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## Evaluation of the performance of a carotid subclavian by-pass as a source for internal thoracic artery

**Abstract:** The concomitance of atherosclerotic subclavian occlusive lesion with coronary artery disease has an extraordinary importance in coronary artery bypass surgery. The development of a lesion in the subclavian artery proximal to the internal thoracic artery (ITA) before or after coronary artery bypass graft (CABG) by ITA can result with the coronary-subclavian steal syndrome and myocardial ischemia may occur. It is pretty vital to be aware of the presence of the subclavian occlusive lesion in patients undergoing CABG. We present in this paper an atherosclerotic case that had a concomitant brachiocephalic and coronary artery disease. He had both carotid and subclavian arterial lesions, but also had a carotid endarterectomy with carotid subclavian bypass formerly to CABG because of his objection as a result of the dominance of his neurological complaints. We discussed the diagnostic methods and the prognosis of brachiocephalic artery diseases concomitant with coronary artery diseases and evaluated the surgical, non-surgical treatment procedures in these patients.

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**Key Words:** Atherosclerosis, brachiocephalic disease, coronary artery disease, coronary subclavian steal syndrome

### Karotid subklavyan bypassın internal torasik arter kaynağı olarak performansının değerlendirilmesi

**Özet:** Aterosklerotik subklavyan tıkaçıcı lezyonu ile koroner arter hastalığı birlikteliğinin koroner arter bypass cerrahisinde ayrı bir önemi vardır. ITA kullanılarak uygulanan CABG öncesi veya sonrasında ITA proksimalinde subklavyan arterde bir lezyon gelişimi koroner-subklavyan çalma sendromu ile sonuçlanabilir ve miyokardiyal iskemik oluşabilir. CABG uygulanacak hastalarda subklavyan tıkaçıcı lezyonun varlığından haberdar olmak oldukça hayattır. Bu yazıda biz de brakiosefalik ve koroner arter hastalığı birlikte olan aterosklerotik bir olguyu sunduk. Hastanın karotid ve subklavyan arteriyel lezyonları mevcuttu, bununla birlikte hastaya, nörolojik şikayetlerinin daha baskın olması nedeniyle CABG'den önce karotid endarterektomi ile karotid subklavyan bypass uygulandı. Koroner arter hastalığı ile birlikte görülen brakiosefalik arter hastalığının prognozunu ve tanısal yöntemlerini tartışıp bu hastalarda uygulanan cerrahi ya da cerrahi olmayan tedavi prosedürlerini değerlendirdik.

Received: May 22, 2008  
Accepted: April 16, 2009

**Anahtar Sözcükler:** Ateroskleroz, brakiosefalik hastalık, koroner arter hastalığı, koroner-subklavyan çalma sendromu

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#### Introduction

There are major risk factors for diffuse systemic atherosclerosis and the numbers of these factors are claimed to augment the formation and the progression of atherosclerosis (1). Location of the atherosclerotic plaques predicate the severity and the variety of the symptoms but atherosclerotic disease of the subclavian artery (SCA) carries an extraordinary importance because of its extremely important branches for the central nervous and cardiovascular systems, such as vertebral and internal thoracic arteries (ITA). Significant

stenosis of proximal SCA may result with the symptoms of vertebral-subclavian or coronary-subclavian steal syndrome in addition to ischemia (2).

Left ITA is the primary graft choice to the left anterior descending artery (LAD) for coronary artery bypass graft (CABG) unless a significant stenosis or occlusion of left SCA originates proximally to the left ITA. Coronary-subclavian steal syndrome (CSSS) occurs in patients who have undergone CABG operation with ITA when a significant stenosis or occlusion of the subclavian artery originates proximal to the ITA and may result with impaired myocardial blood flow because the vascular segment between the origin of the SCA and the coronary artery functionally becomes part of the coronary circulation.

We present a case report that had concomitant brachiocephalic and coronary artery occlusive diseases. Left carotid endarterectomy, left carotid-subclavian by-pass formerly, and then CABG were performed. Left in situ ITA was anastomosed to LAD without any hesitation by the approval of the patency of the left carotid-subclavian by-pass (CSB) and he had no other ischemic cardiac disorders till that time.

