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Recanalization of chronic left anterior descending artery occlusion with laser contrast enhanced atherectomy

Rekanalizacja gałęzi przedniej zstępującej z wykorzystaniem aterektomii laserowej wspomaganej kontrastem

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ABSTRACT

Excimer laser coronary artherectomy (ELCA) is a unique supporting modality that can vaporize plaque in complex coronary anatomy containing fibrous tissue, calcium, soft atheroma, or thrombus. Absorption within the atheromatous, thrombotic material results in photomechanical (breaking of chemical bond) and photothermal (increase in the target's temperature) processes that causes vaporization and removal of irradiated lesion. The mechanism of ELCA in lumen enlargement is known to be a combination of tissue ablation and vessel expansion. Laser-supported coronary angioplasty is a safe and effective supporting modality for the management of complex lesions, including calcified stenosis, chronic total occlusions, under-expanded stents, in stent restenosis and non-compliant plaques. Good lesion preparation of calcified lesions prior to stent implantation using available modern technology is a key to success. Laser technique should be considered more widely in complex, calcified lesions. In this paper we have shown successful recanalization of chronic total occlusion of left anterior descending artery with laser contrast enhanced atherectomy in patient following coronary artery bypass surgery.

Key words: excimer laser coronary artherectomy, complex coronary lesions, chronic total occlusion

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STRESZCZENIE

Ekscymerowa laserowa aterektomia wieńcowa (ELCA, *excimer laser coronary artherectomy*) to unikalna oraz innowacyjna metoda leczenia zmian w naczyniach wieńcowych wykorzystywana w przypadkach zmian miażdżycowych zawierających duże ilości tkanki włóknistej, masywne złogi wapnia, miękką blaszkę miażdżycową lub nawet skrzepliny. Podstawowym mechanizmem działania ELCA jest absorpcja energii przez materiał ściany naczynia przy wykorzystaniu procesów fotomechanicznych (zerwanie wiązania chemicznego) oraz fototermicznych (wzrost temperatury), które przyczyniają się do zniszczenia, odparowania, usunięcia części blaszki miażdżycowej i w następstwie tych działań do „zmiękczenia" zmiany. Mechanizm działania ELCA zwiększający światło naczynia polega wykorzystaniu kombinacji ablacji tkankowej oraz poszerzenia naczynia. Angioplastyka wieńcowa z wykorzystaniem lasera ELCA stanowi bezpieczną i skuteczną metodą wspomagającą leczenie złożonych zmian w tętnicach wieńcowych obejmujących masywnie uwapnione, niepodatne blaszki, przewlekłe zamknięcia naczyń wieńcowych, nieodprężone stenty czy nawroty zwężenia w stentach. Optymalne przygotowanie zmiany blaszki miażdżycowej przed wszczepieniem stentów przy wykorzystaniu dostępnych nowoczesnych technologii stanowi klucz do sukcesu. Dostępne dane wskazują, że ELCA warto częściej brać pod uwagę w przypadkach złożonych i uwapnionych zmian. W tym artykule przedstawiono udaną rekanalizację przewlekłej niedrożności gałęzi międzykomorowej przedniej z zastosowaniem ELCA u pacjenta po operacji pomostowania aortalno-wieńcowego.

Słowa kluczowe: ekscymerowa laserowa aterektomia wieńcowa, złożone zmiany wieńcowe, przewlekła niedrożność tętnicy wieńcowej

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Introduction

Excimer laser coronary artherectony (ELCA) is a unique supporting modality that can vaporize plaque in complex coronary anatomy containing fibrous tissue, calcium, soft atheroma, or thrombus. Absorption within the atheromatous, thrombotic material results in photomechanical (breaking of chemical bond) and photothermal (increase in the target's temperature) processes that causes vaporization and removal of irradiated lesion. The mechanism of ELCA in lumen enlargement is known to be a combination of tissue ablation and vessel expansion [1–6].

