

Drug-coated balloons used in peripheral artery disease: experience from a single center

Journal of International Medical Research

48(8) 1–6

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DOI: 10.1177/0300060520940157

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Abstract

Objective: This retrospective single-center study aimed to analyze immediate and follow-up results of using drug-coated balloons (DCBs) for treating peripheral arterial disease.

Methods: In this study, we identified a total of 75 patients who underwent DCB therapy at our institution. The ankle–brachial index (ABI) was measured before and after intervention. Intermittent claudication and whether there was healing of ulcers were determined by telephone.

Results: The cohort consisted of 56 men and 19 women aged 38 to 87 years (68 ± 12 years). Twenty-three patients had Rutherford grade III, 15 had Rutherford grade IV, and 37 had Rutherford grade V. Seventeen patients had stents and 18 had the Rotarex system used. The postoperative ABI was significantly greater than the preoperative ABI (0.911 ± 0.173 vs 0.686 ± 0.249). Good results for treatment were obtained. Intermittent claudication and rest pain did not occur in subjects with Rutherford grades III and IV during follow-up. The amputation rate was 4.1% among all patients using DCB therapy during follow-up.

Conclusions: DCB therapy is safe and effective for treating peripheral arterial disease in real-world patients. Future prospective studies on this issue are recommended.

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Keywords

Drug-coated balloon, Rotarex system, peripheral arterial disease, ankle-brachial index, Rutherford grade, amputation

Date received: 26 February 2020; accepted: 15 June 2020

Introduction

The prevalence of peripheral arterial disease (PAD) is increasing.¹ There are some methods for treatment of PAD, such as medical treatment, endovascular therapy, and bypass surgical therapy. Additionally, endovascular interventions improve quality of life for those with claudication and reduce amputation rates among those with critical limb ischemia.² Traditional endovascular interventions include standard percutaneous transluminal angioplasty (PTA), stent implantation, and new devices, such as the Rotarex thrombectomy system³ and drug-coated balloons (DCBs),⁴ which have improved patency for moderate-length lesions. These new devices reduce the rate of using stents, and thus reduce the rate of restenosis of the artery. Roh et al. found that treatment with a DCB showed excellent primary patency and target lesion revascularization-free survival at 1 year of follow-up.⁵ Additionally, the Global SFA Registry 24-month outcomes confirmed that DCBs were a safe and effective long-term treatment option in patients with PAD with superficial femoral artery lesions.⁶

Previous studies have shown the effectiveness and safety of DCB use.^{6,7} However, this technology is not used as much in China as in other countries. Our vascular center has used this technology since 2016 and showed great effects. This study aimed to describe DCB use in therapy of PAD. There is a large number of patients with peripheral vascular disease in China. Therefore, the present study might provide some advice for treating PAD using DCBs in China.

Patients and methods

Patients

In this retrospective study, patients with occlusion of the peripheral arteries were consecutively selected for treatment from September 2016 to June 2019. A total of 500 patients were admitted to the Department of Vascular Medicine for PAD. Patients who were treated with a DCB during interventional therapy were enrolled in the present study. This study was exempt from the requirement for ethics committee approval because patients received standard treatment and the study constituted a retrospective review of their records.

Computed tomography angiography (CTA) of the peripheral artery was performed. According to the disease history, symptoms, and findings on CTA, vascular lesion characteristics, such as plaque or thrombus, were ascertained. These characteristics were confirmed during the intervention using a catheter. All of the patients were fully informed about the procedure and possible complications, and written informed consent for interventional therapy was obtained.

Procedural details and DCB angioplasty

A preliminary judgment of the composition of thrombus was obtained according to the progress of the disease and CTA findings, such as a low density shadow. Catheter activity was used to confirm thrombus during the operation. Additionally, a thrombectomy device, such as the Rotarex system (Straub Medical, Wangs,

Switzerland),⁸ was used in patients with thrombus lesions. A DCB was used when residual stenosis was less than 30% after thrombectomy therapy or stents were used. During intervention of DCB (Orchid; Acotec Scientific, Beijing, China) angioplasty, vessel preparation with general balloon dilation was performed before DCB angioplasty. After balloon catheter dilatation, DCB therapy was then applied from healthy to healthy vessel, and the inflation time was 180 s.

