ORIGINAL RESEARCH

Efficacy and Safety of Drug-Coated Balloon in Elderly Patients with Intrastent Restenosis After Lower Extremity Arteriosclerotic Obliterans After Rotarex Thrombus Removal

Shoutian Lv, PhD; Gang Wei, MM; Xueyan Shi, MD; Qiong Xu, BM; Xueli Li, BM

ABSTRACT

Objective • This study aims to compare the efficacy and safety of drug-coated balloon (DCB) and standard angioplasty balloon (SAB) in the treatment of intrastent restenosis (ISR) after lower extremity ASO following rotarex thrombus removal.

Methods • 94 patients with ISR after lower extremity ASO were selected and divided into DCB group (47 cases) and SAB group (47 cases). After patients were treated with DCB and SAB methods, six months after discharge care, the therapeutic effect, lower extremity dorsal arterial blood flow, ankle-brachial index, lameness distance, hemorheology, endothelial function indexes, and lipid levels were measured.

Results • DCB group showed significantly higher effective rate compared to SAB group ($P < .05$). After treatment, post-treatment improvements in dorsalis arterial blood flow, ankle-brachial index intermittent claudicity distance, high-density lipoprotein cholesterol (HDL-C) and nitric oxide (NO) contents were more pronounced in the DCB group than SAB group ($P < .05$).Indexes of hemorheology and the contents of total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), and endothelin-1 (ET-1) levels significantly decreased after treatment, with greater reduction observed in DCB group ($P < .05$). In addition, No significant change in adverse reactions between groups, but DCB group had lower adverse drug reaction rate.

Conclusions • Overall, DCB demonstrated superior efficacy in treating ISR after lower extremity ASO, offering a promising option for improving patient outcomes. (*Altern Ther Health Med.* [E-pub ahead of print.])

Shoutian Lv, PhD, Chief physician; **Gang Wei, MM**, Associate chief physician; **Xueyan Shi, MD**, Associate chief physician; **Qiong Xu, BM**, Attending doctor; **Xueli Li, BM**, Resident doctor; Department of Vascular Surgery, Dongying People's Hospital, Dongying Hospital Affiliated to Shandong Provincial Hospital Group, Dongying, China.

Corresponding author: Xueli Li, BM
E-mail: lixueli_dy@163.com

INTRODUCTION

Arteriosclerotic obliterans (ASO) is commonly used in the lower extremities，from intermittent claudication to pain at rest. and is associated with atherosclerotic lesions of lower limb arteries caused by multiple risk factors, It also occurs as a secondary chronic artery obliterans disease caused by vascular stenosis or obstruction. It often manifests as lower limb cooling, numbness, pain or, intermittent claudication, etc. In severe cases, it can cause distal limb necrosis or even amputation.[1,2] It is difficult to treat, has a poor prognosis, high disability and fatality rates, it brings heavy economic pressure and mental burden to patients. According to epidemiology, there are as many as 200 million ASO patients in the world, and the incidence and prevalence are still on the rise.and has become one of the major diseases threatening human health worldwide. The patency rate of intrastent restenosis (ISR) was only 13.4% at 12 months using a standard angioplasty balloon (SAB), which could not achieve a satisfactory curative effect and seriously affected the patients' long-term prognosis and quality of life.[3] The surface of the drug-coated balloon (DCB) is coated with lipophilic and anti-endothelial cell proliferation drugs for treatment. When the balloon expands, it can be quickly absorbed by the vascular wall and undergo effective biotransformation, inhibiting the proliferation of vascular smooth muscle cells and reducing the ISR caused by the proliferation of newborn intima.[4-6] Many studies[7,8] have confirmed that the treatment of ASO in lower limbs can reduce the incidence of ISR. Rotarex thrombus removal is mainly applied to the removal of arterial thrombus. The head end rotates and rotates intracavity embolism at high speed to remove the embolism and enter the thrombus removal catheter. The catheter guiding wire does not touch the vascular wall to avoid irritation and damage.This study compared the efficacy and safety of DCB and SAB in ISR

after lower extremity ASO after rotarex thrombus removal, providing a reference for the optimization of ISR treatment.

