Subklavyan Arterin Tıkayıcı Hastalığı: Koroner ve Subklavyan Çalma Sendromu

OCCLUSIVE DISEASE OF SUBCLAVIAN ARTERY: SUBCLAVIAN AND CORONARY STEAL SYNDROME

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Özet

Amaç: Bu çalışma, subklavyan arterin oklüziv hastalıklarında politetrafluroetilen (PTFE) greftlerle uygulanan karotiko-subklayan bypass operasyonlarının kısa ve uzun dönem sonuçlarını tespit etmek için yapıldı.
Materyal ve Metod: Ocak 1990 ve Ocak 2003 arasında tanısı subklavyan çalma sendromu (54) ve koroner çalma sendromu (12) olan ve karotiko-subklavyan bypass uygulanan 66 hastanın bilgileri retrospektif olarak incelendi. Erken ve geç sonuçlar analiz edildi. Kümülatif açıklık ve tüm yaşamda kalım hızları yaşam-tablosu yöntemiyle incelendi.
Bulgular: İntraoperatif ölüm görülmedi, ancak 30-gün takiplerde bir hasta kaybedildi. Ortalama 96 aylık (6-44 ay) takiplerde 13 hasta kaybedildi. 1., 3., 5. ve 10. yıllarda primer açıklık oranları %98, %91, %83 ve %47 olarak bulundu. Aynı dönemlerde yaşamda kalım ise %100, %95, %93 ve %38 şeklindeydi.
Sonuç: PTFE greftlerle karotiko-subklavyan bypasslar güvenilir, efektif ve kalıcı sonuçlar sunmaktadır. Rejyonel anestezi ile yapılabilirliği ayrıca kolaylık sağlar.

Anahtar kelimeler: Karotid, subklavyan, koroner arter, bypass, subklavyan çalma sendromu

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Summary

Backgrounds: This review was conducted to analyze the long-term results of carotid-subclavian bypass with polytetrafluoroethylene (PTFE) grafts used for occlusive subclavian artery disease.
Methods: In this retrospective study, the medical records of 66 (54 for subclavian steal syndrome and 12 for coronary steal syndrome) patients undergone carotid-subclavian bypass between January 1990 and January 2003 were reviewed. Early (operative mortality and morbidity) and late results cumulative patency and overall survival rates were analyzed with life-table method.
Results: There was no intraoperative mortality and one case of mortality in 30-day follow-up. Only one peri-operative cerebrovascular accident was observed. Over a mean follow-up of 96 months (6-44 months) after operation, 13 patients died. The primary patency rates at 1, 3, 5 and 10 years were 98%, 91%, 83% and 47% and the overall survival rates at 1, 3, 5 and 10 years were 100%, 95%, 93% and 38%, respectively.
Conclusions: Carotid-subclavian bypass with PTFE grafts is a safe, effective and durable procedure. It can be easily applied to patients under regional anaesthesia when percutaneous intervention is unsuccessful or impossible.

Keywords: Carotid, subclavian, coronary artery, bypass, steal syndrome

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Introduction

Subclavian steal syndrome (SSS) occurs when there is stenosis or occlusion of the subclavian artery proximal to the vertebral artery. This blockage reverses normal direction of blood flow in the vertebral artery, and is named as "steal", because it steals blood from the cerebral circulation. Subclavian steal syndrome is diagnosed with the symptoms of arm or cerebral ischemia like vertebrobasilar or brainstem hypoperfusion [1].
On the other hand, the occlusive disease of subclavian artery seems to cause another subset of SSS that is the coronary-subclavian steal syndrome (CSS) which occurs in patients who underwent coronary artery revascularisation with internal mammary artery [2-4]. The blood flow in vertebral artery and/or left internal mammary artery is drawn back to the arm [2,5].
The aim of the treatment is to restore permanent antegrade blood flow to the vertebral and internal mammary artery and to eliminate cerebral and myocardial hypoperfusion. The traditional treatment of SSS has been surgery [6-8]. However, there is a recent trend towards percutaneous transluminal

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angioplasty. Percutaneous catheter intervention may help avoid the morbidity of operative intervention and provide acceptable results [9]. Extraanatomic revascularisation with carotid subclavian bypass can be performed to prevent cerebral and/or myocardial ischemia when a percutaneous intervention is not feasible. This extraanatomic bypass procedure is particularly significant for patients with CSS, because this procedure provides IMA patency and relieves recurrent myocardial ischemia without the risk of redo coronary artery reconstruction [10,11].

