteration of dissections in our study. In follow-up angiographic outcome, five cases of complete obliterations of dissections were additionally reported in only double stent method group. Surely, incomplete occlusion of aneurysm in acute stage provides a chance of re-rupture. However, it took a long time that dissections were completely obliterated. At the same time, we should recognize that long-term anticoagulation and antiplatelet therapy are required in cases of stent replacement and this fact can suggest delayed thrombosis of dissected zone or aneurysmal sac. Therefore, stent angioplasty can be sufficient in unruptured dissecting aneurysm and double stent method is superior to single stent method.

There was one case of complication in our study, which was parent artery occlusion by acute thrombosis. Acute thrombosis happened when ruptured right VA dissecting aneurysm was treated using three stents. We found acute thrombosis only after third stent replacement and thrombosis was resolved by urokinase and Tirofivan. This patient had a good recovery without newly developed neurologic deficit. However, if dissected segment involved important branches in this case, this patient would have a worse outcome. We could have learned important tips via this case: If dissected segment involve important branches and endovascular treatment require three or more stents, we should consider possibility of acute thrombosis of parent vessel.

Conclusion

Intracranial vertebral artery dissection can be treated effectively by endovascular treatment using stent. However, stent angioplasty is not acceptable in ruptured dissecting aneurysm because of low complete obliteration ratio. Two or more stents placement should be performed carefully. At that time, the operator should keep in mind of the elevated chance of acute thrombosis. Also, careful stent placement is required when dissected segment involves important branches.

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