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Management of in-stent restenosis of the left main coronary artery with laser atherectomy guided by intracoronary optical coherence tomography

Tratamento de reestenose intra-stent de tronco de coronária esquerda com aterectomia a laser guiada por tomografia de coerência óptica intracoronariana

Luis Augusto Palma Dallan[1], Gabriel Tensol Rodrigues Pereira[1], Hiram Grando Bezerra[1]

[1] *The Valve & Structural Heart Disease Intervention Center, Division of Cardiovascular Medicine, Harrington Heart and Vascular Institute, University Hospitals Cleveland Medical Center, Cleveland, Ohio, USA.*

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ABSTRACT – We describe the case of a patient with multiple comorbidities scheduled to undergo intracoronary optical coherence tomography-guided percutaneous coronary intervention. Based on the images acquired, it was possible to observe the mechanism of restenosis and the anatomy of the lesion, and to optimize planning of the procedure. Our strategy was to resect the neointimal hyperplastic tissue using laser atherectomy, with great results and a successful procedure.

Keywords: Coronary stenosis; Recurrence; Atherectomy; Lasers; Angina, stable; Tomography, optical coherence

RESUMO – Descrevemos o caso de um paciente com múltiplas comorbidades, que seria submetido à intervenção coronária percutânea guiada por tomografia de coerência óptica intracoronariana e, de acordo com as imagens obtidas, pudemos observar o mecanismo de reestenose, a anatomia da lesão e o planejamento do procedimento de forma otimizada. Optamos por estratégia de ressecção tecidual de hiperplasia neointimal com aterectomia a laser, com ótimo resultado e sucesso do procedimento.

Palavras-chave: Estenose coronária; Recidiva; Aterectomia; Laser; Angina estável; Tomografia por coerência óptica

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Corresponding author
Luis Augusto Palma Dallan
Division of Cardiovascular Medicine
Harrington Heart and Vascular Institute
University Hospitals Cleveland Medical Center
11100 Euclid Avenue, Cleveland, Ohio 44106, EUA.
E-mail: gutodallan@hotmail.com

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INTRODUCTION

Excimer laser coronary atherectomy (ELCA) is an adjuvant procedure to percutaneous coronary intervention (PCI), aimed to properly preparing the coronary lesion for optimized stenting.[1] It is an effective form of atherectomy for complex coronary lesions,[2,3] and has been gaining space in the management of lesions that require appropriate ablation, like in-stent restenosis and chronic coronary occlusions.[2,4]

We describe a case of a PCI guided by intracoronary optical coherence tomography (OCT), using laser atherectomy.

CLINICAL CASE

A 70-year-old Caucasian male patient, with a history of multiple medical conditions, including arterial hypertension, obesity, dyslipidemia, former smoking, hypothyroidism, ischemic cardiomyopathy. Two years before, the patient had been treated for severe ischemic mitral regurgitation with MitraClip®, associated with PCI of the distal third of the left main coronary artery (LMCA) and of the proximal third of the left anterior descending artery (LAD), with rotational atherectomy (Rotablator™, Boston Scientific) and placement of a drug-eluting stent. Six months ago, the patient was electively admitted to the hospital to treat a coronary lesion due to stable angina (CCS 3), and had his drug therapy optimized. A cardiac magnetic resonance imaging (MRI) showed a non-viable lateral wall; however, the anterior wall was viable.

Coronary angiography

The patient underwent an elective coronary angiography that showed a major in-stent restenosis of 95% in the LMCA/LAD (Figure 1); chronic occlusion of the left circumflex artery (LCx; present 2 years before); presence of well-developed collateral circulation grade III for the LCx; and calcification of the right coronary artery (RCA), with no significant obstructive lesions.