PATIENTS AND METHODS

General Information

A retrospective study was conducted on 94 patients with ISR after lower extremity ASO after thrombus removal admitted to the vascular surgery department of our hospital (approval no. 20210316-052). Inclusion criteria: (1) Patients who had previously received rotarex thrombus removal and developed ISR or complete occlusion were diagnosed by CT angiography (CTA); (2) Primary ISR without surgical intervention; (3) After rotarex thrombectomy, only the distal inflow and outflow channels were in good condition (≥2 distal outflow channels); (4) The patient had good compliance and normal cognitive function; (5) Patients and their families sign informed consent. Exclusion criteria: (1) Allergy or obvious contraindications to drugs and contrast agents involved in this study; (2) History of organ bleeding and stroke within 3 months before enrollment; (3) History of major surgery and severe trauma 1 month before enrollment; (4) Severe limb ischemia leads to severe disability, and limb function is estimated to be unable to recover; (5) Complicated with severe local or systemic infection; (6) Severe organ failure occurred before surgery. Patients were randomly divided into 2 groups: DCB (47 cases) and SAB (47 cases) groups. There were no significant differences in gender, age, complications, and other general conditions between the two groups (Table 1).

Table 1. Comparison of general data between the two groups

Index	DCB (n = 47)	SAB (n = 47)	χ^2	*P* value
Gender			0.184	>.05
Male	31	29		
Female	16	18		
Age			0.172	>.05
>70 years	25	27		
≤70 years	22	20		
Lesion type			0.211	>.05
stricture	44	45		
block	3	2		
hypertension			0.050	>.05
Yes	33	32		
No	14	15		
Smoking			0.174	>.05
Yes	21	19		
No	26	28		

Treatment Methods

Surgical method. (1) The patient was placed in a supine position with routine disinfection and towel placement, and the puncture point was determined according to the preoperative CTA examination. (2) After local anesthesia with Lidocaine (national medicine permission number H20059049, Jichuan Pharmaceutical Group Co., LTD), the contralateral femoral artery puncture was performed by Seldinger technique, and 6-8F suitable type of arterial sheath (Medtronic, Ireland) was inserted. The guide wire was introduced into the lower segment of the abdominal aorta with the assistance of a pigtail catheter, and the lesion was located by angiography. The lesion and obstruction degree were determined, and the radiography confirmed that the guide wire was located in the distal true cavity. The initial dose of heparin was 80 U/kg, and then 1000 U was added 1 hour later. (3) After systemic heparinization was achieved, the guide wire and catheter were inserted into the target vessel, and the normal balloon (Beijing Jingqi Huacheng Plastic Products Co., LTD., Beijing, China) with a small diameter was used for predilation first (8-10 atmospheres for 30~60 s). Angiography showed that the target vessel stenosis or occlusion was improved. (4) The DCB group was then expanded (10-12 atmospheres, 120-180 s) using DCB with the same diameter as the inner diameter of the original stent (surface coating drug paclitaxel, Senreda). (5) The SAB group was expanded with the same internal diameter as the original stent (10-12 atmospheres, 120-180 s). After the completion of dilation, the two groups were re-angiography, such as stenosis rate was still >50%, prolonged dilation time of about 120 s, such as re-angiography stenosis rate is still >50% needed to be implanted in a self-expanding metal bare stent. (6) Angiography observed that the shape of the blood vessels in the target lesion segment recovered well and the blood perfusion was ideal. No shrinkage of blood vessels was observed, and no stenosis of the distal outflow tract or formation of arterial segment thrombosis was observed. After the operation, the catheter was removed, and the local puncture was compressed and bandaged.

