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Original Article

Our experience of endovascular treatment in coronary subclavian steal syndrome with a review of the literature

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Abstract

Aim: The purpose of this study was to assess the effectiveness of endovascular treatment in patients with coronary subclavian steal syndrome.

Material and Methods: The archive records for six patients diagnosed with coronary subclavian steal syndrome and treated using the endovascular method between January 2012 and August 2017 were examined retrospectively. Data concerning diagnosis and treatment were recorded and evaluated in the light of the current literature.

Results: All patients had undergone coronary artery bypass graft surgery at external centers a mean 5.7 years previously. Angiography revealed severe stenosis in the proximal subclavian artery in three patients and total occlusion in three. One hundred percent success was achieved in the three patients with stenosis by establishing full patency by means of a stent procedure. Full patency was also established in two of the three patients with total occlusion using the stent procedure. The symptoms of the five patients treated successfully resolved post-procedurally. No restenosis findings were encountered at clinical and Doppler ultrasonography follow-ups.

Conclusion: While surgical options predominated in the early years in the treatment of coronary subclavian steal syndrome, endovascular techniques are widely employed today. However, surgical therapeutic alternatives are still important for patients in whom success cannot be achieved with the endovascular method.

Keywords: Aorta Coronary Bypass; Coronary Internal Mammary Artery Anastomosis; Subclavian Steal.

INTRODUCTION

Coronary subclavian steal syndrome (CSSS) was first described by Harjola and Valle in 1974 (1). The incidence has grown due to the increasing use of the left internal mammary artery (LIMA) graft in coronary artery bypass graft (CABG) surgery. CSSS may be seen in patients with patent LIMA grafts but with critical stenosis or occlusion in the proximal subclavian artery. Chest pain worsening with exertion, dyspnea and rarely myocardial infarction may develop in addition to upper extremity ischemia-related findings such as claudication, paresthesia and digital ischemia (1-3).

Subclavian artery stenosis generally follows an asymptomatic course. The ability to detect subclavian artery stenosis in patients with coronary artery disease is important in order to prevent subsequent CSSS. Upper extremity circulation examination in patients scheduled for CABG and a interarm blood pressure difference exceeding 20 mmHg may be suggestive of subclavian artery disease (2). Reverse flow in the LIMA can be shown with transthoracic doppler ultrasonography performed for diagnostic purposes. Reverse LIMA flow at angiography is the gold standard for diagnosis of CSSS. In addition to surgical methods in the treatment of CSSS, endovascular applications have come to prominence in recent years (3).

The purpose of our study was to assess the efficacy of treatment in patients with CSSS and in whom revascularization was achieved with the endovascular technique.

MATERIAL and METHODS

The study was planned with receipt of KTU University Faculty of Medicine local ethical committee approval and informed consent from participants. The archive records for six patients diagnosed with CSSS and treated using endovascular methods between January 2012 and August 2017 were examined retrospectively. Coronary and left subclavian artery angiography was performed on all patients with chest pain and a previous history of

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CABG. Retrograde filling in the in-situ LIMA graft from the coronary circulation to the subclavian artery was shown at coronary angiography. Diagnosis of CSSS was confirmed by advanced stenosis, and total occlusion in the proximal region of the subclavian artery at left subclavian artery angiography.

Revascularization using the endovascular method under elective conditions was scheduled for all our patients. Before the procedure, the therapeutic methods and potential risks were explained to the patient and/or first-degree relatives, and signed informed consent forms were obtained. Five thousand units of intravenous heparin were prepared before the procedure. The lesion was approached with retrograde percutaneous access from the femoral artery under local anesthesia. If the diseased segment could not be entered, retrograde percutaneous access was performed from the left brachial artery. A stent was inserted with balloon dilation once the subclavian artery was reached. Percutaneous transluminal angioplasty (PTA) was also performed to ensure full patency in some cases. Following placement, patients received subcutaneous 1 mg/kg low molecular weight heparin twice daily until discharge. Patients were also started on lifelong 100 mg/day acetylsalicylic acid and 75 mg/day clopidogrel for one year from the day of insertion. Following discharge, patients were followed up with clinical examination and Doppler ultrasonography after one, three, six and 12 months, and yearly thereafter.