### Case Report

A 57 year-old man who had all the major risk factors for diffuse systemic atherosclerosis (1) admitted to the Cardiovascular Department of Hacettepe University after a couple of transient ischemic attacks and myocardial infarction with the symptoms of diplopia, dizziness, and chest pain. He underwent a coronary angiography and ventriculography concomitant with a carotid digital subtract angiography (DSA). Coronary angiography revealed atherosclerotic lesions in LAD; circumflex and right coronary (RCA) arteries whereas DSA demonstrated an ulcerative, irregular, 2-cm lengthened atherosclerotic plaque expanding from the left common carotid artery to the internal carotid artery and a major lesion in the ostium of the left vertebral artery. Surgical plan of the patient was directed to the intervention of the carotid lesion formerly because of the patient's objection for

CABG operation due to the dominance of his neurological disturbances. Left carotid artery endarterectomy, left carotid-subclavian bypass with an 8-mm polytetrafluoroethylene (PTFE) graft and left internal carotid arterial stent to the distal part of the carotid endarterectomy region was performed. The ostial plaque of the left vertebral artery was demonstrated to be extending to the proximal region of SCA. The patency and the flow of the left SCA and left ITA had an extreme specialty and importance for this patient because of the plan of CABG. As a result of this situation, left CSB was performed to support the flow of the left SCA to be able to keep the graft performance of the left ITA and to prevent the left arm from ischemia. Neurological disturbances of the patient were defeated but unfortunately he still had periodical chest pain attacks and finally he agreed to have CABG operation. The patency of left carotid-subclavian bypass and ITA was approved by DSA before CABG. Left in situ ITA was anastomosed to LAD; saphenous veins were anastomosed to obtuse marginal and RCA individually. After a 3-year follow-up of the patient, no myocardial ischemic symptoms were observed and the patency of left ITA depending on the adequate flow from CSB was confirmed for several times by DSA, computerized tomography (CT) angiography, and ultrasonographic duplex scanning (Figures 1 and 2).

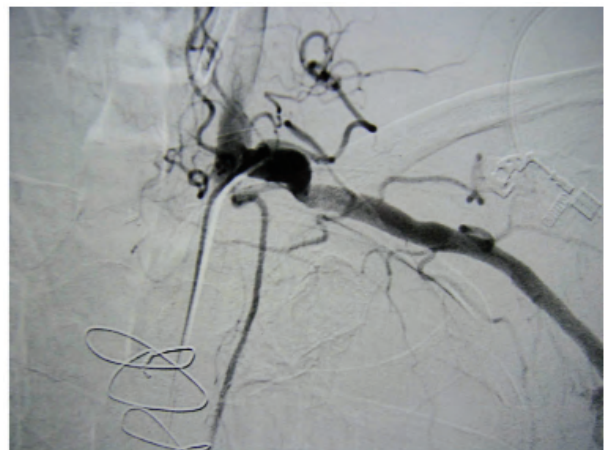


Figure 1. DSA view of the patent carotid subclavian bypass and left ITA.



Figure 2. Patent left ITA and LAD anastomosis screened by computerized tomography angiography.

## Discussion

A special attention should always be paid to SCA stenosis or occlusive lesions in patients who have coronary artery disease because ITAs are the primary graft choices for CABG. It is obviously vital to be aware of the lesions of SCAs to prevent the patients from CSSS, which is a distinct clinical entity mentioned first in around 1974 (3).

Bilateral upper extremity blood pressure measurement is an excellent diagnostic method for detecting the presence of SCA stenosis. A blood pressure difference of more than 20 mmHg is highly suggestive of SCA stenosis. However, such a difference may not always be found in this group of patients because some of them have diffuse brachiocephalic occlusive disease and both upper extremities may have been affected. Ultrasonographic duplex scanning before and after arm exercise is a valuable non-invasive diagnostic method whereas the most efficient way of diagnosis is DSA in this pathology although it is an invasive method.