Postoperative management: (1) the affected limb was immobilized for 12 h, and low molecular weight heparin sodium was routinely injected subcutaneously (national medicine permission number H32020612, Jiangsu Wanbang Biochemical Pharmaceutical Co., LTD.), 0.6 ml/time, twice/day; (2) Alprostadil injection (national medicine permission number H20103292, Hainan Bikai Pharmaceutical Co., LTD.) was given intravenously, 10 μg/time, twice a day, for 3 days. (3) After discharge, all patients continued to receive "dual antibody" treatment for 6 months, then switched to "monoclonal antibody" treatment, strictly quit smoking, and continue using antihypertensive, hypoglycemic, lipid-regulating drugs to control blood pressure, blood sugar and lipid levels. Monoclonal antibody treatment refers to the use of a single antiplatelet drug. In this study, aspirin (J20130078, Bayer Medical & Healthcare Co., LTD.) was used for treatment, orally, once a day, 100mg/ time, for 20 days. Dual antibiotic therapy refers to dual anti-platelet aggregation therapy, using aspirin enteric-coated tablets (SINopharmal J20130078, Bayer Healthcare Co., LTD.) and clopidogrel (Sinopharmal H20123115, Lep Pharmaceutical Co., LTD.) treatment, aspirin orally, once a day, 100mg/ time, clopidogrel orally, once a day, 50mg/ dose for 6 months.

Observation Indicators

Efficacy evaluation[9]: Cured: The patient's clinical symptoms basically or completely disappeared, the peripheral blood circulation disorder of the limb was significantly improved, and the wound healed completely. Obvious effect: The patient's clinical symptoms were significantly improved, the peripheral blood circulation disorder was significantly improved, and the wound healed basically. Effective: The

patient's clinical symptoms were improved to a certain extent, the peripheral blood circulation disorder was improved, and the wound was reduced. Ineffective: There was no improvement in clinical symptoms, peripheral blood circulation, or wound condition.

Observation of blood flow, ankle-brachial index, and claudication distance of lower extremity: intermittent claudication length was recorded, blood vessel peak, tube diameter, and contralateral brachial artery systolic pressure of both lower extremity, blood flow and ankle-brachial index of malleolus of affected limb were detected. The outcome was correlated with the therapeutic effect.

Observation of the changes of hemorheology and endothelial function indexes: 5 mL of peripheral venous blood was collected from the patients, of which 3 mL of blood was used for the detection of high tangential viscosity and low tangential viscosity of whole blood, and the other 2 mL of blood was used for the detection of plasma viscosity content and hemocyte sedimentation rate after plasma separation. The rotation speed was 3000 r/min, the centrifugation radius was 12 cm, and the centrifugation was performed for 12 min. Vascular endothelial function indexes were observed. 3 mL peripheral venous blood was collected, the rotating speed was 3000 r/min, the centrifugation radius was 12 cm, and centrifugation was performed for 12 min. After serum separation, ET-1 and NO levels were detected within 24 h.

Lipid test: The automatic biochemical analyzer DP-180 was used to detect the lipid indexes of total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C).

Statistical analysis of postoperative adverse reactions, including subcutaneous hematoma, toe necrosis, and lower limb ulceration.

Statistical analysis

Statistic Package for Social Science (SPSS) 22.0 statistical software (SPSS Inc., Chicago, IL,USA) was used to analyze the experimental data, and the measurement data was expressed as mean ± standard deviation. The *t* test of two independent samples was used to compare the conditions between groups, and the *t* test of paired samples was used to compare the conditions between groups before and after treatment. When the data did not meet the normal distribution, the rank sum test was applied. Chi-square test was used to compare count data, $P < .05$ represents a significant difference.

RESULTS

Measurement of effective rate

The DCB group showed a significantly higher treatment effective rate (93.62%) compared to the SAB group (74.47%) ($P < .05$) (Table 2).

Measurement of dorsal foot arterial blood flow, ankle-brachial index and intermittent claudication distance

Dorsal foot arterial blood flow, ankle-brachial index, and intermittent claudication distance showed statistically significant differences between the DCB and SAB groups ($P < .05$) (Table 3).

Table 2. Measurement of effective rate (n, %)

Group	n	Cured	Obvious effect	Effective	Ineffective	Total effective rate (%)
DCB group	47	11	21	12	3	44(93.62)
SAB group	47	6	14	15	12	35(74.47)
χ^2						8.604
P value						.035