Material and Methods

Medical records of sixty-six patients that underwent carotid-subclavian bypass for symptomatic occlusive subclavian artery diseases between Jan, 1990 and Jan, 2003 were reviewed (54 for SSS and 12 patients for CSS with polytetrafluoroethylene [PTFE] grafts; Gore-tex, W.L. Gore and Associates, Inc, Flagstaff, Ariz.) at our institution. The medical records were reviewed to establish the demographic data, risk factors, presenting clinical manifestation, the location of the subclavian disease and immediate postoperative results. Indications for surgery were classified as arm ischemia (claudication or rest pain), symptomatic subclavian steal or vertebrobasilar insufficiency (VBI) or myocardial ischemia.

All patients underwent noninvasive duplex ultrasonographic scanning and angiographic evaluations (four-vessel arch aortography with carotid and subclavian arteriography) before surgery. Following diagnosis, the patients were also assessed for operation by neurologists to rule out other causes of the symptoms. The appropriate anesthesia type for patients was determined by considering overall patient status as well as noninvasive and invasive evaluations and the surgeon's preference. All procedures were conducted with systemic heparinization and with a principle of initial subclavian anastomosis. The flow was initially restored to the upper extremities to prevent embolisation of the coronary and vertebral arteries. The patients were managed in surgical intensive care unit for one day and in ward for 3 days and discharged from hospital on the fourth day. All patients were followed by clinical examination, duplex scan, pulse volume recording and myocardial perfusion imaging. Perioperative morbidity and mortality were defined as events occurring within 30 days of operation. After being discharged from hospital, the patients were periodically observed with serial clinical examination and noninvasive vascular testing. Determination of graft patency was made with color doppler imaging, the presence of symptoms of patients, or in some cases, with magnetic resonance angiography when indicated. The cumulative patency, and overall survival rates were calculated with the life table method.

Results

The main clinical presentation was SSS in 54 patients, and CSS in 12 patients. The demographic characteristics of the patients are summarized in Table I. The lesions were observed at the left subclavian artery in 39 (72.5%) patients and at right subclavian artery in 15 (27.5%) patients with SSS. Thirty four (62.5%) patients with SSS had total occlusion whereas 20 (37.5%) had stenosis of the subclavian artery. In 12 patients with CSS, the lesions were stenosis in 3 (25%) and total occlusion of left proximal subclavian artery in 9 (75%) patients. The mean preoperative arm pressure gradient was 32.4 (range: 25-50) mm Hg in patients with subclavian artery disease. Table II summarizes the predominant symptoms of the patients. The symptoms of cerebral ischemia were predominant in 43 patients (80%). The most common symptom of cerebral ischemia was dizziness which was found in almost 70% of all cases. The predominant symptom in patients with CSS was the recurrent chest pain after aortocoronary bypass surgery (CABG). The mean duration between the initial CABG with the in situ IMA conduit and the recurrent chest pain due to symptomatic steal was 60 months (range: 24-116 months).

Table III demonstrates the distribution of anesthesia types for procedures. Authors used 6-8 mm polytetrafluoroethylene (PTFE) grafts. An 8 mm graft was placed in 36 of the patients and 6 mm conduit in 18 patients with SSS. Two patients required concomitant carotid endarterectomy (CEA) for high grade stenosis before the bypass procedure. Out of 12 patients with CSS, we used 8 mm graft in 9 patients and 6 mm graft in 3 patients.