Follow-up study

Aspirin and warfarin were used for 1 year in patients who were treated with thrombectomy therapy. Aspirin and clopidogrel bisulfate were used in the following year, and then aspirin was used for the remaining time. Aspirin and clopidogrel bisulfate were used for 1 year in patients who were not treated with thrombectomy therapy, and then aspirin was used for the remaining time. The ankle-brachial index was measured before and after intervention before discharge. The median follow-up time was 12 months (minimum to maximum: 2–33 months). Not all patients visited our hospital after 12 months. Therefore, intermittent claudication, ulcer healing, and the survival rate were determined by telephone.

Statistical analysis

Categorical variables are expressed as number and percentage. Continuous data are presented as a range of values with the median or as mean \pm standard deviation. No hypothesis testing was required. SPSS 13.0 (SPSS Inc. Chicago, IL, USA) was used for analysis.

Results

Seventy-five patients (56 men and 19 women) aged 38 to 87 years (68 ± 12 years) were treated by drug-coated balloon

angioplasty. Two patients (both 38 years old) were diagnosed with thromboangiitis obliterans with limb ulcers, four were diagnosed with thromboembolism caused by atrial fibrillation, and 12 were diagnosed with atherosclerotic occlusion complicated by thrombus. Therefore, these 18 patients were treated with the Rotarex system. The remaining 57 patients were diagnosed with atherosclerotic occlusion. The technical success rate of DCB therapy immediately during the operation was 100% in these 75 patients. Vessel dissection was found in four patients, and all were A type vessel dissection without a requirement for treatment. There was no in-hospital mortality or complications during hospitalization.

Table 1 shows the basic characteristics of these patients. The 75 patients used DCB therapy. Twenty-three patients had Rutherford grade III, 15 had Rutherford grade IV, and 37 had Rutherford grade V. Therefore, most of these patients were suffering from defects or ulcers of tissue in the lower extremities. Seventeen patients had stents and 18 had the Rotarex system used. Additionally, 5 patients had stents and 15 had the Rotarex system used in those with Rutherford grades III and IV. Twelve patients had stents and three had the Rotarex system used in those with Rutherford grade V.

Table 2 shows the location where DCB therapy was used. Most DCBs were used in femoropopliteal artery occlusion. The post-operative ABI was significantly greater than the preoperative ABI ($p = 0.003$).

All patients were alive during follow-up. We found that intermittent claudication and rest pain did not occur in patients with Rutherford grades III and IV during follow-up. Patients with Rutherford grade III improved to Rutherford grade 0 and those with Rutherford grade IV at baseline improved to Rutherford grade 0 or 1 by follow-up. None of the patients underwent further arterial intervention, and target

Table 1. Clinical characteristics of all patients.

Characteristics	
Age (years)	68 ± 12
Male/female	56/19
Hypertension, n (%)	51 (68.9)
Diabetes mellitus, n (%)	51 (68.9)
Coronary artery disease, n (%)	33 (44.6)
Atrial fibrillation, n (%)	8 (10.8)
Smoking, n (%)	48 (64.9)
Creatinine (μmol/L)	83.98 ± 29.92
FPG (mmol/L)	7.05 ± 3.66
UA (μmol/L)	310.80 ± 102.65
TC (mmol/L)	4.06 ± 1.26
HDL-C (mmol/L)	0.98 ± 0.29
LDL-C (mmol/L)	2.35 ± 0.87
TG (mmol/L)	1.46 ± 1.12
Hs-CRP (mg/L)	18.02 ± 25.58
SBP (mmHg)	135.6 ± 14.7
DBP (mmHg)	75.5 ± 10.0
Preoperative ABI	0.686 ± 0.249
Postoperative ABI	0.911 ± 0.173
Diameter of the drug-coated balloon (mm)	4.3 ± 0.7
Length of the drug-coated balloon (mm)	161.6 ± 61.3
Stent implantation, n (%)	17 (22.9)
Rotarex system, n (%)	18 (24.3)
Rutherford grade III, n (%)	23 (29.7)
Rutherford grade IV, n (%)	15 (20.3)
Rutherford grade V, n (%)	37 (50)
Median follow-up time (months)	12 (2–33)

Values are mean ± standard deviation, median (range), or n (%). FPG: fasting plasma glucose; UA: uric acid; TC: cholesterol; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; TG: triglycerides; SBP: systolic blood pressure; DBP: diastolic blood pressure; ABI: ankle-brachial index.

lesion revascularization was 0 during follow-up. Healing of ulcers was found in 34 Rutherford grade V patients. However, three patients suffered from toe amputation. The amputation rate was 4.1% among all patients who used DCB therapy.

