Cardiovascular Revascularization Medicine xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Cardiovascular Revascularization Medicine

Critical hand ischemia treatment via orbital atherectomy—A single center observational retrospective analysis

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ARTICLE INFO

Article history:
Received 29 August 2016
Received in revised form 11 October 2016
Accepted 25 October 2016
Available online xxxx

Keywords:
Critical hand ischemia
Calcification
Orbital atherectomy

ABSTRACT

Background/Purpose: Critical hand ischemia (CHI) can be devastating and may result in amputation. Distal vessel calcification has been shown to be a major factor in causing CHI. Atherectomy in the upper extremities is not typically considered due to the small anatomy; however, the Diamondback 360° Peripheral Orbital Atherectomy System (OAS) (Cardiovascular Systems, Inc.) can access treatment areas with a reference vessel diameter of 1.5 mm.

Methods/Materials: A retrospective, observational, single center (Merit Health Center, Jackson, MS) analysis of 11 CHI patients with calcific disease of the radial artery treated with orbital atherectomy (OAS) was completed. Demographics and procedural to 30-day outcomes were assessed.

Results: All patients had good blood flow to the hand after intervention and none experienced complications during or immediately post-procedure. At 30-days the freedom from revascularization and amputation was 100%, and all the wounds were healed. The following important principles were followed during the use of OAS for CHI: (1) ACT was therapeutic (~250 s); (2) Gentle wire manipulation; (3) Utilization of a small OAS crown (1.25 mm); (4) Aggressive vasodilator use—given through the exchange catheter; (5) Angioplasty balloon was matched to the size of the vessel and long and low pressure inflations were completed.

Conclusions: Critical hand ischemia can be treated with endovascular techniques. Obtaining good outflow to the fingers is critical for wound healing and preventing amputation. Orbital atherectomy is a useful tool in preparing vessels for balloon angioplasty; particularly in cases where calcification is present.

1. Introduction

Critical hand ischemia (CHI) is less common than critical limb ischemia, however it can be devastating and may result in amputation [1,2]. Patients with CHI usually present with pain, discoloration, necrotic tissue, and/or gangrene of fingers [3,4]. It can be caused by obstruction of the above- or below-the-elbow arteries. Below-the-elbow (BTE) artery disease is more prevalent in diabetic patients or in patients with end-stage renal disease (ESRD) on hemodialysis [1,5]. Both diabetes and ESRD, as well as older age, are the main risk factors for peripheral artery calcification [6] and it has been shown that distal vessel calcification is a major factor in causing CHI [7,8]. It is well known that calcified lesions are technically challenging, they respond poorly to angioplasty, they are difficult to completely dilate, and prone to dissection during balloon angioplasty [9–11]. Lesion preparation before balloon angioplasty with atherectomy is essential in complex calcified lesions [10,12], however, atherectomy in BTE arteries is not typically considered due to the small anatomy. The Diamondback 360° Peripheral Orbital Atherectomy System (OAS) (Cardiovascular Systems, Inc.) is one of the atherectomy devices that can access treatment areas with a reference vessel diameter of 1.5 mm. In this report, we describe the outcomes of eleven (11) successful cases of radial artery revascularization via orbital atherectomy, with a detailed description of one case.

2. Material and methods

A retrospective, observational, single center (Merit Health Center, Jackson, MS) analysis of 11 critical hand ischemia (CHI) patients with calcific disease of the radial artery treated with orbital atherectomy (OAS) was completed. Demographics and procedural to 30-day outcomes were assessed.

3. Results

The average age was 53 years and the majority of the patients were African-American and male. Eighty-two percent of the patients suffered from end-stage renal disease (ESRD) and 91% of them had a finger wound. Table 1 summarizes the demographic characteristics of the

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http://dx.doi.org/10.1016/j.carrev.2016.10.009

Please cite this article as: Bahro A, et al, Critical hand ischemia treatment via orbital atherectomy—A single center observational retrospective analysis, Cardiovasc Revasc Med (2016), http://dx.doi.org/10.1016/j.carrev.2016.10.009

Table 1
Demographics.

Average age	53 years (n = 11)
Male	91% (10/11)
African-American	73% (8/11)
Diabetes	82% (9/11)
Hypertension	100% (11/11)
Peripheral vascular disease	100% (11/11)
End-stage renal disease	82% (9/11)
Finger wound or necrotic tissue	91% (10/11)
Duration of symptoms (onset to intervention)	6–12 weeks

patients in this study. The radial artery was treated in all patients with orbital atherectomy using a 1.25 mm crown (micro or solid). The average balloon inflation pressure was 5.7 atm, and the angiographic success was 100%. The following important principles were followed during the use of OAS for CHI: (1) ACT was therapeutic (~250 s); (2) Gentle wire manipulation; (3) Utilization of a small OAS crown (1.25 mm); (4) Aggressive vasodilator use—given through the exchange catheter; (5) Angioplasty balloon was matched to the size of the vessel and long and low pressure inflations were completed.

