Rates of symptom reoccurrence after endovascular therapy in subclavian artery stenosis and prevalence of subclavian artery stenosis prior to coronary artery bypass grafting

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Abstract: Percutaneous transluminal angioplasty (PTA) and stenting is commonly used to treat subclavian artery stenosis (SAS). In this study, the outcomes of 43 consecutive cases, performed at one institution from October 1997 to October 2005, were analyzed. Mean stenosis was 84.41% pre-intervention and 6.83% post-intervention. Five of the procedures were angioplasty alone; 38 were angioplasty with stenting. Technical success was achieved in 42 out of 43 patients. The 30-day mortality rate was 0%. At one-month post intervention, all patients were symptom free. Ten patients redeveloped symptoms by one year. Demographic data, patient comorbidities, and indication to treat were analyzed. It was found that prior coronary intervention led to a statistically significant higher rate of symptom reoccurrence ($p = 0.036$). Additionally, a divergence in the rate of symptom reoccurrence based on indication to treat SAS was noted with the highest rate of symptom reoccurrence in the pre-coronary artery bypass grafting (CABG) group and the lowest rate of symptom reoccurrence in the subclavian steal syndrome (SSS) group. The coronary subclavian steal (CSS) group had an intermediate rate of symptom reoccurrence. During this time period, 1154 CABGs were performed. Flow-limiting stenosis was noted on angiography in 17 of these patients, giving pre-CABG prevalence of 1.46%.

Keywords: subclavian artery stenosis, coronary steal syndrome, subclavian steal syndrome, coronary artery bypass graft, percutaneous intervention, restenosis

Introduction

Subclavian artery stenosis (SAS) can be treated either surgically or endovascularly. Long term patency rates for surgery and endovascular therapy are similar. A 10-year study completed in 1991 combining all extrathoracic surgical techniques documented patency rates of 95% at one year, 86% at three years, and 73% at five years (Salam 1994). A 10-year, single-center study completed in 2005 documented an initial technical success rate of 93% and a five-year clinical patency rate of 89% with percutaneous transluminal angioplasty (PTA) (De Vries 2005). A 1999 comparison study between stenting and surgical treatment of subclavian and brachiocephalic artery stenosis demonstrated equal effectiveness but fewer complications in the stenting group; it concluded that stenting should be first line therapy for subclavian or brachiocephalic obstruction (Hadjipetrou 1999).

Subclavian artery stenosis can lead to a myriad of symptoms depending on the underlying pathology and anatomy. In patients who have undergone CABG using the left internal mammary artery (LIMA), the subclavian artery functionally becomes part of the coronary circulation via the LIMA (Elian 2002). Ischemia distal to a stenotic subclavian artery in this clinical picture can lead to angina; this defines the coronary

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steal syndrome. Given the potential complications of CSS, every effort to detect SAS before using a LIMA graft should be made (Harjola 1974). At the institution studied, subclavian arteriography is routinely performed at cardiac catheterization in patients who will likely require CABG.

While safety and efficacy of endovascular therapy in SAS has been fairly well established, the low prevalence means these patients remain a unique population that most interventionalists see only occasionally. The prevalence of SAS is 3.5% in the general population and 5.3% in patients with potential surgical coronary disease (English 2001). Therefore, more data are needed to assess what clinical picture will lead to higher rates of symptom reoccurrence in this unique patient population. Also, more published data are necessary to accurately determine the prevalence at SAS prior to CABG.

Methods

The subject population consisted of 43 consecutive patients with subclavian or brachiocephalic artery stenosis or occlusion, who underwent PTA or stenting between Oct. 1997 and Oct. 2005 at a large military medical treatment facility (MTF) in southern California. All patients were included; there was no exclusion criterion. Follow-up data were obtained from inpatient records, outpatient clinic notes, and more recently from the electronic medical record.

Patient demographics, patient comorbidities, and indication to perform the procedure were analyzed to ascertain if the variable in question led to a statistically significant difference in symptom reoccurrence at 12 months.

The pre-CABG group was defined as patients with angiographic evidence of SAS and a planned LIMA graft to the left anterior descending artery (LAD). The CSS group was defined as angina in a patient with a LIMA graft and flow-limiting SAS. The SSS group was defined by both arm claudication or vertebrobasilar symptoms and SAS. Symptom reoccurrence was defined as return of the above-noted symptoms. Symptoms were evaluated either in the clinic or in the hospital. Complete information at 12 months was obtained in all patients.

Statistical analysis was performed by the statistics department at the MTF. Analysis using Fisher's Least Significant Difference test was performed. p values <0.05 were considered statistically significant.

An institutional review board approved the study.