Table 1. Demographic characteristics of the patients.

Demographic		**S.S.S**		**C.S.S**
	No.	**Percentage**	**No.**	**Percentage**
Average Age (years)		60 (range, 42-70)		66 (range, 62-74)
Men/woman	32/22	60%/40%	9/3	75%/25%
Smoking	35	65%	10	83%
Diabetes Mellitus	15	27%	3	25%
Hypertension	24	45%	6	50%
Coronary disease	19	35%	12	100%
Cerebrovascular disease	10	20%	4	33%
Peripheric arterial disease	10	20%	5	42%
Carotid artery disease	30	55%	6	50%
Site of lesion: left/right	39/15	72%/28%	12	100% left
stenosis/occlusion	20/34	38%/62%	3/9	25%/75%

S.S.S:Subclavian Steal Syndrome, C.S.S: Coronary Subclavian Steal Syndrome

Table 2. The symptoms of patients.

	S.S.S		C.S.S	
Symptoms	**Number**	**%**	**Number**	**%**
Dizziness/vertigo	38	70%	6	50%
Syncope	20	37%	2	15%
Ataxia	7	12%	6	50%
Visual field disturbance	8	15%	4	25%
Hemiparesis	3	5%	0	0%
Claudication	14	27%	2	15%
Distal embolism	5	10%	0	0%
Digital necrosis	2	2%	0	0%
Myocardial ischemia	2	2%	12	100%

S.S.S:Subclavian Steal Syndrome, C.S.S: Coronary Subclavian Steal Syndrome

Table 3. Type of anesthesia with carotid-subclavian bypass.

	Type of anesthesia		
patients with	**General**	**Local**	**Total**
S.S.S	21 (39%)	33 (%61)	54
C.S.S	4 (25%)	8 (%75)	12
Total	25 (38%)	41 (62%)	66

Early period:
No intraoperative mortality was seen. Only one perioperative cerebrovascular accident was observed in patients with SSS during carotid-subclavian bypass procedure. Upon examination of the perioperative morbidity and mortality occurring within 30 days of operation, we noted only one mortality in patients with SSS due to myocardial ischemia on postoperative day II. Among seven (%11) morbidities seen in this period, two patients with SSS and one patient with CSS underwent reoperation due to bleeding, one patient with SSS underwent brachial embolectomy due to embolisation of the distal arterial system and two patients with SSS underwent reoperation due to early (one in the second hour and one on the second day) graft thrombosis. The two grafts in patients with early graft thrombosis were excised and revised to carotid-axillary bypass. The mean preoperative arm pressure gradient was 32.4 mmHg with a mean postoperative pressure gradient of 5.4 mmHg (range: 4-10). Immediate relief of symptoms was achieved in 100% with an early graft success of 97%.

Late period:
Over a mean follow up of 96 months (6 month-144 months) after operation, thirteen patients with SSS died: three patients due to cardiac, four due to cerebrovascular and six due to other reasons. The PTFE grafts were patent in seven and occluded in six patients when they died. There were eleven late graft thrombosis observed in patients with carotid-subclavian bypass. Eight patients with an occluded graft refused surgical options and chose medical therapy after discussing the management options. Three patients accepted to undergo revision of the graft and had carotid-axillary bypass with PTFE graft. However, two of them were occluded at 20 and 24 months and they died. Only one patient with second bypass graft was alive with a patent graft at 38 months. In total, five patients with occluded PTFE grafts were alive.

