The Difficulties and Risks of Y-Stent–Assisted Coiling: A Comparison of First and Second Stenting Procedures

Jung Soo Bang[1], Chang Hun Kim[2], Bae Ju Kwon[3], Sung-Choon Park[1], Young Kim[1]

■ OBJECTIVE: **Y-stent–assisted coiling (YSAC) requires multiple device accesses for double stenting. The purpose of this study was to test the hypothesis that second stenting procedures are riskier than first stenting procedures.**

■ METHODS: **We retrospectively reviewed the medical records of 19 patients with 20 aneurysms undergoing YSAC. Difficulty was determined for each device when the difficulty number was >1. Procedure-based and device-based difficulties were compared between 2 stenting procedures. For second stenting procedures, stent-delivery-catheter difficulties (SDs) in passing through the struts of the first stent were assessed for 3 catheter types, 2 delivery methods, and 3 first-stent types.**

■ RESULTS: **All YSACs were successful. Difficulties occurred more frequently with second stenting procedures than with first stenting procedures (procedure-based difficulties, 4 [20%] vs. 7 [35%], $P = 0.29$; device-based difficulties, 4 [9%] vs. 8 [18%], $P = 0.19$). In second stenting procedures, SDs occurred in 4 (20%) procedures and caused the midportion of the first stent to be bent into aneurysms in 2 of the procedures. Failures following difficulties were observed in only 2 (10%) second stenting procedures, necessitating other methods to complete procedures: 1 of the procedures had SD-related thrombosis leading to morbidity at discharge (modified Rankin Scale score 2). SDs were found only with 1 catheter type (4 of 15; PROWLER SELECT Plus) and 1 delivery method (4 of 15; direct over-the-wire) and not with the other catheter types (Rebar-18 or Excelsior 1018) and the other method (catheter-exchange). SDs were found most frequently with the use of the CODMAN ENTERPRISE stent in first stenting procedures (50%).**

■ CONCLUSIONS: **In YSAC, second stenting procedures seem riskier than first stenting procedures, particularly when SDs occur. A proper device or delivery method may reduce the risks.**

INTRODUCTION

In endovascular treatment of cerebral aneurysms, self-expanding stents are known to provide mechanical support for coils, flow diversion away from aneurysms, and a scaffold for endothelial growth and vessel healing.[1-3] As a result of these effects, stent-assisted coiling has been considered a treatment option with acceptable results in selected wide-necked aneurysms.[4-8] Self-expanding stents have broadened the selection criteria for endovascular treatment of cerebral aneurysms. The implantation of flow diverters, braided mesh stents with high metal surface area coverage, has gained widespread acceptance for the treatment of cerebral aneurysms, particularly giant or fusiform aneurysms.[9-11]

Despite advances in self-expanding stent technology, endovascular treatment of wide-necked aneurysms incorporating 2 daughter branches remains a challenge. Single stent placement across part of the aneurysm neck into 1 branch may not prevent coil protrusion completely, so an additional technique, such as a multicatheter technique,[12-14] balloon remodeling,[15,16] or Y-configured stenting (Y-stenting), is required.[17-21] A multicatheter technique may achieve good anatomic results while preserving the unprotected part, but it is not always feasible because of the risk of coil collapse in the initial period of coiling. The use of balloon remodeling in combination with the single stent assistance also is not straightforward. Navigation through the stent interstices of a balloon catheter into the incorporated branch is difficult, and its success does not guarantee safe remodeling

Key words
- Endovascular techniques
- Intracranial aneurysm
- Stents

Abbreviations and Acronyms
MCA: Middle cerebral artery
SD: Stent-delivery-catheter difficulty
YSAC: Y-stent–assisted coiling
Y-stenting: Y-configured stenting

From the Departments of [1]Neurosurgery, [2]Neurology, and [3]Radiology, Myongji Hospital, Goyang-si, GyeongGi-Do, Republic of Korea

To whom correspondence should be addressed: Bae Ju Kwon, M.D., Ph.D. [E-mail: bjkwon74@gmail.com]

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with repetitive inflation and deflation. By contrast, several studies on Y-stent–assisted coiling (YSAC) showed promising results for complex aneurysms. YSAC also necessitates considerable experience with many devices and skills to achieve good results.

