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Endovascular management of patients with coronary artery disease and diabetic foot syndrome: A long-term follow-up

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Abstract

Background To investigate the long-term results of global coronary and peripheral interventional treatment of diabetic foot patients. **Methods** We retrospectively included 220 diabetic patients (78.5 ± 15.8 years, 107 females, all with Fontaine III or IV class) who were referred to our centre for diabetic foot syndrome and severe limb ischemia from January 2006 to December 2010. Patients were evaluated by a team of interventional cardiologists and diabetologists in order to assess presence of concomitant coronary artery disease (CAD) and eventual need for coronary revascularization. Stress-echo was performed in all patients before diagnostic peripheral angiography. Patients with indications for coronary angiography were submitted to combined diagnostic angiography and then to eventual staged peripheral and coronary interventions. Doppler ultrasonography and foot transcutaneous oximetry of transcutaneous oxygen pressure (TcPO2) before and after the procedure were performed as well as stress-echocardiography and combined cardiologic and diabetic examination at 1 and 6 month and yearly. **Results** Stress-echocardiography was performed in 94/220 patients and resulted positive in 56 patients who underwent combined coronary and peripheral angiography. In the rest of 126 patients, combined coronary and peripheral angiography was performed directly for concomitant signs and symptoms of coronary heart disease in 35 patients. Coronary revascularization was judged necessary in 85/129 patients and was performed percutaneously after peripheral interventions in 72 patients and surgically in 13 patients. For Diabetic foot interventions the preferred approach was ipsilateral femoral antegrade in 170/220 patients (77.7%) and contralateral cross-over in 40/220 patients (18.8%) and popliteal retrograde + femoral antegrade in 10/220 patients (4.5%). Balloon angioplasty was performed in 252 legs (32 patients had bilateral disease): the procedure was successful in 239/252 legs with an immediate success rate of 94.8% and a significant improvement in TcPO2 and ABI with ulcer healing in 233/252 legs (92.4%). Freedom from major amputation was 82.8% at a mean follow-up of 3.1 ± 1.8 years (range 1 to 5 years) whereas survival was 88%. **Conclusions** Global coronary and peripheral endovascular management of diabetic foot syndrome patients seems to lead to an high immediate success and limb salvage rates and increasing survival compared to historical series.

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Keywords: intervention; angioplasty; diabetes; complications

1 Introduction

Diabetics are 40 times more likely to require an amputation than non-diabetics and foot ulcer precedes the need for amputation in 80% of such patients.[1] Diabetic patients with lower extremity ulceration and critical limb ischemia are at significant risk for limb loss and require evaluation of vascular status in order to improve distal lower-extremity perfusion and promote effective wound healing reducing amputation risk. Up to 85% of amputations may be prevented by early detection and appropriate treatment.[2] Interventional treatment for diabetic foot syndrome is rapidly becoming the therapy of choice in such patients, while coronary artery disease is one of the major determinants of mortality and ulcer healing.[3] Our study is aimed to assess the long-term results of interventional treatment of diabetic foot and associated coronary artery disease.

2 Methods

We retrospectively included 220 diabetic patients who were referred to our centre for diabetic foot syndrome from January 2006 to December 2010. The mean age of patients was 78.5 ± 15.8 years (Table 1). Indications to interventional

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revascularization included class III or IV Fontaine with pain at rest.[4] Patients were evaluated by a team of interventional cardiologist and diabetologists in order to assess the presence of concomitant coronary artery disease (CAD) and eventual need for coronary revascularization. Stress-echo was performed in all patients with clinical history suggestive for coronary artery disease before diagnostic peripheral angiography. Patients with indications for coronary angiography were submitted to combined diagnostic angiography and then to eventual staged peripheral and coronary interventions on the basis of echo-stress data or if not performed, on the basis of pressure-wire (Volcano Inc., Rancho Cordova, CA, USA) results. A clinically significant CAD was defined as a coronary lesion in a major epicardic vessel > 50% stenosis of luminal vessel, correlated with an ischemic region on stress-echo or positive to pressure–wire interrogation (FFR < 0.90). Clinical recurrence was defined as positive stress-echo in a region previously revascularized and congruent with angiographic as narrowing > 50% of a vessel previously submitted to revascularization or new appearance of ischemia in a region not previously revascularized.

