Cardiovascular Revascularization Medicine 16 (2015) 197–200

Contents lists available at ScienceDirect

Cardiovascular Revascularization Medicine

The efficacy of excimer laser pretreatment for calcified nodule in acute coronary syndrome

Takashi Ashikaga *, Shunji Yoshikawa, Mitsuaki Isobe

Department of Cardiovascular Medicine, Tokyo Medical and Dental University, Tokyo

ARTICLE INFO

Article history:
Received 22 August 2014
Received in revised form 22 September 2014
Accepted 30 September 2014

Keywords:
Coronary artery disease
Percutaneous coronary intervention
Optical coherence tomography
Intravascular ultrasound

ABSTRACT

Stent underexpansion is known as a major cause of restenosis and stent thrombosis in calcified coronary lesions. We report a case of calcified nodule pretreated with excimer laser coronary angioplasty (ELCA) in acute coronary syndrome (ACS). Excimer laser use altered underlying lesion morphology such as calcified nodule and accompanied plaque and thrombus. Pretreatment of ELCA may be a useful tool to get a full expansion of the deployed stent without distal embolism for calcified nodule in ACS.

1. Introduction

The majority of acute coronary syndrome (ACS) events are the result of sudden luminal thrombosis, with 55% to 60% due to plaque rupture, 30% to 35% caused by plaque erosion, and a small portion resulting from a calcified nodule in histopathological findings [1]. Calcified nodule consists of areas of fragmentated calcified stenosis from small calcified nodules that are surrounded by fibrin and have a small luminal thrombus. Recent advancement of imaging modalities such as intravascular ultrasound (IVUS) and optical coherence tomography (OCT) demonstrated the existence of calcified nodule in clinical practice [2–4].

Description of recent nonselective cohorts of patients requiring coronary angioplasty included 12% of severely calcified lesions [5]. Since the calcified lesions are usually rigid, even high pressure balloon dilatation may fail to fully dilate the lesion but may lead to vessel dissection or incomplete stent deployment with its attendant risk of restenosis and stent thrombosis. Although it is less known about the clinical outcome of coronary angioplasty for calcified nodule, stent underexpansion is suggested because of the existence in superficial calcium.

Excimer laser coronary angioplasty (ELCA) is a unique revascularization modality that has a lytic effect on thrombus in addition to its debulking effect on the atherosclerotic plaque beneath the thrombus [6]. Emission of excimer light results in enhanced antegrade TIMI flow within the infarct-related vessel [7]. The interaction of excimer laser energy with thrombus that is typical for pulse-waved lasers includes induction of acoustic shock waves propagation onto fibrin strands leading to their fracture and dissolution. In addition, ELCA 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) process that leads to vaporization and removal of irradiated lesion [8]. We here demonstrated the effect of ELCA for vaporization of calcified nodule and thrombus in ACS.

2. Case

A 69-year-old female with hypertension, diabetes mellitus and dialysis underwent investigation for non-ST-elevation ACS. Coronary angiogram revealed a severe stenosis in the proximal right coronary artery (RCA) (Fig. 1). The RCA was engaged with a 6 F JR 4.0 guide catheter (Boston Scientific, Natick, MA, USA) from the right femoral approach. After crossing RCA with a 0.014-inch guidewire (Neo's Fielder FC, Asahi Intec., Nagoya, Japan), IVUS catheter could not be crossed this lesion. After predilatation with a 2.0/15 mm balloon (Ikazuchi, Kaneka, Osaka, Japan), IVUS and OCT examinations could be performed (Fig. 2). IVUS finding showed that the culprit lesion is an eruptive, dense, calcified mass having an irregular and protruding with a convex surface. OCT finding showed a nodular calcification

* Corresponding author at: Yushima 1-5-45, Bunkyo-ku, Tokyo 113–8519, Japan. Tel.: +81 3 5803 5231; fax: +81 3 5803 0133.
E-mail address: ashikaga.cvm@tmd.ac.jp (T. Ashikaga).