The treatment of complex coronary lesions, as calcified stenosis, calcified occlusions, chronic total occlusions, underexpanded stents, in stent restenosis and non-compliant plaques seems to be a promising area for excimer ELCA use. Such complex lesions are difficult to adequately treat with balloon angioplasty and intracoronary stenting. Existing techniques such as cutting balloons, high-pressure balloons or rotational atherectomy are often ineffective and can cause major complications [1–3].

Case report

A 59-year old male, following coronary artery bypass surgery (CABG), underwent coronary angiography due to unstable angina. Angiography demonstrated 3-vessel coronary artery disease, with occluded left internal mammary artery graft to left anterior descending (LAD) artery and patent, without lesions venous graft to marginal branch. After the Heart-Team consultation the patient was qualified for the LAD chronic total occlusion (CTO) angioplasty. Heavy calcified occlusion in middle and distal LAD segments was the main target (type C lesion) (Fig. 1). In addition to calcifications, the LAD artery had anatomically spiral shape, especially in middle segments.

Regular guiding wires were unable to pass through the calcified occlusion. The second choice guide wire (ASAHI Fielder XT) was successful. In the next step the SuperCross 90 micro-catheter was used to cross the lesion (Fig. 2). High-pressure, 2mm diameter regular balloons could not pass the lesion because of the heavy calcifications and vessel tortuosity. Because of the vessel tortuosity the rotational atherectomy seemed not to be a safe and optimal option. In order to modify the calcification and deliver balloons directly into occlusion area we decided to use ELCA. There were several unsuccessful laser catheter placements attempts, the significant spiral vessel anatomy remained serious problem. In order to place laser catheter directly into heavy calcified vessel area, in coaxial position (in order to avoid perforation) the Guideliner (Teleflex USA) was used (Fig. 3). After optimal laser catheter position was confirmed, laser artherectomy was performed. We decided to use laser atherectomy in all occluded middle LAD segments, starting from proximal part and advancing to distal parts. The 0,9 mm X-80 Vitesse-RX catheter (Spectranetics) was used, with incremental energy settings, starting from 40 mJ/25Hz up to 60 mJ/Hz, 11502 ELCA pulses during 153 seconds were applied. Between laser applications, we have tried several times to cross the lesion with the balloons and after third laser application we were successful. But problem still remained, the balloons could not expand due to heavy calcified area (Fig. 4). After two more laser applications and lasing parameters modifications the predilatation was performed with successful result. After 2,5/20 mm NC balloon predilatation (a 20 atm) optimal angiographic result was achieved (Fig. 5). In the next stage stents DES Xience 2,5/12 mm (middle LAD segments) and DES Xience 2,25/18 mm (distal LAD segments) were implanted with optimal result. Full stent expansion could be accomplished by further balloon dilatation with an ordinary pressure. The side LAD branches were present. The procedure was finished by repeated high-pressure balloon postditataions. Optimal result was confirmed in IVUS HD scan. During procedure the patient was stable, no chest pain and no ecg ischemic abnormalities were present.

Discussion

It has been noted that the impact of ELCA on the surrounding tissue is dependent on the association with contrast media, saline and blood [7]. The technique of saline "flush and bathe" is used in order to reduce the risk of coronary dissection induced by high-pressure waves [8]. In patients with underexpanded stents and calcified lesions ELCA using a contrast or blood medium could assist the achievement of optimized expansion of these lesions by disrupting the underlying plaque [9]. In our case we used the contrast medium (25% concentration) during lasing to help create bubbles of a larger size and to achieve more powerful shockwave, softening the calcium in the vessel wall. This strategy proved to be effective and successful without any complications [10–12].

Laser-supported coronary angioplasty is a safe and effective supporting modality for the management of complex lesions, as calcified stenosis, chronic total occlusions, under-expanded stents, in stent restenosis (IRS) and non-compliant plaques. ELCA was associated with high clinical and procedural success rates and low incidence of adverse events [1, 3, 5].

