Uncovered stent insertion for isolated superior mesenteric artery dissection

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Abstract
The aim of this study is to describe our clinical outcomes in isolated superior mesenteric artery dissection (SMAD) patients that underwent uncovered stent insertion.

Between January 2016 and August 2019, consecutive isolated SMAD patients at our center were treated via uncovered stent insertion. Both short- and long-term outcomes in these patients were analyzed.

Over the course of the study period, 11 total isolated SMAD patients meeting the criteria for stent insertion at our hospital were treated via uncovered stent insertion. Stent placement across the SMAD site was successful in all patients, with 1 stent being used per patient. There were no instances of procedure-related complications, and the median operative duration was 60 minutes. Patency of the distal superior mesenteric artery and branches thereof was achieved in all cases. Patients experienced progressive SMAD-related symptom relief and were followed for 6 to 49 months (median: 22 months). Over this follow-up period, the obliteration of the dissection was observed within 3 months in all patients. We did not detect any instances of stent occlusion, bowel ischemia, or anti-platelet-related bleeding during the follow-up period.

Uncovered stent insertion can achieve favorable short- and long-term outcomes in isolated SMAD patients.

Keywords: dissection, superior mesenteric artery, uncovered stent

1. Introduction
Isolated superior mesenteric artery (SMA) dissection (SMAD) is an increasingly common condition,[1] with the increased use of abdominal contrast-enhanced computed tomography (CT) scanning approaches having led to progressive increases in the rate of isolated SMAD detection. Following detection, isolated SMAD can be treated via conservative therapy, stent insertion, or open surgery, although open surgical approaches are very rarely employed.[1–11] The selection of an appropriate isolated SMAD treatment strategy is typically dependent upon individually evaluating the symptoms and imaging features of each patient.[1–11]

Prior studies of isolated SMAD patients had indicated that between 29.4% and 87.5% of patients ultimately needed to undergo stent insertion.[1–11] The types of stents used in these previous studies (covered or uncovered), however, were not always clarified, with both stent types having been used in certain studies. Specific examinations of the efficacy and safety of covered and uncovered stents for the treatment of isolated SMAD patients are still lacking.

Herein, we describe clinical outcomes from isolated SMAD patients that were treated via uncovered stent insertion in our hospital.

2. Materials and methods
This was a retrospective, single-center analysis that was approved by our Institutional Review Board. The requirement for participant written consent was waived owing to the retrospective nature of this study.

2.1. Study design
Consecutive isolated SMAD patients presenting to our center between January 2016 and August 2019 were treated via uncovered stent insertion.

In order to be included in this study, patients had to meet the following inclusion criteria:
(a) patients with a confirmed isolated SMAD diagnosis;
(b) patients with isolated SMAD that was symptomatic; and
(c) patients that were appropriate candidates for stent insertion.

Patients were excluded from our study if they:
(a) declined to undergo stent insertion; or
(b) suffered from severe lung, heart, kidney, or coagulatory
diseases.

2.2. Indications for stent insertion

Stent insertion indications included:
(a) patients that did not respond in a satisfactory manner to conservative treatments;
(b) patients with $>70\%$ true lumen compression; and
(c) patients with an aneurysmal false lumen that was likely to rupture.

2.3. Diagnosis

Symptoms, axial abdominal contrast-enhanced CT, and CT multi-planar reconstruction results were used to diagnose isolated SMAD in this study population (Figs. 1–3). Abdominal CT findings were used to evaluate the length of dissection, degree of true lumen compression, and SMAD type as defined according to the classification scheme of Sakamoto et al.[12] Classification I: patent false lumen with both entry and re-entry sites; Classifica-
tion II: “cul-de-sac”-shaped false lumen without a re-entry site. Classification III: thrombosed false lumen with ulcer-like projection; Classification IV: completely thrombosed false lumen without ulcer-like projection.

2.4. Stents

Uncovered self-expanded metal stents (Bard, NJ or Cordis, FL) were used to treat all patients in this study.
Appropriate stents were selected based on the following criteria:
(1) stents needed to cover the entire length of the dissection; and
(2) stents needed to have a diameter that was $\sim 10\%$ larger than that of the normal proximal SMA.

2.5. Stent insertion

Fluoroscopic guidance was used when performing all procedures described in this study. A right brachial approach was used to achieve stent insertion. Briefly, a 4F angiographic catheter (Cordis) was placed at the ostium of the SMA via a 0.035-inch normal guide wire (Terumo, Tokyo, Japan). Angiographic analysis of the length of the dissection was then conducted, after which the normal guide wire was exchanged for a 0.035-inch stiff guide wire (Cook). This wire was then used to introduce the stent delivery system, with the stent being deployed such that
Figure 2. A 50-year-old male with isolated superior mesenteric artery (SMA) dissection. (a) Preoperative abdominal contrast-enhanced computed tomography demonstrated the isolated SMA dissection (arrow). (b-e) The postoperative computed tomography demonstrated obliteration of the dissection with patent SMA and branches was achieved at 1, 3, 6, and 12 months after uncovered stent insertion (arrows).

Figure 3. A 49-year-old male with isolated superior mesenteric artery (SMA) dissection. (a) Preoperative abdominal contrast-enhanced computed tomography demonstrated the isolated SMA dissection with thrombosed false lumen (arrow). (b-e) The postoperative computed tomography demonstrated obliteration of the dissection with patent SMA and branches was achieved at 1, 3, 6, and 12 months after uncovered stent insertion (arrows).
it covered the entirety of the dissection site. Distal SMA patency was then confirmed via angiography.

