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Original Research Article

Evaluation of Infrapopliteal Revascularization for Ischemic Diabetic Foot in Hemodialysis Patients

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Abstract

Objective: To evaluate the outcomes of infrapopliteal revascularization for diabetic hemodialysis patients with ischemic diabetic foot. ***Methods:*** From 2017 to 2021, 250 patients with diabetic foot identified as stage C (ischemia) or D (ischemia and infection) of Texas Wound Classification underwent successful infrapopliteal surgical and endovascular revascularization at the vascular surgery department of Moulay Ismail Military Hospital in Meknes. The outcomes were retrospectively compared in hemodialyzed patients (HD group: 48 patients), and not hemodialyzed patients (not HD group: 202 patients) during the same period. ***Results:*** Outcomes were expressed as healing, major amputation, revascularization patency and mortality rate. Hemodialysis was a negative predictor of healing and a positive predictor of major amputation. Outcomes for HD and not HD groups were respectively: healing (62.5 vs 82 %), major amputation (37.5 vs 18 %). There was no significant difference in revascularization primary patency between the two groups (70 vs 73.6%). The mortality rate was higher in the HD group than in the not HD group (21 vs 10%). ***Conclusions:*** Our study shows that ischemic diabetic foot associated with hemodialysis have a bad prognosis with a higher risk of major amputation and death. Infrapopliteal revascularization with infection control should be performed to enhance the rate of limb salvage in this risk group.

Keywords: Diabetic foot, Ischemia, Hemodialysis, Infrapopliteal arterial lesions, Distal bypass, Endovascular treatment.

INTRODUCTION

Diabetes mellitus represents a major health challenge and its incidence is still rising. The diabetic foot belongs to the most frequent complications of diabetes. The pathogenesis of the diabetic foot is complex. Three major factors: neuropathy, ischemia, and infection interact resulting in the diabetic foot [1]. Ischemia results from peripheral arterial occlusion disease. In diabetes, atherosclerosis is frequent and more severe in the form of diffuse multivessel involvement with a predilection for infrapopliteal arteries [2]. Revascularization may be accomplished urgently by means of bypass surgery or angioplasty [3]. Diabetic nephropathy is a major chronic complication of diabetes. It is among the leading causes of end-stage renal disease requiring dialysis [4].

The aim of this study is to evaluate the outcomes of diabetic patients with ischemic diabetic foot who underwent infrapopliteal revascularization comparing subjects under hemodialysis treatment and not.

PATIENTS AND METHODS

We performed a retrospective study between January 2017 and December 2021 of the patients who underwent infrapopliteal revascularization for ischemic diabetic foot identified as stage C (ischemia) or D (ischemia plus infection) of Texas Wound Classification [5]. This work was carried out at the vascular surgery department of Moulay Ismail Military Hospital in Meknes. The study group included 250 diabetic patients. The patients were divided into two groups: 48 hemodialyzed (HD group) (19,2%) and 202 not hemodialyzed (not HD group) (80.8%).

All patients included in this analysis were managed according to a defined protocol that includes: infrapopliteal revascularization, surgical debridement, and antibiotic therapy. Patients' general health was optimized with the control of comorbidities, glycemic levels and electrolyte balance. According to American

Diabetes Association patients were considered to have target levels of glycemia, blood pressure (BP) and low-density lipoproteins (LDL) in presence of respectively HbA1c < 7.0%, BP < 130/80 mmHg and LDL < 70 mg/dl [6].

An electrocardiogram was routinely performed and in case of abnormalities an echocardiogram was performed. In case of significant coronary heart disease, cardiac revascularization was performed before the lower limb revascularization.

All the patients underwent noninvasive vascular assessment of lower limbs arteries by CT angiography to detect arterial stenosis and/or obstruction allowing to define the treatment road map by open surgery or endovascular approach. Sometimes, in case of very distal arterial lesions, selective arteriography was done under local anesthesia through a contralateral retrograde or ipsilateral antegrade common femoral artery approach. Lesion characteristics were determined as defined by the modified TransAtlantic Inter-Society Consensus (TASC) classification [7].

Endovascular procedures were performed during the initial diagnostic arteriography under a weight-based dose of heparin by balloon angioplasty without stenting of the tibioperoneal vessels for TASC A and B lesions. The procedure was considered angiographically successful when all technically accessible lesions to the guidewire crossing and ballooning were treated with a <30% residual stenosis All patients were given a 300-mg loading dose of clopidogrel after the procedure and were maintained on 75 mg daily for 12 weeks.

Distal bypass surgery using appropriate autologous vein grafts was primarily adopted for TASC C and D lesions. Reversed saphenous veins were most frequently used as autologous vein grafts and were used in situ in selected cases. Arm veins were used when saphenous veins were not available.

After revascularization, patients underwent debridement or minor amputation back to healthy tissue and bone. In case of extended infection early debridement was performed, even before revascularization, to limit the progression of infection and completed after adequate perfusion was ensured. Intravenous broad-spectrum antibiotic therapy was administered and then adapted to culture results during the follow-up. Home nursing was used liberally to assist with wound.

A noninvasive hemodynamic assessment was routinely performed 01 month after the procedure by doppler ultrasound imaging which included ankle-brachial indices (ABI). Studies were repeated at 6-month intervals or when the patient's clinical condition dictated.

The followed outcomes were recorded: healing, major amputations, revascularization patency and mortality rate. The outcomes were considered separately for patients on hemodialysis and not. Wound healing was defined as the achievement of complete epithelialization of all wounds without major amputation. Major amputation was defined as above-the-ankle amputation. Patency was considered to be lost in patients who experienced a return of symptoms that was secondary to tibioperoneal lesions regardless of whether the recurrent lesion was a restenosis, occlusion, or a new lesion in the same infrapopliteal anatomic segment.