A good lesion preparation of calcified lesions prior to stent implantation using available modern technology is a key to success. ELCA should be considered more widely in complex, calcified lesions. Sometimes, especially when the vessel tortuosity

Figure 1. Heavy calcified occlusion in middle and distal LAD segments - type C lesion

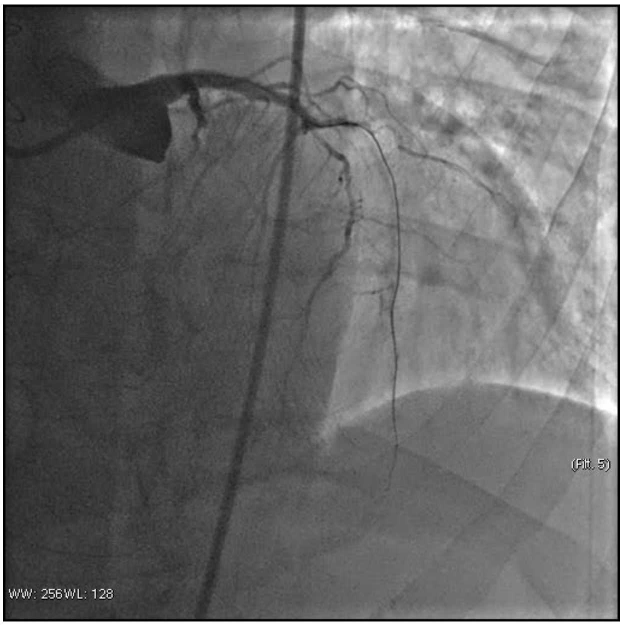

Figure 2. Micro-catheter used to cross the lesion

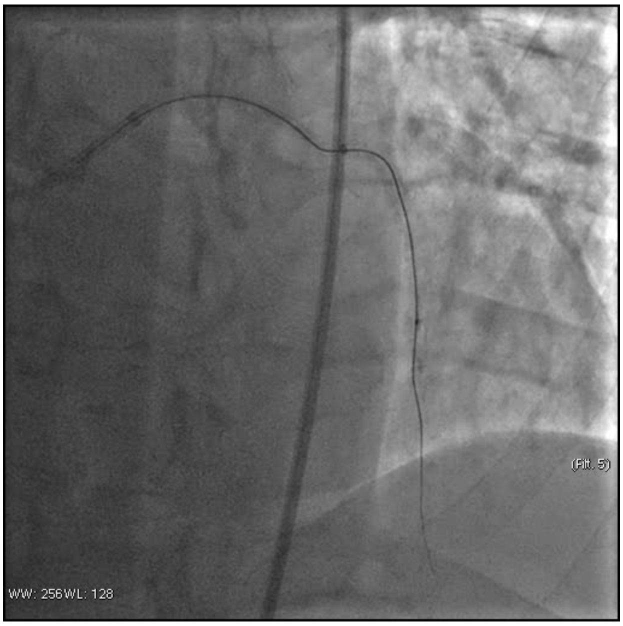

Figure 3. Guideliner supported ELCA

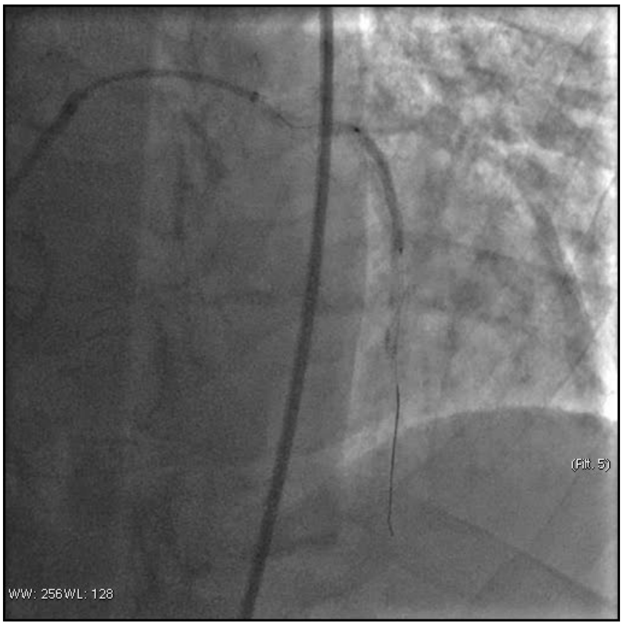

Figure 4. Not sufficient balloon expansion during predilatation

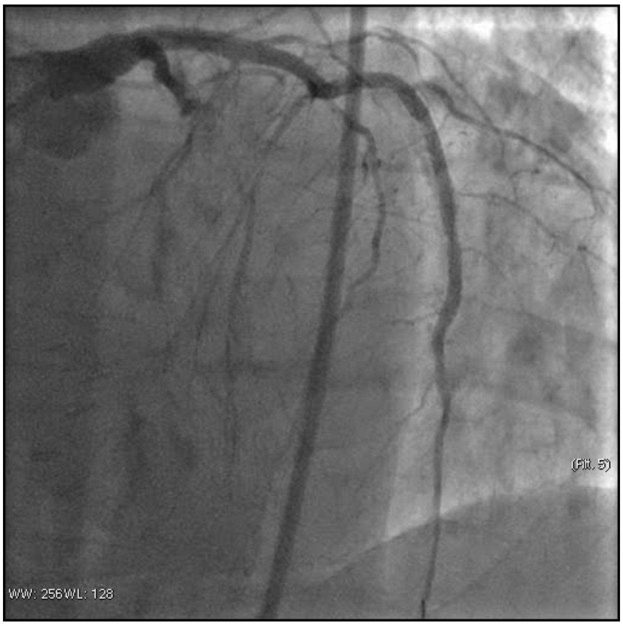

Figure 5. Optimal angiographic result after ELCA supported PCI

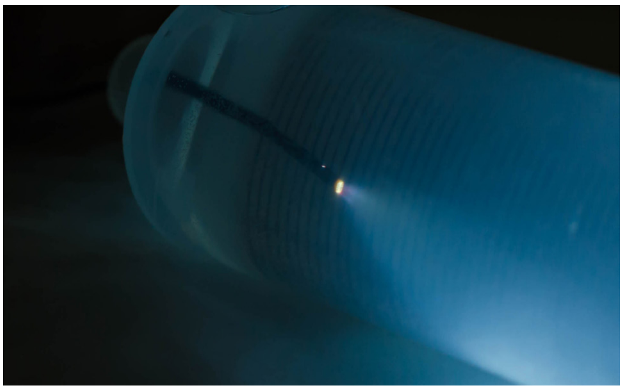

Figure 6. ELCA catheter

is significant rotablation is not an option, in such a cases ELCA seems to be optimal choice. Also ELCA procedures in contrast to rotablation need standard angioplasty guide wire only, which makes the procedure simpler and safer, the laser tip is very small (Fig. 6).

With increasing number of patients treated with PCI, a large subset of coronary lesions cannot be adequately treated with balloon angioplasty and/or intracoronary stenting alone. Heavily calcified or fibrotic, and undeletable/balloon no-crossable lesions are still the problem for interventional cardiology. Despite advances in technique and technology, these lesions may remain resistant or untreatable with percutaneous techniques, which restrict therapeutic options. Calcific balloon-resistant coronary stenosis remain a technical challenge. They may cause stent underexpansion, especially if adequate lesion preparation was not performed. Even now, stent underexpansion remains an important risk factor for in-stent restenosis (ISR) and stent thrombosis (ST) [6]. ELCA has been reported to facilitate stent expansion in balloon-resistant lesions [10–12].

Registries are still in progress and we hope that they will allow us to expand the ELCA usage on a larger scale. Our internal ELM registry confirms the efficacy, reproducibility and safety of ELCA with contrast injection to modify the underlying plaque and improve stent expansion in complex undilatable lesions, the outcomes will be published in near future.

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