At 30-days the freedom from revascularization and amputation was 100%, and all the wounds were healed (Table 2).

3.1. Case example details

The patient was a 43-year-old African-American female with past medical history of hypertension, diabetes, hyperlipidemia, ESRD - on dialysis, and rheumatoid arthritis. She was referred with resting ischemia in the left hand. Angiogram revealed calcified disease in the distal left radial artery. The severity of the disease was later confirmed with IVUS.

The right groin was prepped and draped in the usual fashion. Lidocaine 1% was used for local anesthesia. A 5 Fr sheath was used to cannulate the right femoral artery. A 5 Fr Bernstein catheter and an Advantage wire were used to cross into the proximal left brachial artery. Over this wire, a 6 Fr long destination sheath was advanced. Heparin was given intravenously. A ChoICE PT guidewire and a Seeker catheter were used to cross the lesion in the distal left radial artery. Verapamil was injected through the catheter. Then over the wire, IVUS was performed, revealing that the lesion in the distal radial artery is calcified and severely diseased. Then, orbital atherectomy was performed using a 1.25 mm Micro Crown, followed by balloon angioplasty using a 2.0 × 150 mm balloon, which was inflated up to 4 atm for 2 min. Final angiogram revealed excellent results. At the conclusion of the procedure, the sheath was left in place to be taken out when ACT is below 180. The procedure was performed without complications (Fig. 1).

4. Discussion

Upper limb ischemia accounts for less than 5% of patients with limb ischemia [13]. However, delays in diagnosis and treatment can lead to severe functional impairment and even amputation [14]. Revascularization of below-the-elbow (BTE) occlusions is rarely described in literature, and most of them are case reports or single center experiences with small number of patients [1–3,15–22]. Ferraresi and colleagues were the first to report a balloon angioplasty case of a patient with heavily calcified ulnar and radial arteries [15]. They obtained good final angiographic result with immediate pain relief and the patient was asymptomatic at 8 months. Moreover, this group was the first that evaluated the feasibility, safety and outcomes of balloon angioplasty in the treatment of critical hand ischemia due to occlusive BTE artery disease in 28 patients (34 affected hands) [1]. They concluded that the angioplasty of BTE arteries is feasible and safe, with a technical success rate of 82%. In the remaining 18% the angioplasty was unsuccessful due to the inability to cross severely calcified lesions.

Even after successful crossing, calcification increases the likelihood of procedural failure and complications after balloon angioplasty [23]. Atherectomy prior to balloon angioplasty may improve outcomes in calcified lesions, however, only a couple of case reports are available regarding the use of atherectomy in the treatment of calcified lesions located in the upper limb [4,24]. Directional atherectomy was used in both cases and only above-the-elbow arteries (brachial [24] and axillary [4]) were treated.

Ours is the first below-the-elbow atherectomy study of 11 patients with critical hand ischemia due to calcified radial artery disease. All patients treated with orbital atherectomy had good blood flow to the hand after intervention and none experienced complications during or immediately post-procedure.

Table 2
Outcomes, wound status.

Radial lesion treated	100% (11/11)
Average balloon inflation pressure	5.7 atm (n = 6)
Angiographic success	100% (11/11)
Freedom from revascularization at 30 days	100% (11/11)
Freedom from major amputation* at 30 days	100% (11/11)
Wound healed	100% (11/11)

* Major amputation = amputation of two fingers or more. Three patients had a pre-planned minor amputation of necrotic tissue post index.

5. Conclusions

Critical hand ischemia can be treated with endovascular techniques. Obtaining good outflow to the fingers is critical for wound healing and preventing amputation. Orbital atherectomy is a useful tool in preparing vessels for balloon angioplasty; particularly in cases where calcification is present. Larger studies, as well as randomized trials, are needed to determine the ideal revascularization strategy for critical hand ischemia patients with calcific disease.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Please cite this article as: Bahro A, et al, Critical hand ischemia treatment via orbital atherectomy—A single center observational retrospective analysis, Cardiovasc Revasc Med (2016), http://dx.doi.org/10.1016/j.carrev.2016.10.009