All the patients with CSS were alive nearly after 48 months and there is no late complication and all the grafts were patent. The evaluation of these patients with dipyridamole-thallium scans showed the improvement in reversible defects noted preoperatively in the anterior and lateral myocardial segment supplied by IMA. We examined the cumulative patency, and

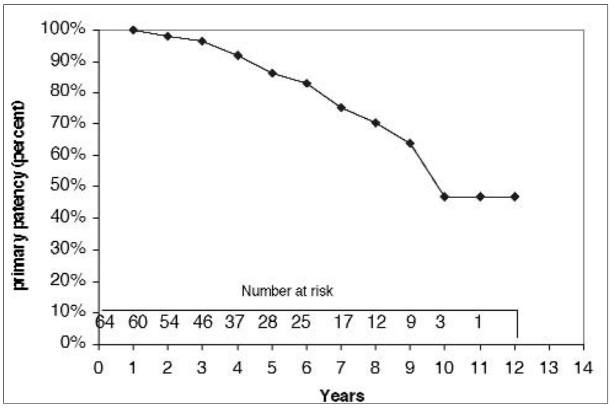

Figure 1. Cumulative patency rates PTFE graft used at carotid-subclavian position.

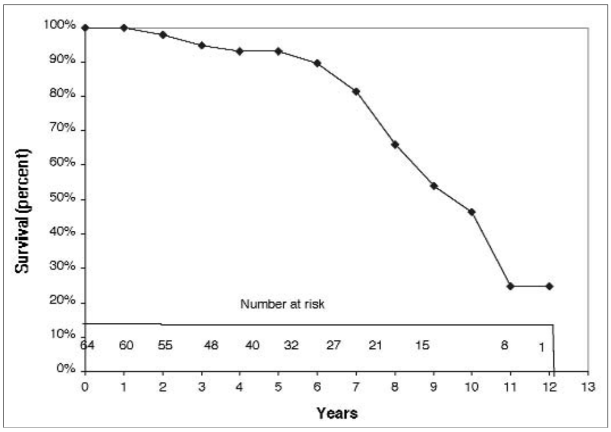

Figure 2. Survival rates of patients with carotid-subclavian bypass.

overall survival rates of all PTFE grafts used in the same anatomic position irrespective of the predominant symptoms. We determined that immediate symptoms were relieved in 97% of patients. The primary patency rates at 1, 3, 5 and 10 years were 98%, 91%, 83% and 47% (Figure 1) and the overall survival rates at 1,3,5 and 10 years were 100%, 95%, 93% and 38%, respectively (Figure 2).

Discussion

After left internal mammary artery (IMA) graft surgery to the coronary artery, subclavian artery becomes a part of the two most important blood circulations in the body as long as IMA is used for coronary bypass surgery. As only 20% of blood flow to the brain is supplied by the vertebral arteries and presence of alternative blood supply for vertebral artery like carotid arteries via circle of Willis and contralateral vertebral artery, the symptoms related to brain do not occur unless a pathology of these alternative pathways exist. Nevertheless, when subclavian artery becomes part of coronary circulation there is no alternative flow pathway. So, severe cardiac symptoms occurs.

The most common location for atherosclerotic lesion causing reversal of blood flow is the proximal part of the left subclavian artery. A preponderance of 3:1 of symptomatic subclavian artery lesions on the left to the right was reported in the literature [12]. In this study, the lesions were seen at the left subclavian artery in 39 (72.5%) patients and at right subclavian artery in 15 (27.5%) patients with SSS while the lesion was left-sided in all patients with CSS. The symptoms of cerebral ischemia resulting from subclavian steal syndrome were thought to be exacerbated by arm exercise. Augmentation of steal with arm exercise seldom reproduces the symptoms of posterior circulation insufficiency [3]. It has been postulated that only one major blood supply to the intracranial circulation is required to prevent cerebral ischaemia [13]. A complete circle of Willis is a relative rarity. Miller-Fischer, reported a lack of adequate collateral channels in the anterior circulation in 44% and a small posterior communicating artery in 49% consecutive autopsy dissections [14]. Therefore, a combination of extracranial vascular stenosis plus an incomplete intracranial network may result in reduced blood flow to either anterior or posterior cerebral regions.