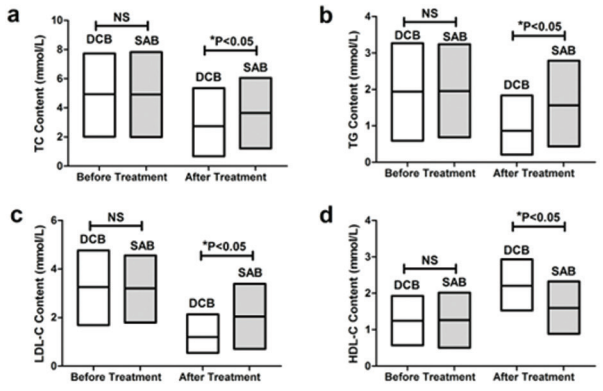
Table 3. Measurement of dorsal foot arterial blood flow, ankle brachial index and intermittent claudication distance between the two groups ($\bar{x} \pm s$)

Index		DCB	SAB	χ^2	*P* value
Dorsalis pedis blood flow (mL /min)	Before treatment	21.96±2.78	22.07±2.86	1.471	>.05
	After treatment	36.12±4.53	30.41±3.29	7.832	<.05
Ankle-humeral index (mPa·s)	Before treatment	0.53±0.07	0.52±0.08	0.963	>.05
	After treatment	0.94±0.08	0.83±0.09	8.554	<.05
Intermittent claudication distance (cm)	Before treatment	233.17±25.43	237.63±26.84	2.467	>.05
	After treatment	677.28±75.47	602.39±52.48	21.47	<.05

Table 4. Measurement of hemorheology indexes ($\bar{x} \pm s$)

Index		DCB	SAB	χ^2	*P* value
High tangential viscosity in whole blood (mPa·s)	Before treatment	5.81±0.84	5.86±0.87	0.446	>.05
	After treatment	4.02±0.51	5.03±0.69	6.933	<.05
Whole blood low tangential viscosity (mPa·s)	Before treatment	12.47±2.37	12.45±2.42	0.125	>.05
	After treatment	8.04±0.83	10.14±0.98	8.463	<.05
Blood sedimentation rate (mm/h)	Before treatment	21.26±3.41	21.09±3.37	1.710	>.05
	After treatment	11.01±2.64	15.33±2.96	9.616	<.05
Plasma viscosity (mPa·s)	Before treatment	2.15±0.36	2.13±0.33	0.074	>.05
	After treatment	1.24±0.17	1.81±0.24	7.332	<.05

Figure 1. Measurement of serum lipid levels. (a) Measurement of TC content in DCB group and SAB group. (b) Measurement of TG content in DCB group and SAB group. (c) Measurement of LDL-C content in DCB group and SAB group. (d) Measurement of HDL-C content in DCB group and SAB group. $P < .05$ vs. before treatment.



Measurement of hemorheology indexes

After treatment, all hemorheology indexes were significantly reduced, with the DCB group showing a more noticeable reduction compared to the SAB group ($P < .05$) (Table 4).

Measurement of serum lipid levels

Following treatment, TC, TG, and LDL-C levels decreased in both groups. The reduction was more significant in the DCB group. HDL-C levels increased in both groups,

Figure 2. Measurement of vascular endothelial function indexes. (a) Measurement of NO content in DCB group and SAB group. (b) Measurement of ET-1 content in DCB group and SAB group. $P < .05$ vs. before treatment.

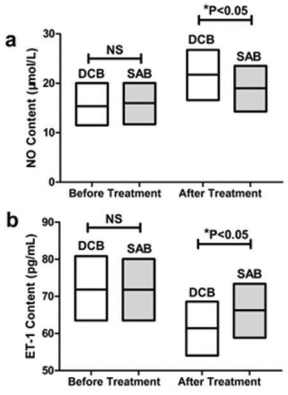


Table 5. Measurement of the adverse reactions (n, %)

Group	n	Subcutaneous hematoma	Toe necrosis	Lower extremity ulceration	Incidence of adverse reactions
DCB group	47	1	0	1	2(4.26)
SAB group	47	3	1	1	4(8.51)

with a more pronounced increase observed in the DCB group ($P < .05$) (Figure 1).

Measurement of vascular endothelial function indexes

Post-treatment, NO content increased in both groups, with a more substantial increase in the DCB group. ET-1 content decreased in both groups, with the DCB group exhibiting a more prominent decrease ($P < .05$) (Figure 2).

Measurement of occurrence of adverse reactions

The incidence of adverse reactions did not significantly differ between the DCB and SAB groups ($P > .05$) (Table 5).