The disadvantages of DSA may be reduced if the procedure is performed concomitantly with angiography. Currently at several institutions, SCA has started to be screened in all of the patients undergoing angiography to enable to prevent patients from CSSS by diagnosing preoperatively (2). However, CT angiography is also a strong nominee to be the gold standard in this subject by the advantage of its less invasiveness especially for

the follow-up of the late post-operative period in the outpatients.

The presence of SCA occlusion concomitant with coronary artery disease requires the surgeon to answer a really hard question to choose in situ ITA as a graft for CABG or not. CSSS will probably be avoided if alternative graft procedures, such as free ITA, radial artery, or vein grafts, are preferred instead of in situ ITA but unfortunately it is not clear whether other graft choices can achieve the same long term performance with in situ ITA (4,5). Finally, the surgeon has to choose the most convenient subclavian artery reconstruction procedure to perform not to compromise the documented advantages of in situ ITA. The most successful and popular correction methods of SCA occlusive disease may differ as aorta-subclavian (6), carotid-subclavian (CSB), subclavian-subclavian, axillo-axillary and carotid axillary bypass, subclavian-carotid transposition (SCT), transposition of the ITA (7), and percutaneous transluminal angioplasty with stenting (8).

Even the optimal approach and technique for SCA reconstruction has not been established, long term high patency rates with tolerable low morbidity and mortality can be achieved by SCT (100%) or CSB (86%) procedures in brachiocephalic diseases (9). Nevertheless SCT owns the advantages of being completely an anatomic procedure compared with CSB. SCT offers a prograde flow through SCA whereas CSB may cause turbulence by the retrograde flow to vertebral artery from SCA. Also rarely there may be thrombosis or infection in CSB but technically it is more difficult to perform SCT than CSB. The patency results in CSB may be promoted by using short Dacron and PTFE grafts but not venous conduits because of their smaller size, kinks or angulations in the bypass grafting segment, and by performing the anastomosis as proximal as possible in the first segment of SCA to prevent procedure from thrombosis.(10)

Although the surgical management of single-vessel brachiocephalic disease is well established, the introduction of endovascular techniques has permitted new pathways for the treatment of brachiocephalic diseases. More recently, angioplasty and stenting have started to be performed in

brachiocephalic occlusive diseases because of less invasiveness, more cost effectiveness, and acceptable early term results. Nonetheless, results in the literature show that mid-term patency rates are significantly better after operative bypass than after endovascular intervention for the treatment of single-vessel brachiocephalic diseases. It is possible that long term follow-up, which is ongoing for both groups of patients, will reveal an even greater difference in durability than that found at mid-term (11).

Although reconstruction method of SCA depends on the individual personal risk factors and anatomic distribution of the disease, operative procedures are chosen more frequently when the occlusive disease of SCA is ostial or diffuse and diagnosed before CABG because of the proven safety and the long term durability of the open operative procedures performed in conjunction with CABG (12). Endovascular techniques are preferred to be performed in elderly patients, revealing poor medical conditions for general anesthesia, and who have CSSS after CABG because if endovascular techniques are used formerly, obligation of anticoagulation administration may affect postoperative CABG outcome. Also the sternal

retractor may compress subclavian stents, deform them and promote restenosis.

In our case, CSB was chosen to be performed to the patient by 8-mm PTFE graft as a result of its proven long durability period and because the patient was not very old; also he was already under general anesthesia, SCA occlusion was noticed during left carotid endarterectomy. It was wise to perform CSB depending on the ease and competitive patency results of the procedure with SCT via only an extension of the incision downwards to the ostium of ipsilateral SCA. Close follow-up of the patient was performed by physical examinations, ultrasonographic duplex scanning, and CT angiographies to monitor the progress of the disease, the patencies of left ITA and CSB. CT angiography was a quite valuable and convenient method in this case as an outpatient in the follow-up period.

Finally, CSB, performed to prevent the patient from a probable CSSS after CABG, seems to be successful as a source for ipsilateral ITA after a 3-year close follow-up period but further investigations about the ongoing of concomitant brachiocephalic and coronary artery diseases are required to solve problems in this subject.

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