Objective Reverse flow in the internal thoracic artery (ITA) after coronary bypass surgery due to an occlusion or severe stenosis of the subclavian artery is a rare situation. Symptoms can be recurrent and intermittent angina pectoris in the case of a coronary-subclavian steal (CSSS) or – in addition with cerebral symptoms – in the case of a coronary-subclavian-vertebral steal syndrome (CSVSS).

Method We describe the cases of four patients with recurrent angina pectoris 5, 11, and 14 years as well as directly after coronary bypass surgery with LITA grafts to LAD. In two patients there was the additional aspect of vertebral steal symptoms with dizziness and intermittent drop attacks. Results A PTA of the subclavian occlusions in three cases was not feasible, so that three patients were operated on by extrathoracal approach and carotido-subclavian bypass (CSB) in two cases, and local thrombendarterectomy of the subclavian and vertebral artery (TEA) + patchplasty in one case.

Patient 4 was treated by PTA and stent placement into the subclavian artery. Antegrade flow in all four LITAs could be achieved resulting in immediate relief from angina pectoris and cerebral symptoms. Patients 1 and 3 showed no further symptoms with equal BP of the upper extremities and antegrade flow in the LITA grafts and vertebral artery at 10-month follow-up. Patient 2 unfortunately died from an unrelated cause (asthmatic state) 4 months after the operation despite an uneventful recovery.

Conclusion The occurrence of a CSSS or CSVSS after coronary bypass surgery with retrograde flow in the ITA graft (as described in our four patients) is a rare, but potentially hazardous, situation. If the subclavian occlusion is not amenable to endovascular strategies, the extrathoracal approach by CSB or local TEA and patchplasty provides an excellent means with good midterm and long-term results.

Key words Coronary-subclavian-vertebral steal – carotido-subclavian bypass – subclavian PTA
Introduction

The coronary-subclavian steal syndrome tends to be a rare, but potentially hazardous, situation for patients after coronary bypass procedure with ITA grafts.

The internal mammarian artery originates from the subclavian artery and arterial flow is strongly dependent on a noncompromised inflow by the vessels of the aortic arch. Severe stenosis or occlusion of the subclavian artery or the brachiocephalic trunk may cause insufficient blood flow in the internal mammaria artery, even retrograde blood flow as a steal effect could be demonstrated with the reappearance of angina pectoris symptoms. In the case of additional retrograde flow in the vertebral artery, a steal phenomenon with cerebral dysfunction, dizziness and drop attacks may complicate the situation.

Due to the fact that the use of one or even two in situ ITA grafts in coronary bypass surgery is supposed to be the treatment of choice, this attitude may lead to a higher incidence of the coronary steal syndrome in the future.

The rising comorbidity and age of our patients scheduled for coronary bypass procedures include an increasing risk of peripheral arterial disease with development of arterial stenosis or occlusion even in the vessels of the upper extremities.

The incidence of a symptomatic coronary steal syndrome is low (0.44%) [14], whereas a stenosis of the ipsilateral subclavian artery – based on a significant difference of brachial blood pressure – in a group of patients after CABG with ITA graft was described in 5% [7].

Patients and methods

The authors report their experience with patients complaining about recurrent angina pectoris and cerebral symptoms after coronary bypass procedures with LITA grafts to the LAD 5, 11, and 14 years as well as directly after operation.

In the year 2004, three male patients were admitted with the above-mentioned symptoms. Patient 4 had to be operated on due to an acute infarction in cardiogenic shock and appeared with persistent ischemia and recurrent lung edema.

Demographic data, CABG procedures and angiographic status are described in Table 1.

Patient 1 was admitted with recurrent stable angina pectoris and – in addition – with dizziness and drop attacks especially when moving his left arm 11 years after CABG procedure.

A marked bruise in the supraclavicular region could be heard – a BP difference of 80 mmHg suggested an occlusion or severe stenosis of the left subclavian artery. An angiography of the coronary system and the supraaortal vessels revealed an open venous bypass to the circumflex system. The LITA to the LAD turned out to be patent, but with retrograde flow from the LAD towards the subclavian artery, which was occluded proximally to the origin of the LITA (Fig. 1). The left vertebral artery also showed an inversed flow pattern, demonstrated by duplex ultrasound.

In addition, the left ventricle showed all signs of a severe ischemic cardiomyopathy (EF: 20%).

A PTA of the subclavian artery failed and an extrathoracic revascularisation by implantation of a carotido-subclavian bypass was performed.

Patient 2 suffered from acute angina pectoris and a non-ST-elevation infarction 14 years after primary CABG operation.

Besides a severe COPD a marked comorbidity had to be stated. Cerebral symptoms did not occur.

After pulmonary recompensation, the angiography showed a patent LITA to LAD and a significant stenosis of the RCA.

In addition, the LITA showed a retrograde flow pattern resulting from a proximal occlusion of the left subclavian artery. BP difference between right and left arm turned out to be about 75 mmHg.

Due to the severe COPD with the beginning of right heart failure, the patient was not scheduled for a Redo CABG procedure.

Antegrade LITA flow should be achieved by extrathoracic revascularisation, followed by PCI of the RCA.

Because of a complex morphology of the subclavian occlusion, our interventional radiologists pre-

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Gender</th>
<th>CABG</th>
<th>Grafts</th>
<th>Angiography 2004 (vein grafts status)</th>
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<tr>
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<td>2005</td>
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