DISCUSSION

Arteriosclerosis obliterans of the lower extremity are more common in elderly patients with hyperlipidemia, diabetes, and hypertension. They are degenerative senile lesions and belong to chronic ischemic diseases of the lower extremity. If the disease is not under control, its death and disability rate will improve significantly; our incidence rate also has an increasing tendency, hypertension, hyperglycemia, and hyperlipidemia are common risk factors for their occurrence. It has been reported in the literature[10-12] that with the passage of time after endovascular treatment of lower limb arteriosclerotic obliterans, about 40% to 60% of patients have intrastent restenosis, which seriously affects their quality of life and efficacy. DCB[13] is a novel therapeutic drug release technique combining balloon angioplasty and DES-related techniques. When DCB reaches vascular lesions, when balloon dilation makes the intima of the vascular wall be stretched or even torn, anti-proliferative drugs carried by carrier substances on the surface of the balloon will be absorbed by the vascular wall tissue and then play a role in the local inhibition of intima hyperplasia.[14] DCB is composed of antiproliferative drugs, carrier substances, and balloon. Paclitaxel dominates the currently applied DCBS. Due to its high lipophile property, paclitaxel can easily spread to the cell membrane and stabilize microtubules, promote the polymerization of tubulin and inhibit the disintegration of microtubules during mitosis of the cell cycle, thus preventing cell division and inhibiting the proliferation of VSMC and fibroblasts.[15,16]

Lower extremity vascular stenosis and further occlusion are mainly caused by the major artery and middle artery lesions, with ischemia as the main manifestation. Atherosclerotic changes in the intima of the artery will form plaques, which will gradually narrow the vascular lumen and eventually form occlusion, interrupting blood flow. Therefore, arteriosclerosis occlusion of the lower extremity is closely related to abnormal changes in hemorheology. The blood is in a state of high viscosity, which will significantly reduce blood fluidity and further increase the high tangential viscosity of the whole blood. Thus, the decrease of effective blood perfusion in tissues and organs is caused, and the hypoxia-ischemia is aggravated.[17,18] this experiment's results showed no difference in the level of each index before treatment. After treatment, all indexes of hemorheology in both groups decreased significantly, and the decrease range in DCB group was greater than that in SAB group ($P < .05$), indicating that balloon therapy could significantly improve the level of hemorheology indexes in patients. This may be due to the large contact area between DCB and blood vessel wall, more uniform drug release, and high bioavailability, which is consistent with the findings of Zhang Y et al. [19] The main cause of lower limb arteriosclerosis obliterans is the change of arteriosclerosis caused by various pathogenic factors, among which intima injury is the main pathological mechanism of the disease. An important protective barrier between vascular smooth muscle and blood is vascular endothelial, which can be involved in regulating and secreting a variety of vasoactive factors, such as NO and ET-1.[20,21] When atherosclerotic changes occur, vascular endothelial cells will be damaged to varying degrees, resulting in a decrease in NO production and an increase in ET-1 content. This experiment revealed that the level of NO was increased in both groups, and the level of ET-1 was decreased in both groups. The decrease of the NO level in the DCB group was greater than that in the SAB group, and the decrease of ET-1 level was greater than that in the SAB group (P<0.05). These results indicated that paclitaxel, a coating drug on DCB, could play a role in anti-cell proliferation and vascular endothelial injury, and the vascular endothelial physiological function could be significantly improved in DCB group. The results of this study showed that after treatment, there were statistically significant differences in dorsalis arterial blood flow, ankle-brachial index, and intermittent claudicity distance between DCB and SAB groups ($P < .05$). It may be due to the physical expansion effect of the balloon to dilate the balloon at the stenosis of the blood vessel so that the narrow blood vessel can be restored to its original state under

the action of balloon dilation so as to ensure the smooth flow of blood, which was in line with the results of Cui J et al. [22]. In addition, the results of this study also showed that the total incidence of postoperative adverse events in patients treated with drug-coated balloon was 4.26%, slightly lower than 8.51% in patients treated with common balloon in the control group, but the difference was not statistically significant ($P > .05$). This also indicates that the use of drug-coated balloon therapy has a high safety.