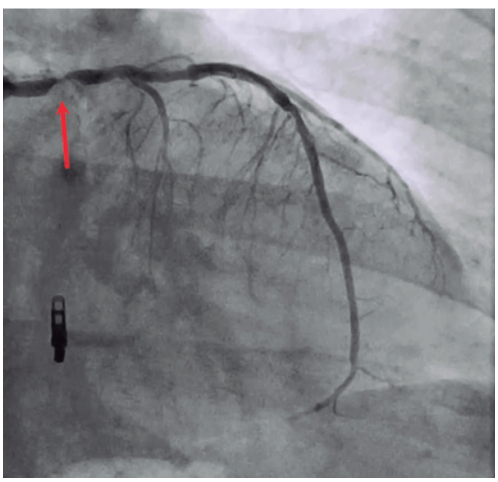

Figure 1. Left main coronary artery/left anterior descending artery with major in-stent restenosis of 95% (arrow).

Procedure

The case was discussed with the heart team due to the high surgical risk of the patient. We chose to electively treat the lesion percutaneously. The procedure was performed via the right femoral artery. An 8F ProGlide® (Abbott) was first pre-implanted, followed by administration of unfractionated heparin 100IU/kg, and catheterization of the LMCA with an 8F 3.5 EBU catheter. A 0.014" RunThrough® (Terumo) guidewire in the LAD and an OCT catheter were used with no need to pre-dilate the lesion, and sharp images were acquired despite severity of the lesion, which could have hindered the procedure. In the LMCA/LAD, there was a great amount of in-stent fibrous tissue, with a mean stent diameter of 2.75mm, considering a mean distal reference diameter of 2.73mm, and a mean proximal reference diameter of 3.62mm (Figure 2).

The OCT was especially important to determine the mechanism of restenosis, anatomy of the lesion and planning of the procedure. There was excessive neointimal hyperplasia, associated with intense and extensive coronary calcification. Failure could occur when attempting to compact this intense proliferation of in-stent fibrous tissue using only pre-dilation with a balloon catheter. The next step was to properly resect the neointimal plaque using laser atherectomy.

A continuous intracoronary infusion of saline solution was administered and laser atherectomy was conducted with the 2.00mm ELCA Coronary Laser® device, at a frequency of 60Hz, fluence 40, with significant photoablation of the neointimal hyperplasia and considerable increase of the lumen area (Figure 3).

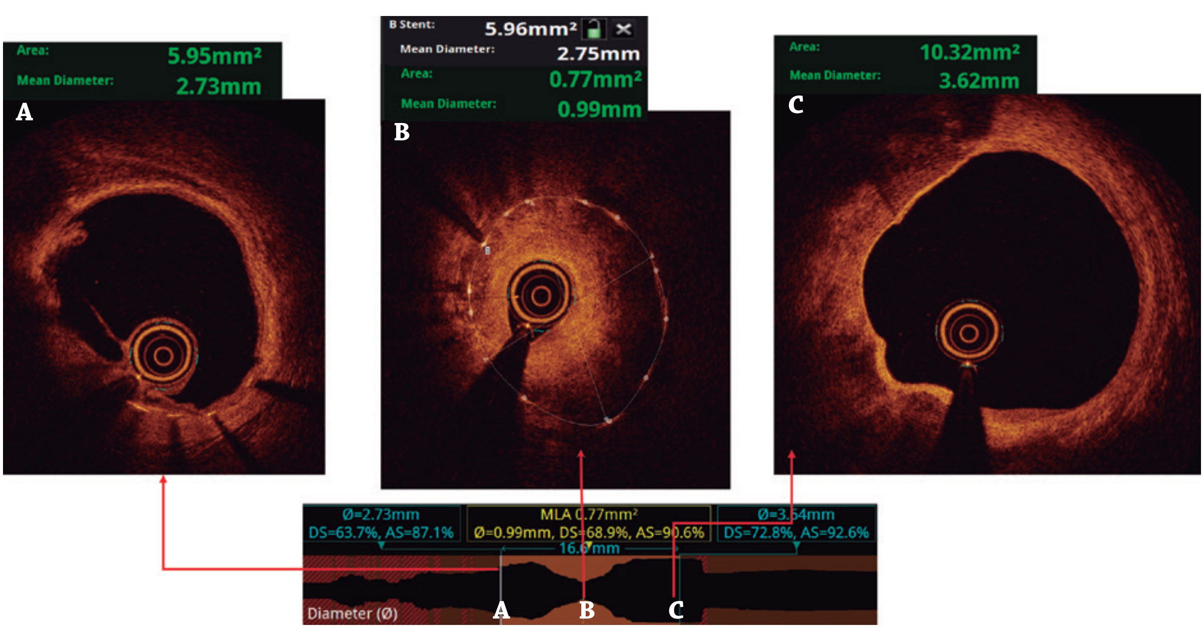

Figure 2. Left main coronary artery/left anterior descending artery with great amount of in-stent fibrous tissue, and a mean stent diameter of 2.75mm (B) considering a mean distal reference diameter of 2.73mm (A), and a mean proximal reference diameter of 3.62mm (C).