Results (see Tables 1–3)

Thirty-eight of the 43 patients were treated with PTA and stent; five were treated with angioplasty alone. Thirty-nine of the total lesions were located in the left subclavian artery, with two of these lesions distal to the vertebral artery. One lesion was located in the right subclavian artery, and three were located in the brachiocephalic artery. Technical success was achieved in 42 out of the 43 patients (97.67%). The patient with technical failure had a total occlusion, and the guide wire could not be passed despite femoral and brachial approaches. The patient was referred to vascular surgery. Mean stenosis pre-intervention was 84.41% (range 60%–100%), with three total occlusions. Mean stenosis post-intervention was 6.83% (range 0%–30%).

The 30-day mortality was 0%; all patients were also symptom free at this point. Two patients developed symptoms two months after the procedure. Seven patients developed symptoms six months after the procedure, and 10 developed symptoms one year after the procedure.

The mean patient age was 67.6 years; 48.8% of the patients were male, 90.7% had hypertension, 46.5% had diabetes, and 88.4% were being treated for hyperlipidemia. Obesity (BMI $>$ 30) was present in 32.6% of the patients; 60.5% of the patients were smokers, 95.3% had coronary artery disease, 48.8% had a previous myocardial infarct, and 55.8% had either a previous CABG or Percutaneous Coronary Intervention (PCI).

Of the demographic data analyzed, only one group was shown to have an increased risk of symptom reoccurrence: patients who had had a previous PCI or CABG ($p = 0.036$). When this group was further subdivided, it was noted that those undergoing the procedure for pre-CABG screening were at increased risk for developing symptoms ($p = 0.025$). Patients undergoing the procedure for subclavian steal or coronary steal were not at increased risk for symptom redevelopment.

Seventeen (39.5%) of the 43 patients treated met pre-CABG criteria. Thirteen (30.2%) patients treated met the

Table 1 Clinical characteristics of the study group (N = 43)

Demographics	#	Percent	p
Men	21	48.8%	0.419
Hypertension	39	90.7%	0.649
Diabetes Mellitus	20	46.5%	0.246
Hyperlipidemia	38	88.4%	0.212
Obesity (BMI $>$ 30)	14	32.6%	0.066
Smoking	26	60.5%	0.581
CAD	41	95.3%	0.479
Previous MI	21	48.8%	0.168
Previous PTCA/CABG	24	55.8%	0.036

History of previous PTCA/CABG was a clinical characteristic that significantly predisposed to symptom reoccurrence at 12 months.

Table 2 Procedural data and results (N = 43)

Procedure	n	Percent
Mean stenosis		
Pre-intervention	(60%–100%)	84.40%
Post-intervention	(0%–30%)	6.80%
Balloon angioplasty	5	11.60%
Stent placement	38	88.40%
Stenosis	40	93.00%
Total occlusion	3	7.00%
Technical success	42	97.67%
30-day mortality	0	0.00%

Table 3 Symptoms reoccurrence

	n	%
All interventions (n = 43)		
1 month	0	0
2 months	2	4.6
6 months	7	16.2
12 months	10	23.3
Pre-CABG (n = 17)		
1 month	0	0
2 months	1	5.9
6 months	4	23.6
12 months	6	35.3
Subclavian steal syndrome (n = 12)		
1 month	0	0
2 months	0	0
6 months	1	8.3
12 months	1	8.3
Coronary steal syndrome (n = 13)		
1 month	0	0
2 months	1	7.7
6 months	2	15.4
12 months	3	23.1

CSS criteria. Twelve (27.9%) patients met the SSS criteria. One (2.3%) patient did not fit into one of the above categories; the procedure indication for this patient was iatrogenic dissection during diagnostic catheterization.

There was divergence of the data based on indication to intervene with the pre-CABG group experiencing the highest rates of reoccurrence (35.3%) at 12 months followed by the CSS group (23.1%) and the SSS group (8.3%).

Eleven hundred and fifty-four CABG procedures were performed during the study period. All patients had had angiographies prior to the procedure, and the subclavian artery was routinely evaluated for stenosis. Seventeen (1.47%) of the pre-CABG patients had significant SAS that required PTA or stenting.

Discussion

This retrospective study of 43 consecutive patients with flow-limiting SAS again illustrates that percutaneous intervention is safe, with a 30-day mortality rate of 0%, and effective, with technical success achieved in 97.67% of patients. The primary success rate of >90% in this study was consistent with other larger studies (Henry 1999; Amor 2004).

Assessing the clinical picture that leads to the highest rate of symptom reoccurrence is useful information to help determine how closely to follow a patient post-intervention. In this study, there was a higher incidence of symptom reoccurrence in patients who had a history of prior coronary intervention. This seems somewhat intuitive, as patients with prior coronary intervention would have the most widespread and advanced atherosclerosis. Following this logic, there was also a divergence of the data regarding indication for intervention, with pre-CABG and CSS patients experiencing higher rates of symptom reoccurrence compared with SSS patients.