CONCLUSION

Treating ISR after lower extremity ASO with drug coated balloon can improve clinical efficacy, clinical symptoms and signs, and positively regulate the level of vascular endothelial function and hemorheology indexes in vivo, improving patient prognosis and improving patient quality of life, it is worthy of clinical promotion and application. However, this study still has some limitations. Firstly, the collection of sample size is limited by the source, which may have some limitations on the universality of the research results. Furthermore, the experimental methods may be influenced by factors such as research time and environment, resulting in certain limitations in the experimental results.

Future development

Undeniably, DCB treatment has its unique advantages, such as avoiding the implantation of metal stents, shortening the time for dual antiplatelet therapy, and conforming to the concept of "intervention without implantation". In addition to the need for more clinical research to confirm the development of DCB in the future, there is also room for improvement in the production process of DCB itself, such as the preparation of amorphous structures, coated balloons with lower drug concentration but no reduced efficacy. Developing different coating methods and drug delivery processes to improve drug utilization efficiency, reduce drug loss during delivery, and encapsulate drugs or test other anti-endothelial proliferation drugs is currently a hot research and development topic.

CONFLICT OF INTERESTS

The authors declared no conflict of interest.

AUTHOR CONTRIBUTIONS

SL, GW and XL designed the study and performed the experiments, XS and QX collected the data and analyzed the data, SL, GW and XL prepared the manuscript. All authors read and approved the final manuscript. SL and GW contributed equally to this work.

FUNDING

This study did not receive any funding in any form.

ETHICAL COMPLIANCE

This study was approved by the ethics committee of Dongying People's Hospital. Signed written informed consents were obtained from the patients and/or guardians.