After the positive outcome of the laser atherectomy, a 3.5x15mm XIENCE Sierra® (Abbott) drug-eluting stent was implanted and deployed at 10atm, and successfully post-dilated with a 3.5x8mm NC Euphora® (Medtronic) non-compliant balloon, at 30atm (Figure 4), with a mean stent diameter of 3.47mm, considering a mean distal reference diameter of 3.42mm and a mean proximal reference diameter of 3.63mm. Hence, there was great expansion and a satisfactory result.

Significant lumen gain was achieved through three mechanisms: ablation of the neointimal hyperplasia with a lumen increase by 3.08mm²; expansion of the previous

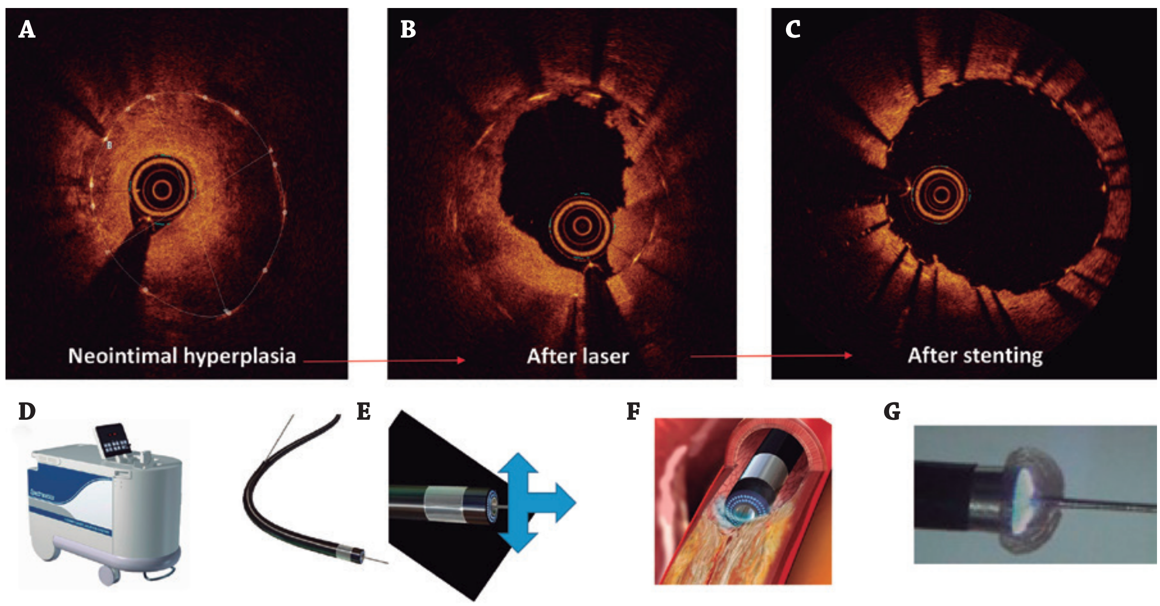

Figure 3. Laser atherectomy with the device ELCA Coronary Laser® and direct placement of drug-eluting stent, with cross section of the same region of the minimum luminal area. (A) Neointimal hyperplasia (B) Aspect of the lesion after laser. (C) Final aspect of the lesion after stenting. (D) Laser generating device. (E) ELCA catheter. (F) Illustration of the action made by ELCA catheter on the coronary artery lesion. (G) Formation of steam bubble on the tip of ELCA catheter. .

