Endovascular treatment of late coronary-subclavian steal syndrome

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Objective: Coronary-subclavian steal syndrome (CSSS) is a rare cause of myocardial ischemia subsequent to stenosis or occlusion of the subclavian artery (SA) proximal to internal thoracic artery (ITA) coronary bypass. Only single cases have been reported in published studies to date. We report a significant series of patients with late CSSS treated through an endovascular approach.

Methods: We reviewed a series of consecutive patients treated for CSSS. The clinical, anatomic, and technical characteristics of the procedures were considered. Follow-up was performed through clinical and laboratory (electrocardiography, echocardiography, duplex ultrasonography) evaluations.

Results: From January 2005 to March 2013, 10 patients with CSSS were treated; 7 had stable and 3 unstable angina. Of the 10 patients, 8 had left SA stenosis (6 ostial to the origin and 2 in the middle segment), 1 had proximal occlusion of the left SA, and 1 had stenosis in the innominate artery (proximally to a right internal thoracic artery). Arterial access was at the brachial artery through surgical exposure (n = 6), or radial artery percutaneously (n = 3). In 1 case of proximal occlusion of the left SA, simultaneous femoral and percutaneous radial access was necessary. Predilatation of the stenotic lesion was performed in 6. Balloon expandable stents were used in 7 patients with proximal ostial stenosis or occlusion and self-expandable stents in 2 with nonostial lesions. In 1 other patient with proximal heavy calcified stenosis, cutting-balloon predilatation was performed, resulting in dissection of the SA and occlusion of the ITA graft; blood flow was restored in the left upper arm and myocardium by adjunctive dilatation of the SA and endovascular coronary revascularization. No patients developed angina during the follow-up period (15 ± 7 months).

Conclusions: A tailored endovascular approach can be used to treat CSSS. However, the occurrence of potentially lethal complications is possible and needs prompt correction. (J Thorac Cardiovasc Surg 2014;148:2112-6)

Coronary-subclavian steal syndrome (CSSS) is a rare cause of myocardial ischemia subsequent to occlusive disease of the subclavian artery (SA) proximally to an internal thoracic artery (ITA) coronary bypass.[1] If SA occlusive disease, possibly leading to CSSS, is detected before the coronary bypass procedure, the surgical approach to myocardial revascularization can be modified or the stenosis corrected beforehand or simultaneously.[2-4] However, postoperative CSSS will develop in about 1% to 4% of patients who have undergone coronary artery bypass grafting (CABG) with an ITA graft,[2,5] with its late incidence undefined in published studies. The onset of CSSS some years after coronary revascularization has been sporadically reported through single case reports.[6-11] Treatment of CSSS aims to correct the SA stenosis, which is usually severe and associated with heavy calcifications. The technique of choice is yet to be defined; however, an endovascular approach could be advantageous in terms of invasiveness. Surgical extra-anatomic bypass (subclavian–subclavian or carotid–subclavian) can be a valuable alternative.[12,13]

The aim of the present study was to review our experience in the treatment of late CSSS.

METHODS

Study Design and CSSS Diagnosis

We retrospectively reviewed, from January 2005 to July 2013, the experience of a vascular surgery center (S. Orsola-Malpighi, Bologna, Italy) and cardiologic interventional center (Maria Cecilia Hospital, Cotignola, Ravenna, Italy) in the treatment of late CSSS. All patients gave their informed consent for the procedure. The study was performed according to the rules of the ethical review boards of our institutions.

All patients who had undergone CABG with an ITA graft and had clinical symptoms of angina were evaluated by coronarography and supra-aortic vessel angiography. Computed tomography angiography was also performed in some instances. Hemodynamic stenosis proximal to the ITA was defined as a trans-stenosis pressure reduction of 30 mm Hg.[3,12,13] The indication to treat the stenosis was the simultaneous presence of symptoms of myocardial ischemia and SA hemodynamic stenosis proximal to the ITA.[12]

Patients

The patients' clinical characteristics, interval from CABG to the new angina symptoms, type of myocardial symptoms, technical aspects of the

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Abbreviations and Acronyms
CABG = coronary artery bypass grafting
CSSS = coronary-subclavian steal syndrome
ITA = internal thoracic artery
SA = subclavian artery

revascularization procedure, and perioperative (30-day) outcomes were entered into a dedicated database. The stenosis was categorized as ostial (in the SA or innominate artery) or located in the middle segment of the vessel proximal to the ITA.

