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How to cite this article:

Kanhouché G, Marchi MF, Ribeiro MH, Campos CM, Nunes Filho AC, Ribeiro HB. Excimer Laser coronary atherectomy as adjunctive treatment of severe stent underexpansion with bulky calcification. J Transcat Intervent. 2022;30:eA20220012. <https://doi.org/10.31160/JOTCI202230A20220012>

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Received on:

Aug 18, 2022

Accepted on:

Nov 29, 2022



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Excimer Laser coronary atherectomy as adjunctive treatment of severe stent underexpansion with bulky calcification

Aterectomia coronária com *Excimer Laser* como tratamento adjuvante da subexpansão grave do stent com calcificação volumosa

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DOI: 10.31160/JOTCI202230A20220012

ABSTRACT - Excimer Laser coronary atherectomy has improved significantly in recent years, emitting high-energy ultraviolet and short wavelength with less penetration and heat emission, ultimately leading to less tissue damage and fewer complications. We described a case of a 66-year-old male patient, former smoker and suffering from hypertension, diabetes mellitus, and dyslipidemia. He underwent multiple percutaneous coronary interventions in the left anterior descending artery with bare metal and drug-eluting stents. In the last percutaneous coronary intervention, the stent was underexpanded and the patient presented acute stent thrombosis and recurrent stent restenosis. New percutaneous coronary interventions with adjunctive Excimer Laser coronary atherectomy were undertaken due to refractory angina, using progressive load and saline injection, followed by subsequent high-pressure balloon inflation and drug-eluting stent implantation with an excellent result. At 8-month follow-up, the patient was asymptomatic.

Keywords: Percutaneous coronary intervention; Lasers, excimer; Atherectomy; Drug-eluting stents

RESUMO - A aterectomia coronária com *Excimer Laser* melhorou significativamente nos últimos anos, utilizando emissão ultravioleta de alta energia e comprimento de onda curto, com menor penetração e menor emissão de calor, resultando em menos danos aos tecidos e menos complicações. Descrevemos o caso de um paciente do sexo masculino, 66 anos, ex-tabagista, hipertenso, diabético, dislipidêmico. Foi submetido a múltiplas intervenções coronárias percutâneas na artéria descendente anterior com stents não farmacológicos e farmacológicos. Na última intervenção coronária percutânea, o stent foi subexpandido, e o paciente apresentou trombose aguda do stent e reestenose recorrente do stent. Foram realizadas novas intervenções coronárias percutâneas com aterectomia coronária com *Excimer Laser* adjuvante, devido à angina refratária, com uso de carga progressiva e injeção de soro fisiológico, seguidas de posterior insuflação de balão de alta pressão e implante de stent farmacológico, com resultado excelente. No acompanhamento de 8 meses, o paciente se manteve assintomático.

Descritores: Intervenção coronária percutânea; Lasers de eximer; Aterectomia; Stents farmacológicos

INTRODUCTION

Laser technology for coronary atherectomy began in 1980, but the initial results were not expressive due to technical difficulties, which certainly warranted refinements. Therefore, enhancements have been performed, including laser technological iterations, together with greater operators' experience and better patient selection. Of note, Excimer Laser coronary atherectomy (ELCA) uses a xenon-chloride monochromatic Excimer Laser and has improved significantly in recent years, emitting high-energy ultraviolet (UV) and short wavelength, with less penetration and heat emission, ultimately leading to less tissue damage and fewer complications.^{1,2}

Excimer Laser coronary atherectomy acts on three different mechanisms for plaque remodeling: photochemical, photothermal, and photomechanical,^{2,3} and in patients with coronary artery disease (CAD), these improvements have permitted its

use in cases of extensive calcified lesions, in-stent restenosis (ISR), and uncrossable lesions. We describe a case of a patient with refractory angina due to recurrent ISR, managed with ELCA and a new drug-eluting stent (DES) implantation.

The study was approved by the Research Ethics Committee of the *Hospital das Clínicas of Faculdade de Medicina* of the *Universidade de São Paulo* (CAAE: 62597822.0.0000.0068, protocol 5.647.066).

CASE REPORT

A 66-year-old male patient, with a past medical history of hypertension, insulin-dependent diabetes mellitus, dyslipidemia, and smoking, was admitted for progressive exercise-induced angina in the last 2 weeks. The patient had an extensive history of coronary interventions. Twenty years ago, he underwent left anterior descending (LAD) percutaneous coronary intervention (PCI) with a bare metal stent (BMS) implantation. Two years later, coronary artery bypass graft (CABG) was performed, with a right internal mammary artery (RIMA) implanted to the right coronary artery (RCA). In the meantime, the patient underwent left circumflex artery (LCx) and posterior descending artery (PDA) PCI with a DES. Ten years after the initial LAD

PCI, a DES was implanted overlapping the previous BMS, followed by an acute thrombosis that was managed with chemical thrombolysis, followed by dual antiplatelet therapy (DAPT) with prasugrel.