Oral aspirin (100 mg/d) and clopidogrel (75 mg/d) were administered to all patients for 3 months following surgery, with only oral aspirin administration being maintained for the remainder of the lifespan of the patient.

2.6. Follow-Up

Abdominal contrast-enhanced CT follow-up was conducted in all patients at 1, 3, 6, and 12 months post-operation, with annual follow-up being performed thereafter.

3. Results

3.1. Patients

In total, 11 isolated SMAD patients meeting our inclusion criteria underwent uncovered stent insertion at our hospital (Table 1). These patients (7 male, 4 female) had a median age of 58 years, and 4 had a history of hypertension.

Eight of these patients were treated via primary stent insertion owing to >70% true lumen compression, whereas the remaining 3 patients underwent secondary stent insertion due to unsatisfactory responses to prior conservative treatment.

3.2. Treatment

Stent placement across the SMAD was successful in all patients, with 11 total stents being deployed among these 11 patients. Stents used varied in length from 40 to 80 mm, and varied in diameter from 6 to 8 mm. No patients experienced any significant procedure-related complications, and the median duration of the insertion procedure was 60 minutes. Patency of the distal SMA and associated branches was achieved in all patients. Progressive relief of SMAD-associated symptoms was similarly achieved in all cases following treatment. Long-term outcomes

Patients in this study were followed for 6 to 49 months (median: 22 months; Table 2). In follow-up abdominal contrast-enhanced CT images, all patients exhibited obliteration of the dissection as well patency of the SMA and its branches (Figs. 1–3), with obliteration of the dissection having been achieved within 3 months. No patients suffered from any instances of stent occlusion, bowel ischemia, or anti-platelet-related bleeding during the follow-up period.

4. Discussion

In the present report, we have detailed the clinical outcomes observed in 11 isolated SMAD patients treated via uncovered stent insertion. The technical success rate of stent insertion in these patients was 100%, consistent with rates in many similar studies of isolated SMAD patients that have been previously
published.\textsuperscript{[11–10]} Treatment of isolated SMAD via stent insertion is generally not technically difficult, as all procedures are conducted under fluoroscopic guidance and there is a large angle between the SMA and the proximal aorta that allowed for easy guide-wire insertion into the SMA via a right brachial approach.

Symptoms associated with SMAD primarily arise as a consequence of true lumen compression.\textsuperscript{[11–10]} Conservative antithrombotic treatment is therefore commonly employed as a first-line option in the treatment of isolated SMAD patients.\textsuperscript{[13–15]} One meta-analysis of 25 studies containing 514 total patients with symptomatic isolated SMAD found that 87% of these patients initially underwent conservative therapy.\textsuperscript{[13]} This therapy, however, was primarily effective in patients with < 70% true lumen compression.\textsuperscript{[2]} Approximately 84.7% of isolated SMAD patients reported experience clinical success when treated via conservative therapeutic approaches, whereas the remaining 14.3% of patients need to undergo direct interventional treatment.\textsuperscript{[13]}

Stent insertion can accomplish 2 primary goals when used to treat isolated SMAD by both effectively re-vascularizing the obstructed true lumen while also effectively blocking blood flow into the false lumen. Isolated SMAD has previously been treated with both uncovered and covered stents.\textsuperscript{[1–6]} with some researchers having suggested that covered stents may be better suited for use in this context as they can completely seal the false lumen.\textsuperscript{[44]} In the present study, however, we observed complete obliteration of the dissection in all 11 patients following uncovered stent insertion. All patients treated in this study and in the prior studies discussed above had cases of un-ruptured isolated SMAD, and as such any reduction in false lumen pressure in these patients can either decrease the size of this lumen or maintain it at a stable level (Table 3). While uncovered stents are unable to fully seal the false lumen, they are able to significantly decrease blood flow into this compartment.\textsuperscript{[49]}

There are a number of advantages to the use of uncovered stents relative to covered stents, including the fact that they are easily placed,\textsuperscript{[81]} can preserve the branches of the SMA, and are less expensive.

In the present study, we observed a long-term stent patency rate of 100%, which was consistent with the 90% to 100% rates reported in other prior studies of stent insertion for the treatment of isolated SMAD.\textsuperscript{[2–5,8,16]} These high patency rates are potentially attributable to the regular administration of anti-platelet treatments to these patients following stent insertion.

There are certain limitations to this study. First, this study is retrospective in nature and is thus susceptible to selective bias. Second, there was no control group in this study, and as such future comparative studies will be needed to compare the efficacy of uncovered stenting to that of other treatment strategies in isolated SMAD patients. Third, this study had a small sample size and focused on a population from a single center. Future multicenter studies are therefore warranted.

In summary, while future studies are necessary, our findings indicate that uncovered stent insertion can achieve positive short- and long-term outcomes in isolated SMAD patients.

### Author contributions

**Data curation:** Lu-Bin Sun.

**Funding acquisition:** Fu-Kang Yuan.

**Methodology:** Gui-Rong Li, Fu-Kang Yuan.

**Supervision:** Feng-Fei Xia.

**Writing – original draft:** Zhi-Qing Yang.

**Writing – review & editing:** Feng-Fei Xia.

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