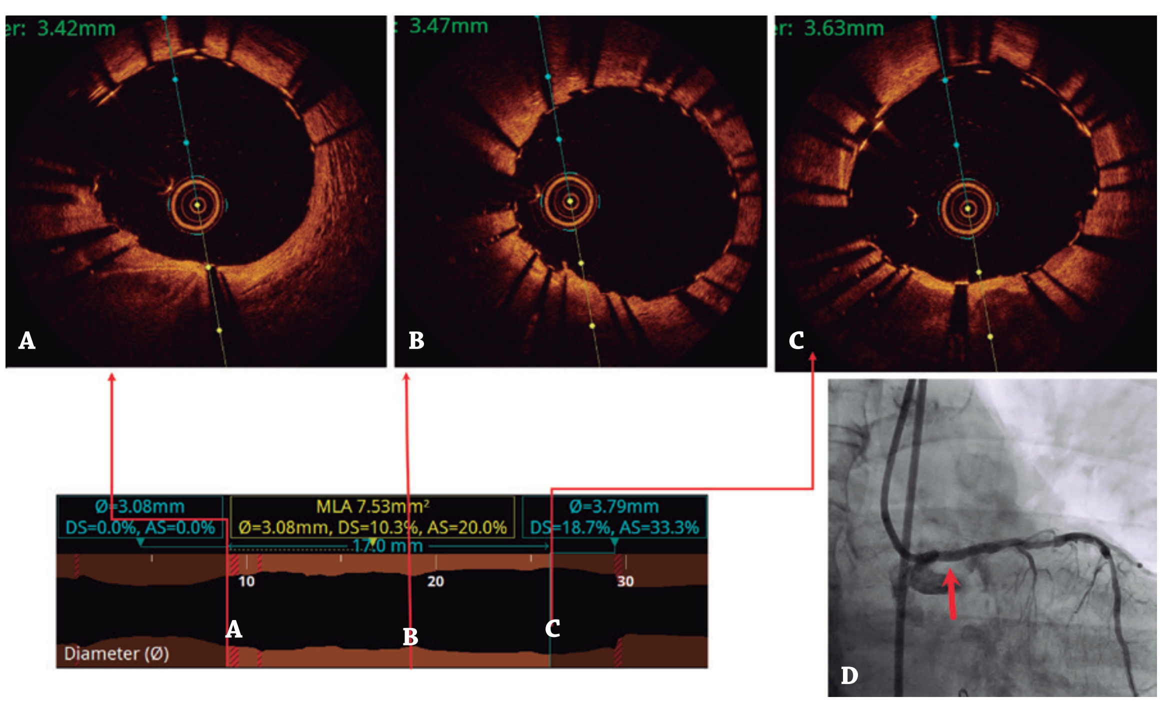

Figure 4. Satisfactory result after laser atherectomy and placement of a drug-eluting stent observed at optical coherence tomography (A, B and C), and angiography showing excellent final result (D).

stent with a lumen gain by 4.99mm²; and compression of the residual neointimal hyperplasia with a lumen gain by 1.71mm².

Final repair of the femoral artery was carried out with the pre-implanted device. The patient was discharged from hospital the following day.

DISCUSSION

ELCA is an adjuvant therapy to PCI, when usual techniques fail due to the impossibility to cross or expand the lesion.[1] Its application promotes molecular changes in the intimal portion of the vessel, modifying its physical structure and allowing the advancement of devices into the distal bed. It is, therefore, an effective form of atherectomy for complex coronary lesions.[2,3]

The use of laser atherectomy is not recent, and it was widely employed in the 1980's as an exclusive intervention to treat coronary lesions.[5,6] However, the use of this type of atherectomy was dramatically reduced in the 1990's due to high restenosis rates, varying from 48% to 57%, resulting from the use of the technique alone, without stenting .[7-9]

In recent years, laser atherectomy has been gaining back space, especially in the management of lesions requiring appropriate ablation, such as cases of in-stent restenosis and chronic coronary occlusion.[2,4] Several factors contributed to this resumption of the use of laser atherectomy, primarily:[3] the great technological evolution of devices and catheters for laser application, both in terms of type of laser (currently the Excimer Laser), and the smaller size and better features of delivery devices, which enable addressing previously inaccessible lesions; laser being no longer used as an isolated targeted therapy, but rather as an adjuvant therapy to more modern devices, with lower restenosis rates; better knowledge of the mechanisms and properties of laser atherectomy, which led to its use in lesions requiring appropriate intimal resection, such as in-stent restenosis and chronic coronary occlusion.