For diabetic foot treatment, revascularization strategy was based on the attempt, whenever possible, to revascularize all the three below-knee vessels, especially when the superficial femoral artery was occluded. Preferred recanalization technique was the subintimal technique[5] and balloon dilation with dedicated long 100-200 mm Sterling (Boston Scientific, Miami, FL, USA) or Amphirion (Invatech, Roncadelle, Brescia, Italy) peripheral balloons for below-knee. In patients with associated femoral occlusion, our technique included the creation of subintimal space looping a 0.035 inch Terumo (Terumo Europe, Leuven, Belgium) guidewire. Lesion was treated with balloon angioplasty with long duration dilation at high pressure (17 atm for 2 min) and with stent (Everflex, EV3 Inc., Plymouth, MN, USA) in case of flow limiting dissection. Immediate success has been defined as ability to restore antegrade flow in at least 2 below-knee arteries with an increase of transcutaneous oxygen pressure (TcPO2) of at least 20 mmHg. Clinical recurrence was defined as onset of ulcer or pain in a leg previously submitted to revascularization with congruent TcPO2 reduction.

The ankle-brachial index (ABI) was measured using a handheld Doppler or Doppler ultrasonography (US), and foot transcutaneous oximetry of TcPO2 were computed before and after the procedure. Combined cardiological and diabetic follow-up visit was performed at one, three months and every six months thereafter to evaluate ulcer healing, need for minor or major amputation and cardiovascular events.

Global complications were divided in major (malignant ventricular arrhythmias, intraprocedural death, acute renal failure or increase in chronic renal failure requiring dyalisis, retroperitoneal hemorrage, vessel abrupt closure or rupture requiring emergent surgery, acute limb ischemia requiring emergent thrombolysis or surgery) and minor complications (self limiting vessel rupture, inguinal haematomas not requiring transfusion, arterial seudoaneurysm, arterovenous fistula). Amputations have been defined as minor (trans-metatarsal) and major (any amputation above the level of the ankle).

Table 1. Demographic and clinical data of the enrolled patients.

	n (%)
Age (years)	78.5 ± 15.8
Female/Male	107/113
Hypertension	192/220 (87)
Smoke habitus	148/220 (67)
Hypercholesterolemia	158/220 (72)
Fontaine class III	45/220 (20.5)
Fontaine class IV	175/220 (79.5)
Coronary artery disease	36/220 (16.4)
previous AMI	12/220 (5.4)
previous PTCA	15/220 (6.8)
previous CABG	9/220 (4.1)
Cardiac valve disease	4/220 (1.8)
Dilated cardiomyopathy	11/220 (5)
Chronic renal failure	46/220 (21)

AMI: acute myocardial infarction; CABG: coronary artery bypass graft; PTCA: percutaneous transluminal coronary angioplasty

3 Results

Stress-echocardiography was performed in 94/220 patients and resulted positive in 56 patients who underwent combined coronary and peripheral angiography. Among the rest of 126 patients, combined coronary and peripheral angiography was performed directly for concomitant signs and symptoms of coronary heart disease in other 35 patients. Coronary revascularization was judged necessary in 85/91 (93.4%) patients and was performed percutaneously using drug eluting stents (Resolute, Medtronic Corp, Minneapolis, MN, USA) after peripheral interventions in 72 patients (mean diameter, 2.6 ± 1.3 mm; mean length, 26.7 ± 12.5 mm, Figure 1) and surgically in 13 patients (Table 2). For diabetic foot treatment, the preferred approach was ipsilateral femoral antegrade in 170/220 patients (77.7%) and contralateral cross-over in 40/220 patients (18.8%) and

popliteal retrograde + femoral antegrade in 10/220 patients (4.5%). Balloon angioplasty was performed in 252 legs (32 patients had bilateral disease, Table 3, Figure 2). The procedure was successful in 239/252 legs with an immediate success rate of 94.8%. ABI (0.29 ± 0.6 to 0.82 ± 0.2, $P < 0.01$) and TcPO2 (16.5 ± 10.6 to 35.3 ± 14.5, $P < 0.01$) improved significantly with ulcer healing in 233/252 legs (92.4%). Only one patient (0.45%) suffered a major complication and died intrahospitally because of a retroperitoneal haematomas. Minor complications occurred in 11/220 patients (5%) including: groin haematomas in three patients, puncture site pseudoaneurysm in two patients, arterovenous fistula in one patient, vessel rupture in five patients. Clinical coronary recurrence was observed in 42/85 patients (49.4%) and was due in 28/42 patients to disease progression rather than in-stent restenosis, whereas clinical peripheral recurrence occurred in 17 patients (7.7%): all underwent successful re-PTCA and re-PTA.

At a mean follow-up of 3.1 ± 1.8 years (range 1 to 5 years), the survival rate was 88% (19 with previous and 6 patients with no previous coronary interventions died, all for cardiac causes: none with peripheral symptoms recurrence or need for amputation) and freedom from minor (35 patients had minor functional amputation) and major (Five patients had a major amputation) amputation were 84.1% and 97.7%, respectively.