The coronary-subclavian steal syndrome was first reported by Harjola an Valle in 1974 in a patient who underwent CABG with in situ IMA [10]. The incidence of CSS is low. Tyras and Barner described an angiographic incidence of steal in 2 of 450 cases (0.44%). This may also result from an occlusion or high grade stenosis in the proximal subclavian artery[2, 5]. Symptoms related to left upper limb or cardiac ischemia may be present in these patients. In CSS, stenosis at the origin of grafted internal mammary artery is either stenosed before bypass surgery or becomes stenosed after surgery allowing steal from the IMA [1,15]. The development of coronary steal may be early or late following CABG procedures. Mostly, CSS cases present within 3 years after bypass surgery. Because of the lack of collateral flow and prior coronary artery disease in the native coronary artery, reversal of blood flow of IMA causes severe recurrent myocardial ischemia. The mean duration between the initial CABG with the in situ IMA conduit and the recurrence chest pain due to symptomatic steal in our cases was 60 months (range: 24-116 months).

In the diagnosis of subclavian artery disease, the difference in systolic blood pressure between arms is suggestive and is also one of the most important signs of SSS and CSS [14,16]. Patients with symptoms of arm ischemia have a contralateral brachial pressure difference of 40-50 mmHg. Those with predominant cerebral symptoms usually have a difference between 20-40 mmHg [12]. In all of our patients, the pressure difference was higher than 40 mmHg. Nevertheless, it was used as a diagnostic tool only in 28 (42%) patients. In others, the pressure differences were recognised after the radiological evaluations of caroticovertebral or coronary arterial systems. So, the pressure difference gains importance after late follow-up period in all patients with CABG. In the case of a suspected SSS, doppler ultrasonography has been demonstrated to be the most sensitive and specific instrument to conclude the diagnosis [6,13]. Some others argue that a confirming arteriogram should be used for definitive diagnosis [14].

Because of the minimal risk of suffering an infarct, most surgeons agree that surgery is only indicated for those patients experiencing frequent and disabling symptoms of SSS [17-18]. Conversely, this does not apply to patients with prior IMA graft surgery to the coronary artery in which the vascular segment between the origin of the subclavian artery and the coronary artery becomes part of the coronary circulation functionally. In the case of CSS, revascularization is inevitable. The subclavian artery occlusion may be treated through percutaneous intervention including balloon angioplasty alone or with stent [15]. Sullivan et al treated 72 patients with innominate and subclavian artery lesion with angioplasty and primary stent for occlusive lesions [9]. Surgical options include extraanatomic reconstruction, anatomic reconstruction with transthoracic approach or redo-coronary artery surgery in patients with CSS. The morbidity of reoperative cardiac surgery and transthoracic procedures may preclude their use in patients with CSS [19-20]. Since 1967, the extraanatomic bypass of carotid and subclavian artery has shown excellent long-term results [22-23]. Besides, carotid-subclavian bypass can be applied with many benefits of regional anesthesia . Subclavian-carotid transposition is less attractive as the potential aggravation of coronary ischemia during interruption of vertebral and IMA blood flow [24]. Arterial transposition demonstrated superior results, with 100% 5-year actuarial patency although it is not recommended for CSS to prevent myocardial ischemia [25].

Two kinds of graft material present prosthetic grafts and autologous saphenous grafts. The prosthetic conduits, polytetrafluoroethylene (PTFE) were preferred over vein for carotid-subclavian bypass because of less tension and kinking of the graft with a better conduit-artery size match [22]. We preferred to use PTFE (6 or 8 mm) grafts. 41 (62%) carotid-subclavian PTFE bypass procedures were applied under local (infiltration and/or cervical blokage) anesthesia and only 25 (38%) procedures were carried out under general anaesthesia. Meanwhile, the cost of procedures and hospitalization time were reduced.

The results of this study support the patency of carotid-subclavian artery bypass, as noted previously in the literature. Carotid-subclavian bypass with PTFE grafts in patients with SSS and CSS is a safe, effective and durable procedure. It can be easily applied to patients even under regional anesthesia when percutaneous intervention is unsuccessful or impossible.

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