http://dx.doi.org/10.1016/j.carrev.2014.09.006
1553-8389/

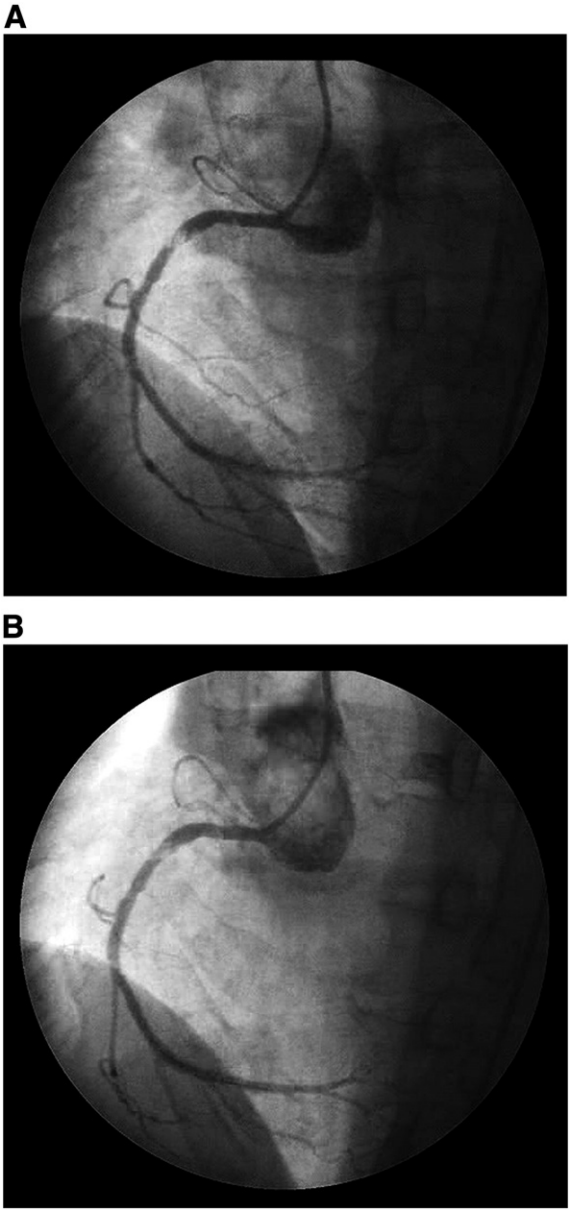

Fig. 1. (A): Baseline angiographic view showing severe stenosis in the proximal right coronary artery (RCA); (B): Angiographic view after post balloon dilatation (2.0/15 mm).

protruding into lumen overlying superficial calcification with red thrombus attached to the disrupted site. These two modalities identified that this culprit lesion includes calcified nodule with red thrombus. ELCA was performed with a Spectronetics CVS-300 System (Spectranetics, Colorado Springs, CO), which is a XeCl excimer laser system. A 1.4 mm concentric ELCA catheter was advanced slowly at a speed of 0.2 to 0.5 mm/s across the lesion, with standard saline flush technique applied [9–11]. We started with laser energy at 45 fluence and 25 Hz. Laser energy was increased to 50 fluence and 30 Hz for two additional sequences. IVUS and OCT findings after ELCA showed that calcified nodules were disrupted and the accompanied plaque and thrombus were also vaporized. Then 3.0/18 mm integrity stent (Medtronic Inc., Minneapolis, Minnesota) was implanted, and postdilatation with 4.0/12 mm high pressure balloon (NC trek, Abbot Vascular, Abbot, Santa Clara, USA) at 20 atm was employed. Final result showed no residual stenosis (Fig. 3). OCT findings showed adequate stent expansion. Clinical follow up at 10 months was uneventful, and the patient remained without angina.

3. Discussion

Calcified nodules are pathologically defined as the presence of fracture of a calcified plaque, interspersed fibrin and a disrupted fibrous cap with an overlying thrombus. The eruptive calcified nodules are usually eccentric, protruding into the lumen, and there is an absence of endothelium and collagen above the nodules of calcium with a platelet-rich thrombus which is usually non-occlusive. If this nodule is non-culprit segments in ACS, previous report demonstrated that there were fewer major adverse events during 3-year follow up [4]. However, if this nodule is the culprit segment in ACS, tailored treatment should be required because calcified nodule is different from plaque rupture and erosion in view of pathophysiological processes [2].

Recent study showed that calcified nodule was observed more frequently in older patients with hypertension, chronic renal disease and higher levels of creatinine level [2]. Coronary calcification was also shown to be more frequent and severe in patients with chronic kidney disease compared to those with normal renal function [12,13]. Calcified lesions may be resistant to balloon and stent expansion, which significantly increases the subsequent risks of in-stent restenosis and stent thrombosis. Although less is known about the clinical outcome for coronary angioplasty in patients with calcified nodule, superficial calcification may lead to underexpansion of the deployed stent.

The use of debulking technique such as rotational atherectomy and ELCA can help overcome the limitation of treatment for calcified lesions [13]. Since rotational atherectomy may lead to distal embolism because of its increased platelet aggregation, it is not recommended in thrombus-containing ACS lesion. ELCA utilizes a xenon chlorides gaseous medium, which generates ultraviolet light energy with a wavelength of 308 nm and a shallow penetration depth of only 50 um^3. In contrast to rotational atherectomy, ELCA showed the reduction in platelet aggregation, which is effective for thrombus containing ACS lesion [14]. Laser-induced thrombolysis improved minimal lumen diameter, lower thickness and enhanced TIMI flow. Because the atherosclerotic plaque and thrombus readily absorb laser energy in the 308-nm ultraviolet (excimer) wavelength, ELCA is believed to produce a favorable interaction with such lesions to prevent distal embolism before ballooning or stenting in acute myocardial infarction. In addition, when interacting with a thrombotic substrate, laser is able to dissolve the thrombus with the mean size of the particles produced of less than 7 um which do not obstruct the microcirculation [2].

Facilitation of adjunct balloon angioplasty and stenting could be accomplished after ELCA with the capability of efficient plaque debulking and thrombus vaporization. Although the mechanism of ELCA in lumen enlargement in nonstented lesions is known to be a combination of tissue ablation and vessel expansion, ELCA has another adjunctive application such as the non-dilatable and/or calcified lesions. Noble S et al. demonstrated that ELCA was effective to expand fully for the underexpanded stent due to severely calcified lesion [15]. Our data showed that laser activation helps create larger-sized bubbles and helps in debulking and softening the calcium to further expand stent fully.

In conclusion, the mechanism of action with ELCA is not only the disruption of tissue within the calcified nodule but also the disappearance of thrombus attached to the lesion. ELCA may be effective for weakening the calcified structure and enabling the balloon and stent expansion fully without distal embolism in ACS lesions with calcified nodule.