RESULTS

Four of our patients were men and two were women, with a mean age of 68.7 years (range 59-83 years). All patients had undergone CABG in external centers. Mean time from CABG to diagnosis of CSSS was 5.7 years (range 1-11 years). Effort angina was present in all patients, arm pain and loss of strength in two, and vertebrobasilar insufficiency findings in one. One patient had received stent placement to a thrombosed dissected lesion in the right coronary artery due to acute inferior myocardial infarction three weeks previously. Interarm blood pressure differences exceeded 20 mmHg in all cases, and left arm pulse pressure was weak. Angiography revealed total occlusion in the proximal subclavian artery in three patients, and severe stenosis (90-95%) in the other three. Coronary angiography revealed a patent LIMA graft, and retrograde filling from coronary circulation (Figure 1a). Stents were inserted with balloon dilation with retrograde access from the femoral artery in three cases with subclavian artery narrowing (Figure 1b,c). PTA was also performed in one of these cases to achieve full patency. Occlusion was easily approached by establishing access from the femoral region in one of the three patients with total occlusion. This patient received stent placement with balloon dilation following predilatation. Lesions in two patients could not be approached despite access from the femoral region. Retrograde insertion was therefore performed from the left brachial artery. The lesion was approached with this method, and the stent was inserted following balloon dilation in one patient. Full patency was achieved with PTA due to 30% residual lesion. In the other patient, the lesion could not be approached despite brachial access. Carotico-subclavian bypass surgery was advised. However, the patient refused surgery, and follow-up with medical treatment was maintained. All patients' demographic and therapeutic process data are shown in Table 1.

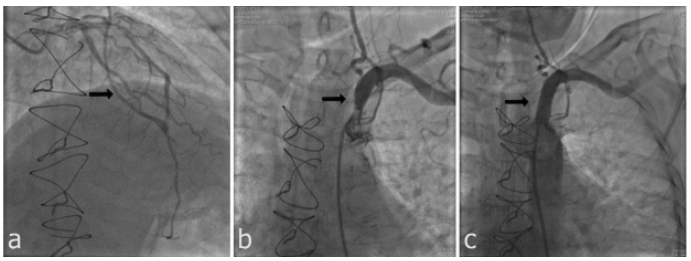

Figure 1. (a) Typical LIMA graft reverse flow at coronary angiography, **(b)** severe stenosis in the proximal subclavian artery at angiography, and **(c)** full patency in the subclavian artery after successful stent implantation in a patient with coronary subclavian steal syndrome

Table 1. Patients' demographic and treatment data

No	Gender	Age	Smoking status	HL	HT	DM	PAD	CAD	CABG (years previous-ly)	Approach site	Lesion (%)	Type of treatment	Follow-up time (months)
1	F	65	-	+	+	+	-	+	1	Femoral	90	Stent	20
2	M	60	+	-	+	+	-	-	5	Femoral+ brachial	100	PTA/Stent	40
3	M	77	+	+	-	-	+	-	9	Femoral	95	PTA/Stent	48
4	F	59	-	-	+	+	-	-	2	Femoral	95	Stent	21
5	M	83	-	-	-	-	+	+	11	Femoral+ brachial	100	_	15
6	M	68	+	+	+	-	-	-	6	Femoral	100	PTA/Stent	29

HL: Hyperlipidemia, HT: Hypertension, DM: Diabetes Mellitus, PAD: Peripheral Artery Disease, CAD: Carotid Artery Disease, CABG: Coronary Artery Bypass Grafting

Mean length of post-procedural hospital stay was 2.1±0.9 days (range 1-3 days). Mean duration of follow-up was 28.8±8.5 months (range 15-48 months). No cerebrovascular event or upper extremity thromboembolism developed in any case. Angina symptoms resolved in patients treated using the endovascular method. Interarm blood pressure differences decreased to less than 20 mmHg. No early or mid-term mortality occurred in any patient.