The concept of "tissue photoablation" by ELCA consists of using light to break, vaporize and remove tissues, in a process mediated by three different mechanisms: photochemical, photothermal and photomechanical.[1-3] Ultraviolet laser light is absorbed by the intravascular material and breaks carbon-carbon bonds (photochemical). The application of high-energy light raises the temperature of intracellular water, leading to cell rupture and formation of a steam bubble on the tip of the catheter (photothermal). The main effect of the ELCA involves a thermomechanical process of rapid expansion and implosion of these steam bubbles, which go on to rupture the obstructive intravascular material (photomechanical). The diameter of fragments released is <10μm, and they are absorbed by the reticuloendothelial system, which prevents microvascular obstruction.[10]

The safety and efficacy of the ELCA are well established, particularly for management of complex lesions requiring appropriate neointimal resection.[1-4] However, since the use of this technique is restricted in our country, due to the high cost of atherectomy devices in general, as well as to the lack of knowledge about new pieces of equipment and favorable outcomes of the current technique, national data regarding its use are still scarce.

In this type of atherectomy, a standard 0.014-inch guidewire is employed to pass the 8F ELCA catheter and apply the laser to the site of the obstructive plaque. Once the indication for laser is defined and the appropriate catheter is selected, the access can be determined. Virtually all interventions can be performed using the radial approach, although the radial deployment of 8F catheters requires specific precautions.[1,2]

The appropriate guidewire must be used to ensure good co-axial support and only then can the ELCA be performed, always observing the appropriate safety precautions. After the ELCA, the stent is deployed, preferably guided by an imaging technique, such as OCT, to check for appropriate tissue ablation and ensure optimized planning.

Currently, the ELCA is used in procedures requiring appropriate tissue ablation, such as acute coronary syndromes, extensive coronary thrombosis, in-stent restenosis, saphenous vein grafts, chronic total occlusions, poorly expanded stents, and calcified lesions.[2-4,11-14]

There are no absolute coronary contraindications for the ELCA. The main complications of ELCA are similar to those seen in other types of atherectomy. Specific questions may arise due to interruption of the continuous saline solution infusion or presence of residual contrast, which may generate excessive heat and increase the risk of coronary perforation. The ELCA is not recommended for lesions with long subintimal extension, as seen in some chronic total occlusions.[1,15]

The main advantage of the ELCA when compared to other types of atherectomy is the delivery system on a standard 0.014-inch guidewire. Also, the technique is relatively simple and can be learned by any interventional cardiologist after a short training period.[1]

The main technical limitation of laser atherectomy is the presence of extensive calcification. In these cases, other types of atherectomy, such as rotational atherectomy, must be used. However, it is possible to perform a hybrid procedure, when rotational atherectomy is required but cannot be used due to the impossibility of advancing the dedicated guidewire. In such cases, the ELCA can create a channel for advancement of the dedicated guidewire and completion of the procedure. This association is known as the RASER technique.[1,15]

In the clinical case described, OCT was especially important to determine the mechanism of restenosis, the anatomy of the lesion and the planning of the procedure. We observed excessive neointimal hyperplasia, associated with intense and extensive coronary calcification, with possible failure when attempting to compact this intense proliferation of in-stent fibrous tissue, using only pre-dilation with a balloon catheter.

With this in mind, we planned an appropriate neointimal resection of the plaque using laser atherectomy, and an accurate measurement of the vessel size to optimize the stenting process, with great outcomes. This ablation is important not only for the direct lumen gain, but also because it reduces the neointimal hyperplastic mass to be compressed, and increases the radial force of the balloon on the previously implanted stent, allowing for an optimized expansion.

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None.

CONFLICT OF INTEREST

The authors declare there are no conflict of interest.

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