RESULTS

Characteristics of patients

The baseline characteristics of the patients are shown in Table I. There were no significant differences, except for coronary artery disease between the two groups. HD had more ischemic heart disease.

Table I: Baseline characteristics of the patients

Parameters	HD group	Not HD group
No. of patients (%)	48 (19,2%)	202 (80.8%)
Age (years)	65.8 ± 9.5	68.6 ± 9.7
Sex (% male)	61.2%	63.5%
Body mass index, kg/m2	20.5 ± 3.2	21.8 ± 3.6
Target HbA1c (%)	52.2%	58.1%
Target blood pressure (%)	48.7%	36.7%
Target LDL Cholesterol (%)	62.3%	53.5%
Ischemic heart disease (%)	59.6%	38.5%
Current smokers (%)	23%	25.6%

Revascularization procedures

The infrapopliteal revascularization features are shown in Table II. There were no significant differences between the two groups with regard to lesion distribution and type of intervention. Procedural complications were present in 25 patients, but there were no significant differences among the two groups. Three patients died after surgery because of severe low ejection fraction and not because of the procedure.

Table II: Anatomic and revascularization features

Variable	HD group No. (%), N= 48	Not HD group No. (%), N= 201
Infrapopliteal lesion distribution according to the modified TASC classification [7]		
TASC A	15 (31.25 %)	69 (34.3%)
TASC B	19 (39.6 %)	74 (36.8%)
TASC C	9 (18.75 %)	41 (20.4%)
TASC D	5 (10.41%)	17 (8.5%)
Revascularization approach		
Percutaneous balloon angioplasty	39 (81.25%)	153 (76.2 %)
Distal bypass surgery	9 (18.75%)	48 (23.9%)
Procedural complications		
Death	1 (2%)	2 (1%)
Hemorrhage/hematoma	2 (4%)	11 (5.4%)
Distal embolization	1 (2%)	5 (2.4%)
Acute thrombosis	1 (2%)	2 (1%)

Outcomes: healing, major amputation, revascularization patency and mortality rate

The outcomes are shown in Table III. Hemodialysis was a negative predictor of healing and a positive predictor of major amputation. There was no significant difference in revascularization primary patency between the two groups. The mortality rate was higher in the HD group than in the not HD group. Associated cardiovascular disease and systemic infection were the most frequent causes of death in the HD group.

Table III: Outcomes: Healing, major amputation, revascularization patency and mortality rate

Outcome	HD group No. (%) N= 48	Not HD group No. (%) N= 201
1-year complete foot healing	30 (62.5%)	164 (82%)
Major amputation	18 (37.5%)	36 (18%)
1-year revascularization primary patency	34 (70%)	148 (73.6%)
1-year mortality	10 (21%)	20 (10%)

DISCUSSION

The association between diabetes and hemodialysis has a severe impact on lower limbs arterial disease, characterized by a rapid progression and increased inflammatory and prothrombotic state. The peculiarities of the arterial disease in these patients are the marked involvement of the infra-popliteal arteries, a widespread vascular calcification and an impairment of microcirculation [8].

Management of the ischemic diabetic foot in end-stage renal failure follows the same principles as general management of the diabetic foot. It is of foremost importance to diagnose ischemia early and to attempt improving blood flow to the limb. Infra-popliteal revascularization may be accomplished either by means of distal bypass surgery or percutaneous balloon angioplasty, and should precede local surgery such as debridement or limited amputation, so as to ensure wound healing and infection control [9].

Previous studies have shown that the limb and life prognoses of patients with ischemic diabetic foot were worse in HD patients than in not HD patients [10]. The presence of both diabetes and hemodialysis confers a dismal prognosis to diabetic foot lesions with a rate of amputations 6.5–10 times higher in comparison to the general diabetic population [11]. Improved limb salvage and patient survival rates, as well as reduced time to heal, have been accomplished by appropriate revascularization in HD patients. However, infrapopliteal revascularization presents a considerable challenge in these patients related to the complexity of arterial lesions [12].

Our study confirms that patients on HD patients have reduced chances of healing and higher risk of major amputation and death if compared to not HD patients. Some characteristic of HD patients might justify the negative outcomes observed. In fact, patients on hemodialysis have a more severe vascular disease, high risk of infection, more frequently a coronary disease, more heel ulcers with poor response of the wound to local treatment, and more steno-obstructions with higher risk of unsuccessful revascularization [13].

Additional treatment options in the diabetic renal foot include mainly Vacuum assisted closure (VAC) is an established technique promoting healing via a pump creating negative pressure within the wound. It has successfully been applied to ischemic diabetic foot ulcers after successful revascularization,

accomplishing faster wound closure. Experience in diabetic patients on hemodialysis is limited but encouraging [14].

Prevention of the diabetic foot is paramount. Adequate patient education, as well as regular foot examination to correct pre-ulcerous conditions, are of great value and should be continuously pursued. This initiative deserves to be applied to the particularly vulnerable population of HD patients [15].

CONCLUSION

The treatment of hemodialyzed patients is a current challenge in the field of ischemic diabetic foot. As previously reported, our study shows that HD is a major risk factor for limb loss as well as death. However, infrapopliteal revascularization, including distal bypass surgery and percutaneous balloon angioplasty, with aggressive control of infection can improve the limb prognosis in this risk group. Equally important is the collaboration between health care providers in a multidisciplinary foot care setting. Moreover, patient education on the measures required to achieve both primary and secondary prevention is of great value.

Disclosure of interest: The authors declare that they have no competing interest.

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