In the last 10 years, optimal medical therapy was implemented, including high-dose statin and cardiovascular rehabilitation. Still, in the last two months, he presented worsening of refractory angina. The electrocardiogram showed sinus bradycardia with signs of left ventricular overload. The echocardiogram showed mild left ventricular dysfunction in anterior wall with preserved ejection fraction.

A new angiography revealed an occluded RCA in its ostium with a patent RIMA for the RCA. Left circumflex artery and obtuse marginals presented patent stents. Furthermore, there were signs of severe stent underexpansion in the proximal LAD, involving the distal left main coronary artery, with critical stenosis (Figure 1). Additional evaluation of the Heart Team contraindicated a new CABG due to the proximity of RIMA with the sternum.

Therefore, PCI was scheduled, using the femoral access with a 7F EBU catheter. Lesion preparation with sequential pre-dilation was performed, initially using a 2.5, followed by a 3.0 non-compliant balloon at high pressures (20 atm), and finally with laser atherectomy using a 0.9 mm X8Vitesse ELCA catheter (Colorado Springs, Colorado, United States). A progressive load of 40/40, 60/60, and 80 mJ/mm²/80Hz,

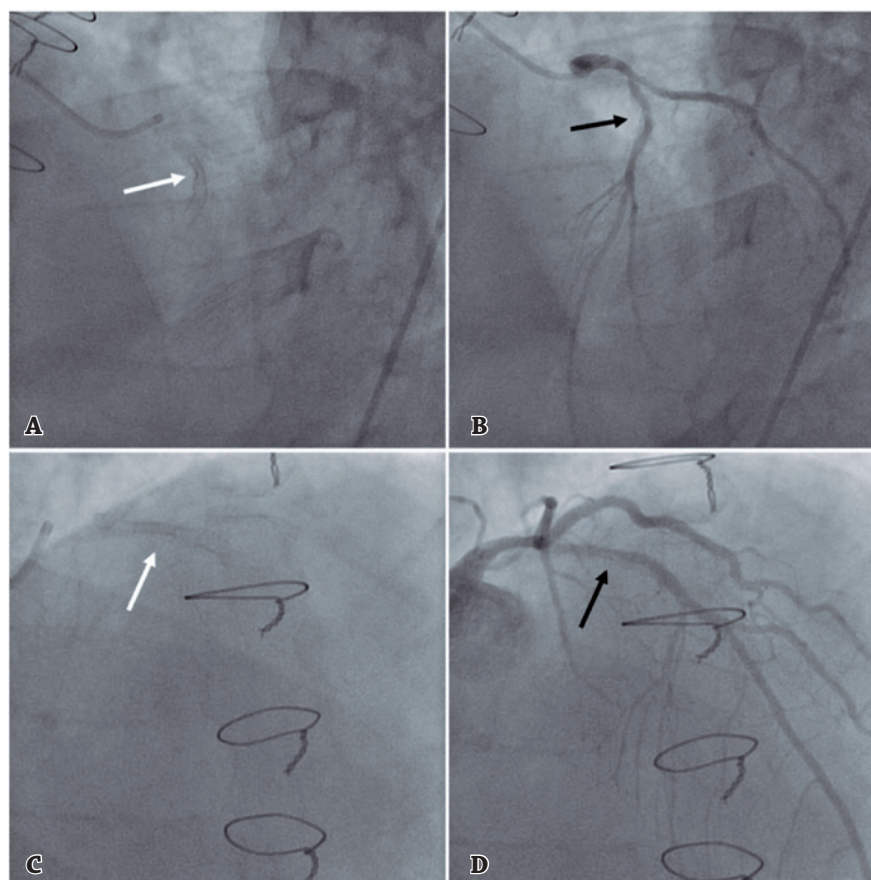


Figure 1. Angiography showing signs of severe stent underexpansion in the proximal left anterior descending artery, involving the distal left main coronary artery. The white arrow in A and C shows stent underexpansion. The black narrow in B and D shows severe luminal artery reduction by angiography.

coupled with saline injection was utilized to prepare the ISR (Figure 2). Then, a DES Firehawk Liberty™ (MicroPort, Shanghai, China) 3.50x38 mm from the left main coronary artery to the LAD was performed. This was followed by post-dilation with a 3.5x15mm non-compliant balloon,

at high pressure, and 4.5x8mm for proximal optimization technique (POT) in the left main with a final kissing balloon between LAD and LCx (Figure 3).