The prevalence of flow-limiting and overall stenosis of the subclavian artery in patients undergoing CABG is not well known. In our population, the prevalence was 1.47%. This appears to be lower than the 3.4% incidence of CSS documented in a recent prospective study of non-cardiac surgery patients (Lobato 2001). Studies report the prevalence of SAS in patients undergoing CABG ranges from 0.5% to 1.1% (Westerband 2003). Larger studies and meta-analysis are needed to more precisely determine the prevalence of SAS in patients going to CABG. Another potential avenue of research is determining if PTA or stenting in patients with flow-limiting SAS and planned LIMA graft protect the patient from developing CSS.

Limitations to this study include: (1) it is retrospective, (2) it has low power, (3) there was heterogeneity in the procedures performed, and (4) a rather subjective endpoint was used. Given that angiographic evidence of restenosis was not assessed, symptom reoccurrence may have been due to progression of CAD or graft stenosis in CABG patients and not restenosis of the left subclavian artery. Indeed, a recent study concluded that progression of CAD rather than recurrent SAS most often leads to coronary symptoms after left subclavian artery percutaneous intervention (Angle 2003). In the BARI study (Whitlow 1999), 12% of patients had reoccurrence of angina 12 months after CABG. Repeat angiography was performed on all patients with 20% of patients having greater than 1 totally occluded graft and an additional 7% of patients having graft stenosis of 50%–99%.

Conclusion

The current study once more illustrates that endovascular therapy in SAS is safe and can be performed with a high

level of initial technical success. A 30-day mortality rate of 0% and an initial success in over 95% of patients were noted. A statistically significant higher rate of symptom reoccurrence was seen with a history of prior coronary intervention. There was a divergence in the rates of symptom reoccurrence based on indication, with the pre-CABG and CSS groups experiencing higher rates of symptom return compared with the SSS group. The higher rate of symptom reoccurrence in patients with coronary disease requires a close post-intervention follow-up after treatment of SAS. Finally, the prevalence of SAS in patients undergoing CABG is low at less than 2%.

Note

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References

Amor M, Eid-Lidt G, Chati Z, et al. 2004. Endovascular treatment of the subclavian artery: stent implantation with or without predilation. *Catheter Cardiovasc Interv*, 63:364–70.

Angle JF, Matsumoto AH, McGraw JK, et al. 2003. Percutaneous angioplasty and stenting of left subclavian artery stenosis in patients with left internal mammary-coronary bypass grafts: clinical experience and long-term follow-up. *Vasc Endovasc Surg*, 37:89–97.

De Vries J, Jager L, Van den Berg J, et al. 2005. Durability of percutaneous transluminal angioplasty for obstructive lesions of subclavian artery: long-term results. *J Vasc Surg*, 41:19–23.

Elian D, Gerniak A, Guetta V, et al. 2002. Subclavian coronary steal syndrome: an obligatory common fate between subclavian artery, internal mammary graft and coronary circulation. *Cardiology*, 97:175–9.

English J, Carell E, Guidera S, et al. 2001. Angiographic prevalence and clinical predictors of left subclavian stenosis in patients undergoing diagnostic cardiac catheterization. *Catheter Cardiovasc Interv*, 54:8–11.

Hadjipetrou P, Cox S, Piemonte T, et al. 1999. Percutaneous revascularization of atherosclerotic obstruction of aortic arch vessels. *J Am Coll Cardiol*, 33:1238–45.

Harjola PT, Valle M. 1974. The importance of aortic arch or subclavian angiography before coronary reconstruction. *Chest*, 66:436–8.

Henry M, Amor M, Henry I, et al. 1999. Percutaneous tranluminal angioplasty of the subclavian arteries. *J Endovasc Surg*, 6:33–41.

Lobato EB, Kern KB, Hughes L, et al. 2001. Incidence of coronary-subclavian steal syndrome in patients undergoing noncardiac surgery. *J Cardiothorac Vasc Anesth*, 15:689–92.

Salam T, Lumsden A, Smith R. 1994. Subclavian artery revascularization: a decade of experience with extrathoracic bypass procedures. *J Surg Research*, 56:387–92.

Westerband A, Rodriguez JA, Ramaiah VG, et al. 2003. Endovascular therapy in prevention and management of coronary-subclavian steal. *J Vasc Surg*, 38:699–703.

Whitlow PL, Dimas AP, Bashore TM, et al. 1999. Relationship of extent of revascularization with angina at one year in the Bypass Angioplasty Revascularization Investigation (BARI). *J Am Coll Cardiol*, 34:1750–9.