Discussion

In recent years, there has been considerable innovation in endovascular therapies for

Table 2. Location of occlusion.

Location	Number
Femoropopliteal artery	63
Deep femoral artery	1
Infrapopliteal artery	12

PAD, including bare-metal stents, covered stents, atherectomy, drug-eluting stents, and DCBs.⁷ The IN.PACT SFA trial was the largest clinical trial on DCBs to evaluate the safety and effectiveness of DCB compared with standard PTA for treatment of patients with symptomatic femoropopliteal artery disease.⁹ The 2-year results of this trial showed that freedom from clinically driven target lesion revascularization at 24 months was 83.3% and the major target limb amputation rate was 0.7%. Furthermore, this clinical trial showed that DCBs continued to perform better than PTA over 5 years, with higher freedom from clinically driven target lesion revascularization.¹⁰ Additionally, post-hoc analysis showed that treatment of femoropopliteal disease with a DCB in patients with chronic limb ischemia was safe throughout a 12-month follow-up, with a low major amputation rate of 1.4%.¹¹ The IN.PACT SFA trial also showed that DCBs were safe and highly effective at 12 months after treatment of patients with chronic total occlusion ≥5 cm in the femoropopliteal arteries.¹² The present study showed that the toe amputation rate was 4.1% among all patients using DCB therapy, and this might have been due to the large amount of patients with Rutherford grade V.

A recent meta-analysis showed that DCB angioplasty was an effective treatment associated with high procedural success.¹³ A recent study showed that the combination of Rotarex thrombectomy and a DCB for treatment of femoropopliteal artery in-stent restenosis was safe and effective.¹⁴ Furthermore, there was a

satisfactory primary patency rate and freedom from clinically driven target lesion revascularization rate at the 12-month follow-up. In the present study, 18 patients used the Rotarex system in combination with a DCB, with mainly Rutherford grades III and IV. Our previous study also showed the effectiveness and safety of the Rotarex system.¹⁵

A study on 200 Chinese patients with severe femoropopliteal lesions showed that DCBs were superior to PTA at a 24-month follow-up and the safety of DCBs was equivalent to that of PTA.¹⁶ Another study involving the popliteal artery showed that the primary patency was 77.4% at a median of 12.2 months.¹⁷ A clinical trial showed that patients who were treated with DCBs showed superior 12-month primary patency (89%) compared with patients treated with PTA (48%, $p < 0.001$).¹⁸ Therefore, this trial showed a superior treatment effect for DCBs vs PTA, with excellent patency and low clinically driven target lesion revascularization rates. However, the current study did not record the patency rate at the 12-month follow-up. These studies and our findings suggest that the DCB system is effective in therapy of PAD.

There are some limitations in the present study. First, as a retrospective analysis, the current study contains certain known limitations. Second, not all patients visited the hospital again at the 12-month follow-up because most patients lived in other cities. Therefore, we did not obtain the value of the ABI, ultrasound results, or The European Quality of Life-5 Dimensions Questionnaire results at the 12-month follow-up. As mentioned above, we did not record the patency rate at the 12-month follow-up. We were only able to obtain claudication, rest pain, and ulcer results by telephone. Third, we did not have patients who were treated only with ordinary balloon dilatation for the reason

of re-stenosis. Therefore, we did not have a control group treated with only ordinary balloon dilatation. Consequently, prospective studies on this issue are recommended in the future.

In conclusion, DCB therapy is safe and effective for treating PAD in real-world patients.

Contributorship statement

Jinbo Liu and Hongyu Wang conceived the idea of the study and were responsible for the design of the study. Jinbo Liu, Tianrun Li, and Wei Huang were responsible for undertaking data analysis and creating the tables. Na Zhao, Huan Liu, and Hongwei Zhao assisted with data analysis. The initial draft of the manuscript was prepared by Jinbo Liu and Tianrun Li, and all authors critically reviewed the manuscript. Jiufeng Xu and Hongyu Wang were responsible for interpretation of the results. All authors read and approved the final manuscript.


Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This work was supported by grants from the hospital fund of Peking University Shougang Hospital to Hongyu Wang (2017-Hospital-Clinical-01) and the National Key Research and Development Plan (2017YFC0113005).

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