DISCUSSION

LIMA is the most commonly used graft in CABG surgery, and has the best long-term patency rate. Disease in the proximal left subclavian artery can lead to CSSS in long-term monitoring of this graft. Although angina is the most common symptom, silent ischemia, congestive heart failure, ischemic cardiomyopathy, and myocardial infarction may also be seen (4).

CSSS was once rare, but is now more frequently encountered (4). Studies have reported stenosis in the proximal subclavian artery in 0.5-15% of patients undergoing CABG (5,6). One recent study reported a prevalence of CSSS of 2.3-6.8% (7). The syndrome can be prevented with preoperative subclavian artery and LIMA evaluation in patients scheduled for CABG (8,9). Although the prevalence of coronary artery disease accompanied by subclavian artery disease is not high, subclavian artery disease should be investigated in all patients scheduled for elective surgery. Some centers recommend routine subclavian artery angiography during coronary angiography. Observing the presence and degree of left subclavian artery disease can thus provide pre-operative information concerning the anatomical course and quality of the LIMA graft (4).

Mean reported time to emergence of CSSS following CABG surgery is 5.8-7.8 years (10,11). All the patients in whom we determined CSSS had previously undergone CABG surgery at different external centers, and CSSS was detected a mean 5.7 years subsequently. Since chest pain was present in all our patients, all underwent angiography, which showed reverse flow in the LIMA graft. Subclavian artery pathology was also shown concurrently with subclavian artery angiography, and CSSS was diagnosed accordingly.

Revascularization is generally required in treatment, in addition to general medical approaches such as regulation of risk factors, reducing movement in the affected arm, and anti-angina therapy (12). Extra-anatomical bypass operations such as carotico-subclavian, subclavio-subclavian, and axillo-axillary procedures, can be performed in the surgical treatment of CSSS. The reported success rate of carotico-subclavian bypass surgery is 98%, with 10-year patency rates of approximately 95% (13). The five-year patency rate in subclavio-subclavian bypass surgery is approximately 86.5% (14). Endovascular treatment methods such as PTA and stent were initially treated with suspicion due to concerns over stroke. However, due to its advantages, such as being less invasive, low complication rates and a shorter hospital stay, endovascular treatment has become the preferred method in recent years (15,16). De Vries et al. reported a three-year patency rate of 93% in the subclavian artery with endovascular treatment (17). Wang et al. reported success rates of 95% for subclavian stenosis and 65% for subclavian occlusion. That study also determined a patency rate of 82% in the subclavian artery at the end of five years (18). Linni et al. compared surgical treatment with endovascular method results and achieved a 52% success rate with PTA/stent in patients with subclavian occlusion, but reported 100% success in patients undergoing surgery. Those authors recommended endovascular treatment for patients with subclavian artery stenosis and surgical treatment for patients with occlusion (19). A study from Turkey involving patients with CSSS who were unsuitable for endovascular treatment reported 100% graft patency rates in the early period. That study also reported medium-term graft patency rates of 80% in carotico-subclavian bypass and 33% in subclavio-subclavian bypass patients (20). Subclavian artery stenosis was present in three of our six patients, and subclavian artery occlusion in three. One hundred percent revascularization success was achieved with an endovascular approach in the patients with stenosis. A success rate of 66.7%, comparable with the previous literature, was achieved by establishing revascularization in two of the patients with occlusion. The patient for whom surgical intervention was recommended since revascularization could not be established, but who refused surgery, is currently being followed-up with medical treatment.

CONCLUSION

The number of patients undergoing CBAG, and therefore LIMA graft usage, is increasing every year. Studies have reported an increase in the prevalence of CSSS in recent years. Subclavian artery and LIMA imaging may be useful in patients scheduled for CABG during coronary angiography in order to prevent CSSS. Although surgical techniques were initially widely used in the treatment of CSSS, less invasive endovascular techniques are now growing in importance. Our study findings suggest that the endovascular approach is reliable and effective in patients with CSSS. However, surgical treatment should not be overlooked in patients in whom success cannot be achieved with the endovascular approach.

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