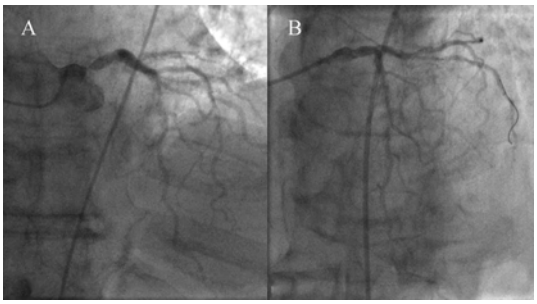

Figure 1. Seventy-eight-year-old patient with ulcer of the foot and concomitant positive stress-echocardiogram: (A) the coronary angiography revealed severe disease of the left main, treated with coronary angioplasty and drug eluting stents (B).

Table 2. Coronary artery disease diagnosis and interventions.

	n (%)
CAD monovessel	29/220 (13.2)
CAD Bi-vessel	21/220 (9.5)
CAD Three-vessel	24/220 (10.9)
LM disease	10/220 (4.5)
PCI monovessel	29/220 (13.2)
PCI Bi-vessel	19/220 (8.6)
PCI Three-vessel	17/220 (7.2)
PCI LM	7/220 (3.1)
CABG Three-vessel	13/220 (5.9)

CABG: coronary artery bypass graft; CAD: coronary artery disease; LM: left main; PCI: percutaneous coronary intervention.

Table 3. Peripheral interventions procedural results.

	n (%)
Iliac occlusive disease	42/220 (19.1)
Femoral occlusive disease	93/220 (42.3)
Popliteal occlusive disease	37/220 (16.8)
BTK monovessel disease	24/220 (10.9)
BTK bi-vessel disease	92/220 (41.8)
BTK triple-vessel disease	114/220 (51.8)
Iliac stent implantation	42/220 (19.1)
Femoral stent implantation	45 /220 (20.4)
BTK stent implantation	7/220 (3.1)
Rotablator use	5/220 (2.3)

BTK: below-the-knee.

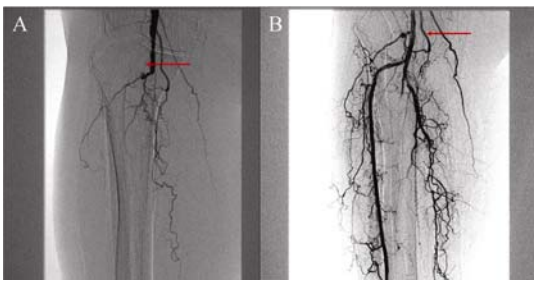

Figure 2. The same patient underwent inferior limb angiography and PTA of his complex below-the-knee (A) with good angiographic result (B) improvement in TcPO2, and ulcer complete healing.

4 Discussion

Our study showed that combined treatment of diabetic foot syndrome and coronary artery disease reduced number of complications, led to a high limb salvage and improved long-term overall survival rate, as compared to historical series. However, coronary symptoms recurrence in such patients remained very high mainly due to disease progression and severe profile of CAD.

PAD in diabetic patients is characterised by below the knee (BTK) arteries involvement and widespread medial calcification, with aortoiliac, femoral and popliteal district frequently spared. Superficial femoral artery stenosis or occlusion must be treated in order to gain access to target infragenicular lesions,[6] but in diabetic patients the risk of femoral stent thrombosis or occlusion depends on the number of patent run-off crural vessels. Trying to recanalize

more than one run-off vessels after femoral stenting is crucial to raise middle and long term patency.[7–10] Heavily calcified distal flow vessels make the distal surgical anastomosis extremely challenging and open surgical procedures, as in the case of femoro-distal bypass, are major and lengthy operations requiring general or regional anaesthesia. The BASIL trial,[11] randomizing 452 patients with "severe limb ischemia" to surgical or endovascular therapy, showed similar results between the two groups in terms of symptom relief and limb salvage, with angioplasty incurring less expense and procedural morbidity. So when an endovascular option is available, it will usually be preferred on ground of safety, procedural related morbidity and cost.

Unfortunately, even after the peripheral revascularization, such patients often die of cardiac causes, mainly from ischemic cardiomyopathy.[12 -13] Thus, a comprehensive management including coronary artery disease treatment may have the potential to reduce cardiac complications and to improve survival.

Our data suggested that the results of combined treatment of diabetic foot syndrome and coronary artery disease were satisfactory as compared to historical series: most recent series reported limb salvage rate of 89%–94.6%, complications rate of 10% at mid-term follow-up. [14-19]

In conclusion, the results from our single institution registry by a combined team of cardiologists and diabetologists, suggests that staged coronary and peripheral revascularization in patients with diabetic foot syndrome allow for a high procedural success rates and a high limb salvage rates and acceptable overall survival on the long-term follow-up, and may reduce the number of cardiac death for coronary artery disease. Further studies are needed in order to assess reliability and effectiveness of this strategy in larger populations.

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