The patient was discharged after 4 days. At 8-month follow-up, he remained asymptomatic and with no antianginal medication.

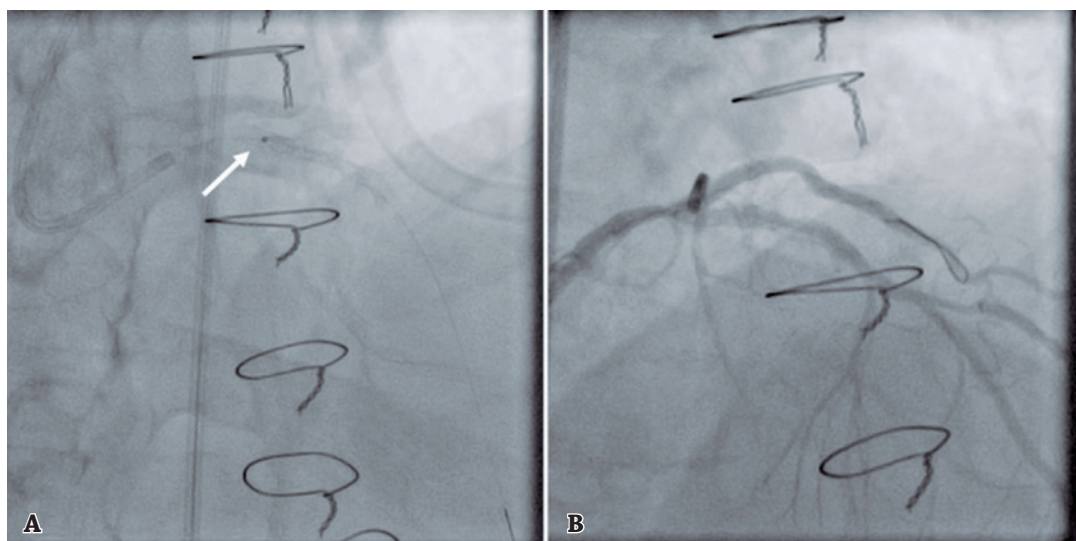


Figure 2. Lesion preparation with sequential pre-dilatation was performed, using a 2.5 and 3.0 non-compliant balloon at high pressure (20 atm), together with laser atherectomy (white narrow) using 0.9 mm X8Vitesse Excimer Laser coronary atherectomy catheter (Colorado Springs, Colorado, United States). A progressive load of 40/40, 60/60 and 80mJ/mm²/80Hz and saline injection method to prepare the in-stent lesion was performed (A). Angiography after pre-dilatation and Excimer Laser coronary atherectomy (B).