The clinical characteristics included the following: age, gender, hypertension (presence of systolic blood pressure >140 and/or diastolic blood pressure >90 mm Hg or specific therapy), dyslipidemia (total cholesterol >200 mg/dL or low-density lipoprotein >120 mg/dL or specific therapy), diabetes mellitus (prediagnosed in therapy with oral hypoglycemic drugs or with insulin), current smoking, chronic obstructive pulmonary disease (defined as chronic bronchitis or emphysema), and chronic renal failure (glomerular filtration rate <60 mL/min). Ongoing therapy with antiplatelet drugs (single or double), β-blockers, anticoagulant agents, and statins was also considered.

The clinical and electrocardiographic findings of new myocardial ischemic symptoms and recurrence of proximal SA disease by duplex ultrasound examination were considered in the follow-up period.

Revascularization Procedures

All procedures were performed with the patients under local anesthesia and systemic heparinization. The access site varied according to the location and type of occlusive disease (stenosis vs occlusion). In the vascular surgery department, surgical exposure of the brachial artery was the approach of choice. In the interventional coronary unit, percutaneous access was the approach of choice. Predilatation was performed when necessary to cross the stenosis with the stent. Balloon expandable stents were used for the ostial lesions and self-expandable for lesions located in the middle segment of the vessels.

The perioperative results included "technical success," defined as treatment resulting in <30% residual stenosis, myocardial or neurologic ischemic events, and access complications (hematoma with the necessity for blood transfusion or surgical revision).

RESULTS

General Characteristics

From January 2005 to March 2013, 10 patients with CSSS were treated: 6 in the vascular surgery department and 4 in the cardiologic interventional unit. The mean interval from CABG to the development of angina symptoms was 9.0 ± 8.4 years. The patients' clinical characteristics are reported in Table 1. Because all patients were referred from other institutions, we could not assess the incidence of CSSS. Of the 10 patients, 7 had an ostial SA lesion (4 stenosis and 3 occlusion), 2 had stenosis of the middle segment of the left SA, and 1 had stenosis in the middle segment of the innominate artery proximally to a right ITA CABG (Table 2). All patients with unstable angina had total ostial SA occlusion and vice versa.

TABLE 1. Patient characteristics

Variable	n (%)
Clinical characteristics	
Male gender	7 (70)
Age (y)	73.3 ± 7.6
Hypertension	10 (100)
Dyslipidemia	10 (100)
COPD	3 (30)
CRF	3 (30)
Diabetes	6 (60)
Smoke	3 (30)
Statins	8 (80)
Double antiplatelet agents	10 (100)
β-blockers	8 (80)
Interval from CABG (y)	9 ± 8.4
Type of symptoms	
Stable angina	7 (70)
Unstable angina	3 (30)

Data presented as n (%) or mean ± standard deviation. *COPD*, Chronic obstructive pulmonary disease; *CRF*, chronic renal failure; *CABG*, coronary artery bypass grafting.

Vascular Access

Surgical left brachial artery exposure. In all 6 patients treated in the vascular surgery department, surgical exposure of the left brachial artery was performed. This approach allows one to cross the lesion with the angiographic catheter in the presence of stenosis and to have sufficient "pushability" through a 6F, 10-cm, introducer (Cordis, Waterloo, Belgium) in the presence of occlusion to cross it with the guidewire (Terumo, Tokyo, Japan).

Percutaneous radial access. Percutaneous radial access was used in 3 patients treated in the cardiologic interventional unit through a 6F sheath (Cordis, Waterloo, Belgium), 2 with stenosis of the middle segment of the SA and 1 of the innominate artery.

Simultaneous percutaneous femoral and radial access. In the case of ostial occlusion of the left SA, simultaneous right femoral (7F sheath Cordis, Waterloo, Belgium) and left radial (6F sheath, Cordis) percutaneous access was performed.

Stenosis Crossing, Predilatation, and Stenting

The stenoses were crossed by a 0.035-in. floppy wire (Terumo, Tokyo, Japan) in 4 patients; in 3 patients with

TABLE 2. Anatomic features

Variable	n (%)
Lesion type	
Stenosis	7 (70)
Subocclusive	4 (57)
Nonsubocclusive	3 (43)
Obstruction	3 (30)
Stenosis location	
Ostium of left SA	4 (57)
Middle segment of SA	2 (29)
Innominate artery	1 (14)
Obstruction location	
Ostium of left SA	3 (100)

SA, Subclavian artery.