Although procedural recommendations for YSAC, including a feasible combination of open-open, open-closed, or closed-closed cell stents and a choice of a more acute-angled branch for the first stenting procedure, have been described in previous reports,[19,20] there still exists the need for knowledge about difficulties and risks in each step. Because second stenting procedures should be performed through the interstices of the first stent, we hypothesized that second stenting procedures are more difficult and riskier. To the best of our knowledge, this hypothesis, although very sensible, has not been tested. The purpose of this study was to investigate that hypothesis and find potential methods of reducing the procedural risks.

MATERIALS AND METHODS

This study was approved by the local ethics review board, and written informed consent was waived. Over the past 5 years, 352 patients with 412 cerebral aneurysms were consecutively treated with endovascular coiling by 1 operator in our institution. Of those patients, 19 patients with 20 (4.9%) aneurysms were treated with YSAC: repeat embolization ($n = 5$), embolization after clipping ($n = 1$), and initial treatment ($n = 14$). YSAC was considered necessary 1) when a daughter branch could not be preserved without the procedure, 2) when there was no delineable aneurysm neck, or 3) when recanalization was highly expected otherwise. The age range of patients was 32–75 years (mean, 56 years ± 11). Aneurysm size was 2.2–16.2 mm (mean, 6.9 mm ± 4.1), with neck size of 2.1–10 mm (mean, 4.9 mm ± 2.2) and dome-to-neck ratio of 0.6–1.6 (mean, 1.1 ± 0.3). All aneurysms had a wide neck by the definition of neck size of >4 mm or dome-to-neck ratio of <1.5. Demographic and clinical characteristics are summarized in Table 1.

Table 1. Demographic and Clinical Characteristics

Characteristic	Number (%)
Patients	19
Sex	
Female	11
Male	8
Hunt and Hess grade	
Unruptured	13 (68)
Ruptured	6 (32)
Good: 1, 2, and 3	4
Poor: 4 and 5	2
Aneurysms	20
Location	
Anterior	16 (80)
MCA	9
AcomA	6
PcomA	1
Posterior	4 (20)
Basilar bifurcation	2
PICA orifice	1
SCA orifice	1
Size	
Small (≤10 mm)	16 (80)
Large (>10 mm)	4 (20)
Neck	
Narrow (≤4 mm)	8 (40)
Wide (>4 mm)	12 (60)
Low dome-to-neck ratio (≤1.5)	18 (90)

MCA, middle cerebral artery; AcomA, anterior communicating artery; PcomA, posterior communicating artery; PICA, posterior inferior cerebellar artery; SCA, superior cerebellar artery.

Procedure

In 13 patients with 14 unruptured aneurysms, dual antiplatelet therapy (oral aspirin 100 mg/day and clopidogrel 75 mg/day) was initiated at least 5 days before procedures, and intravenous heparin was administered during procedures to maintain a target activated clotting time of 200–250 seconds. In 6 patients with 6 ruptured aneurysms, a loading dose of intra-arterial or intravenous tirofiban (0.5–1.0 mg) was given during procedures, after contrast material filling in the dome disappeared following placement of the first few coils, and then a maintenance dose of intravenous tirofiban (0.1 μg/kg/minute) was continuously infused for 12–24 hours and stopped 4–5 hours after oral administration of a loading dose of dual antiplatelet agents (aspirin 325 mg and clopidogrel 300 mg). Afterward, all patients were on lifelong aspirin (100 mg/day) and clopidogrel (75 mg/day) for 3 months.

All procedures were performed under general anesthesia and recorded on video. After a thorough review of digital subtraction angiography and 3-dimensional images, the more difficult branch to access was stented first except for the first 2 cases of the series. A more acute-angled branch was considered the more difficult branch to access, but 2 exceptions were as follows: 1) a branch with an obscure path inseparable from an aneurysm on any attainable views and 2) the superior division at the middle cerebral artery (MCA) bifurcation. That division at the MCA bifurcation was thought to be in the reverse direction to the wire or catheter progress because a simple-curved device had a tendency to face down along the arterial wall at the MCA bifurcation. The reverse direction made the device unstable and easily looped into the wide-necked aneurysm when it was pushed. In addition, as the superior division beyond the MCA bifurcation usually had a more tortuous path and earlier ramifications into small branches, its superselection was thought to be more difficult than the more acute-angled inferior division.