REFERENCES

1. Feng F, Chen Y, Wang G, Huang P, Zhu Q, Zhou B. Correlation of Serum CysC, IMA, and LP-PLA2 Levels With Type 2 Diabetes Mellitus Patients With Lower Extremity Atherosclerotic Occlusive Disease. *Front Surg*. 2022;9:846470. doi:10.3389/fsurg.2022.846470
2. Conte MS, Pomposelli FB, Clair DG, et al; Society for Vascular Surgery Lower Extremity Guidelines Writing Group; Society for Vascular Surgery. Society for Vascular Surgery practice guidelines for atherosclerotic occlusive disease of the lower extremities: management of asymptomatic disease and claudication. *J Vasc Surg*. 2015;61(3)(suppl):2S-41S, 41S. e1. doi:10.1016/j.jvs.2014.12.009
3. Setacci C, de Donato G, Teraa M, et al. Chapter IV: treatment of critical limb ischaemia. *Eur J Vasc Endovasc Surg*. 2011;42(suppl 2):S43-S59. doi:10.1016/S1078-5884(11)60014-2
4. Bausback Y, Wittig T, Schmidt A, et al. Drug-Eluting Stent Versus Drug-Coated Balloon Revascularization in Patients With Femoropopliteal Arterial Disease. *J Am Coll Cardiol*. 2019;73(6):667-679. doi:10.1016/j.jacc.2018.11.039
5. Jiang X, Li X, Chen B, et al. Results of Excimer Laser Ablation Combined with Drug-Coated Balloon for Atherosclerotic Obliterans of Lower Extremity and Risk Factors for Loss of Primary Patency. *Ann Vasc Surg*. 2023;91:223-232. doi:10.1016/j.avsg.2022.11.026
6. Wei F, Huang F, Cui F. Efficacy and Safety Differences between Domestic Paclitaxel Drug-Coated Balloons and Metal Bare Stents in the Treatment of ASO of Femoral-Popliteal Arteries Type IIA-C. *Contrast Media Mol Imaging*. 2022;2022:6817838. doi:10.1155/2022/6817838
7. Yang Y; Effects of Drug-Coated Balloon Therapy on CT Imaging Results and Levels of Vascular Inflammatory Cytokines in Patients with Arteriosclerosis Obliterans Lesions. *Evid-Based Compl Alt*. 2022;2022(4793547. doi:10.1155/2022/4793547
8. Jiang XL, Ju S, Chen B, et al. [Application and value of excimer laser ablation in the treatment of lower limb atherosclerotic obliterans]. *Zhonghua Yi Xue Za Zhi*. 2021;101(14):1026-1030. doi:10.3760/cma.j.cn112137-20200916-02654
9. Eltchaninoff H, Tron C, Sebagh L, Cribier A. [Treatment of intrastent restenosis]. *Pathol Biol (Paris)*. 2004;52(4):218-222. doi:10.1016/j.patbio.2004.01.011
10. Alfonso F, Pérez-Vizcayno MJ, Hernandez R, et al; RIBS-II Investigators. A randomized comparison of sirolimus-eluting stent with balloon angioplasty in patients with in-stent restenosis: results of the Restenosis Intrastent: Balloon Angioplasty Versus Elective Sirolimus-Eluting Stenting (RIBS-II) trial. *J Am Coll Cardiol*. 2006;47(11):2152-2160. doi:10.1016/j.jacc.2005.10.078
11. Gaspar J, Sánchez I. [Treatment of intrastent restenosis]. *Arch Cardiol Mex*. 2002;72(suppl 1):S64-S68. doi.
12. Hong XL, Fu GS, Li ZL, Zhang WB. Intrastent haematoma after treatment with a drug-eluting balloon for in-stent restenosis: a case report. *Eur Heart J Case Rep*. 2021;5(8):ytab295. doi:10.1093/ehjcr/ytab295
13. Jiang X, Ju S, Chen B, et al. Safety and Effectiveness of Excimer Laser Ablation Combined With Drug-Coated Balloon for Atherosclerotic Obliterans in the Lower Extremity. *J Endovasc Ther*. 2022;759157875. doi:10.1177/15266028221092979
14. Qiao GY, Jiang XL, Chen B, et al. [Application and value of intravascular ultrasound for excimer laser ablation combined with drug-coated balloon in the treatment of lower limb arteriosclerotic obliterans]. *Zhonghua Wai Ke Za Zhi*. 2023;61(2):150-155. doi:10.3760/cma.j.cn112139-20220810-00349
15. Jeger RV, Eccleshall S, Wan Ahmad WA, et al; International DCB Consensus Group. Drug-Coated Balloons for Coronary Artery Disease: Third Report of the International DCB Consensus Group. *JACC Cardiovasc Interv*. 2020;13(12):1391-1402. doi:10.1016/j.jcin.2020.02.043
16. Sanchez-Jimenez E, El-Mokdad R, Chaddad R, Cortese B. Drug-coated balloon for the management of coronary chronic total occlusions. *Rev Cardiovasc Med*. 2022;23(2):42. doi:10.31083/j.rcm2302042
17. Chabi F, Champmartin S, Sarraf C, Noguera R. Critical evaluation of three hemodynamic models for the numerical simulation of intra-stent flows. *J Biomech*. 2015;48(10):1769-1776. doi:10.1016/j.jbiomech.2015.05.011
18. Yu Y, Zhou Y, Ma Q, et al. The conical stent in coronary artery improves hemodynamics compared with the traditional cylindrical stent. *Int J Cardiol*. 2017;227:166-171. doi:10.1016/j.ijcard.2016.11.065
19. Zhang Y, Xu G, Chen M, Chen Z, Shen M, Wang P; Ultrasonic Image Feature Analysis under Deep Learning Algorithm to Evaluate the Efficacy of Drug-Coated Balloon for Treatment of Arteriosclerotic Occlusion. *Comput Math Method M*. 2022;2022(3176716. doi:10.1155/2022/3176716
20. Houde M, Desbiens L, D'Orléans-Juste P. Endothelin-1: Biosynthesis, Signaling and Vasoreactivity. *Adv Pharmacol*. 2016;77:143-175. doi:10.1016/bs.apha.2016.05.002
21. Noguchi N, Teramoto K, Ochiai T, et al. The close participation of ET-1 and NO in human hepatic hemodynamics. *Hepatol Res*. 2006;36(2):86-93. doi:10.1016/j.hepres.2006.07.002
22. Cui J, Lun Y, Sun JJ, et al. [Clinical observation of drug-coated balloon in the treatment of lower extremity arterial long segment lesions]. *Zhonghua Yi Xue Za Zhi*. 2019;99(23):1787-1791. doi:10.3760/cma.j.issn.0376-2491.2019.23.007