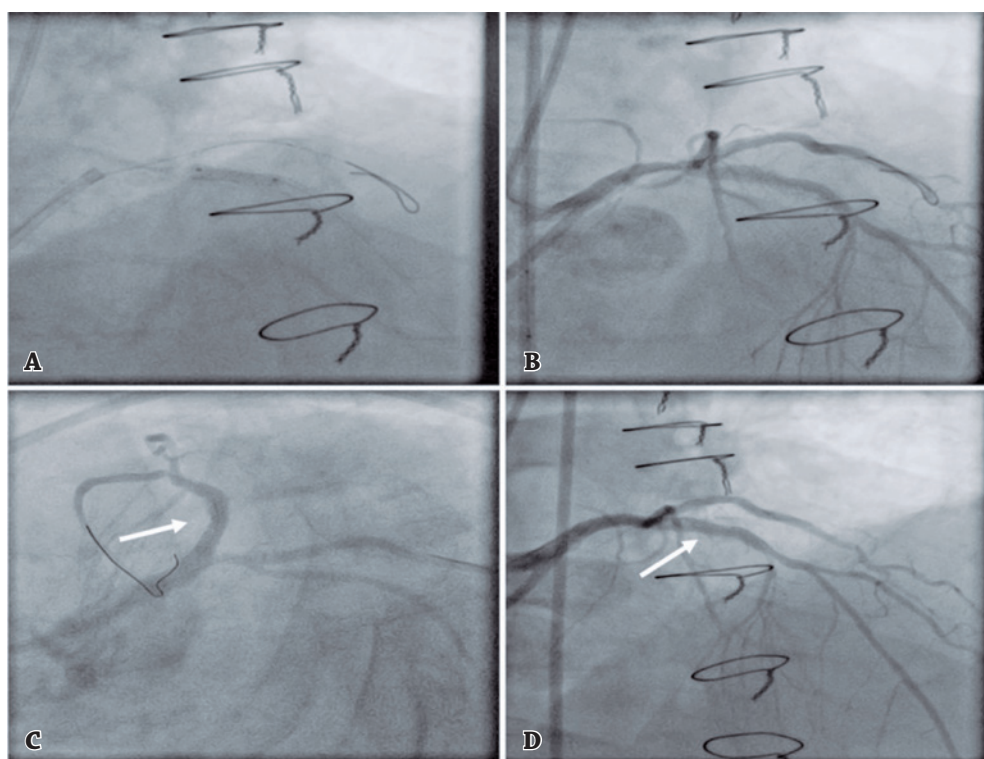


Figure 3. Implantation of a drug-eluting stent Firehawk Liberty™ (MicroPort, Shanghai, China) 3.50x38mm from the left main coronary to the left anterior descending artery. Finally, it was post-dilated with a 3.5x15mm non-compliant balloon at high pressure, and 4.5x8mm for proximal optimization technique in the left main coronary artery, with a final kissing balloon between left anterior descending and left circumflex arteries (A) and (B). Angiography showing the result in two different projections (C) and (D).

DISCUSSION

Excimer Laser coronary atherectomy technology has improved significantly in recent years, and has become an important adjunctive tool for treating complex CAD, including ISR, yet it is not the reality of many centers worldwide due to lack of operators' training and device costs.⁴ The present case demonstrates the importance of this technology, in a patient with multiple interventions and failures, including restenosis of several prior DES, likely attributed to bulky calcification and severe stent underexpansion. Excimer Laser coronary atherectomy was a precise option in this case, since its mechanisms of action allow reaching atherosclerotic plaques beyond the stent, not disrupting its metal architecture. The photochemical role makes dissociation of the cell molecular bonds, the photothermal effect generated by vibration leads to softening of collagen and protein fibers of the atheroma, and the photomechanical effect generated by the explosion and implosion of the vapor bubbles result in plaque rupture.²

In addition to stent under-expansion, ELCA is indicated for ISR, calcification, balloon uncrossable lesions, and chronic total occlusion.^{2,5} The ELLEMENT registry⁶ showed a target lesion revascularization of 4.6% at 6 months using this strategy in patients with undilatable stents. With the increasing complexity of coronary lesions, ELCA becomes an essential tool with unique advantages.

Rotational atherectomy is also a worldwide adjunctive tool used in lesion preparation with extensive calcification before stent implantation. However, it is limited in under-expanded stents, due to the risk of disrupting the stent architecture. High-pressure balloons and cutting balloons are also excellent adjunctive alternatives for complex lesions, but may be limited in some circumstances, such as the present case, in which even very high-pressure inflations were unable to adequately expand the stent. Also, in some lesions, the balloons may be unable to even cross the lesion itself.

Most likely, the patient's acute stent thrombosis in the past was secondary to the underexpanded LAD stent. Excimer Laser coronary atherectomy in such cases can modify the atheroma without disrupting the stent architecture, followed by proper stent expansion. Excimer Laser coronary atherectomy is well indicated in ISR because it can ablate both luminal and extraluminal atheroma. However, no randomized trials compared ELCA with rotational atherectomy or balloon dilatation in patients with ISR. Heavy calcification represents a significant PCI challenge, which can be addressed by ELCA capacity to disrupt the calcium architecture, especially in cases of pre-existing stents.²

In the past, the high complication rates discouraged the use of this device. For instance, some studies from 1990's showed 13 to 23% rates of dissection and 1 to 3% of perforation with the previous systems. Nowadays, these complications rates have been significantly reduced, and Protty et al.⁴ showed rates of dissection and perforation of 4.1 and 1.7%, respectively, without an increase of in-hospital death.^{4,7} In addition to improvement in device technology, saline injection methodology and lower loads of energy administered were essential to reduce the complication rates.^{2,6}

Our case illustrates the importance of ELCA technology as an adjunctive tool in complex PCI. This approach has been confirmed by similar case reports in recent years,⁸ although larger series, with longer-term follow-up, are still required to further enable the more widespread use of ELCA devices.

SOURCE OF FINANCING

None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: GK, MFSM e MHR, CMC, ACBCNF and HBR; data collection: GK, MFSM, MHR, CMC, ACBCNF and HBR; data interpretation: GK, MFSM, MHR, CMC, ACBCNF and HBR; text writing: GK, MFSM, MHR, CMC, ACBCNF and HBR; approval of the final version to be published: GK, MFSM, MHR, CMC, ACBCNF and HBR.

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