ESC European Society of Cardiology

European Heart Journal - Case Reports (2020) **4**, 1–8
doi:10.1093/ehjcr/ytaa411

CASE SERIES
Coronary heart disease

Usefulness of excimer laser in acute coronary syndrome with left main coronary artery: a case series

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Received 10 May 2020; first decision 20 May 2020; accepted 13 October 2020; online publish-ahead-of-print 1 December 2020

Background Acute coronary syndrome caused by unprotected left main coronary artery (ACS-ULMCA) occlusion has a high mortality due to the formation of plaques and rich thrombi. Although excimer laser coronary angioplasty (ELCA) is effective in debulking and ablation of plaque burden and rich thrombi, its effectiveness in ACS-ULMCA remains unknown.

Case summary We conducted percutaneous coronary intervention (PCI) using ELCA for six patients with ACS-ULMCA from February 2016 to May 2019. This case series includes a 65-year-old man who presented with sudden-onset chest pain. Angiography revealed subtotal occlusion of the left main coronary artery (LMCA). The use of a 0.9-mm ELCA catheter advanced from LMCA to the left anterior descending artery markedly improved coronary blood flow, and intravascular ultrasound revealed debulking of the plaque and thrombus. Another 79-year-old man presented with chest pain. Angiography revealed total occlusion of LMCA. Use of a 0.9-mm ELCA catheter improved coronary blood flow. Subsequent kissing balloon technique led to satisfactory results. All cases needed mechanical support (such as intra-aortic balloon pumping or percutaneous cardiopulmonary support) prior to PCI. Five patients survived finally, and one died 34 days after primary PCI.

Discussion After stabilizing haemodynamics by mechanical support, ELCA could be a good option to improve coronary blood flow in patients with ACS-ULMCA.

Keywords Acute coronary syndrome • Case series • Excimer laser • Left main coronary artery

Learning points

- Acute coronary syndrome with unprotected left main coronary artery usually has a large thrombus and lipid-rich plaque. Excimer laser coronary angioplasty (ELCA) breaks down these thrombus and plaque safely and effectively.
- Both excimer laser coronary angioplasty and mechanical circulatory support can be considered in stabilizing haemodynamics in cases of the acute coronary syndrome from unprotected left main coronary artery occlusion.
- The usage of 0.9-mm ELCA with an excellent crossability and high debulking speed for lesions, i.e., within several tenths of a second, may be able to achieve better coronary flow.

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Handling Editor: Elad Asher
Peer-reviewers: Julien Adjedj and Pierre Deharo
Compliance Editor: Max Sayers
Supplementary Material Editor: Vishal Shahil Mehta

Introduction

Although acute coronary syndrome (ACS) is associated with remarkable clinical outcomes owing to advanced interventional technology and pharmacology in recent decades, the mortality due to ACS with the unprotected left main coronary artery (ACS-ULMCA) remains high.[1] Because ACS-ULMCA usually has a rich thrombus, it undergoes initial thrombolysis in myocardial infarction (TIMI) 0/1 flow that makes it difficult to achieve optimal final TIMI flow, resulting in poor outcomes.[2]

Excimer laser coronary angioplasty (ELCA) breaks down the thrombus and debulks the atherosclerotic plaque. The safety and feasibility of this procedure for ACS cases have previously been reported.[3] In thrombus-rich lesions, the effectiveness of ELCA has been mainly demonstrated by the reduction in the incidence of the slow flow phenomenon.[4,5] However, limited data are available on the clinical outcome of ACS-ULMCA using ELCA.

We hypothesized that ELCA is effective for cases of ACS-ULMCA harbouring large thrombi and lipid-rich plaques. Here, we report the results of a case series of ACS-ULMCA wherein ELCA was performed at our institute.

Case presentation

Case 1

A 65-year-old man presented to our hospital with sudden-onset chest pain. He had a history of nephrotic syndrome, which was treated with 5 mg oral prednisolone and 10 mg rabeprazole daily. At the emergency department, his blood pressure was 99/74 mmHg, pulse was 88/min, and respiratory rate was 24/min with oxygen saturation of 98% in room air. He presented with cold sweat due to chest pain. His heart sound was normal on chest examination. Electrocardiogram (ECG) showed ST-segment elevation in aVR (*Figure 1*). Angiography revealed subtotal occlusion of the left main coronary artery (LMCA) with TIMI 1 flow in the left anterior descending artery (LAD) and TIMI 0 flow in the left circumflex artery (LCX) (*Figure 2A–C*, Supplementary material online, *Video S1*). After the crossing of guidewires toward LAD and LCX (*Figure 2D*) with a 0.9-mm ELCA catheter advanced from LMCA to LAD for four cycles of ablation (Supplementary material online, *Video S2*), the flow in LAD improved to up to TIMI 3 flow and intravascular ultrasound (IVUS) revealed debulking of the plaque and thrombus (*Figures 2E and F* and *Figure 3*, Supplementary material online, *Videos S3* and *S4*). A 3.5/23-mm everolimus-eluting stent (EES) was implanted to LMCA

Timeline

Timeline		Case 1
Day 0	15:30	Sudden onset of chest pain
	16:10	ST-segment elevation in chest leads of 12-leads electrocardiogram at the emergency department
	17:01	Subtotal occlusion of the left main coronary artery revealed in angiography
	17:04	Intra-aortic balloon pumping started
	17:33	0.9 mm excimer laser angioplasty performed Coronary flow improved
	17:49	3.5/23 mm everolimus-eluting stent implanted
Day 1- 4		The use of diuretics for heart failure
Day 5		Intra-aortic balloon pumping successfully terminated
Day 18		Discharge home

Timeline		Case 2
Day 0	19:30	Sudden onset of chest pain
	23:53	ST-segment elevation in chest leads of 12-leads electrocardiogram at the emergency department
Day 1	0:45	Intra-aortic balloon pumping started
	0:58	Total occlusion of the left main coronary artery revealed in angiography
	1:10	0.9 mm excimer laser angioplasty performed Coronary flow improved slightly
	1:31	3.0/23 mm everolimus-eluting stent implanted
Day 2		Cardioversion performed for ventricular tachycardia Intubation due to heart failure caused by pneumonia
Day 12		Intra-aortic balloon pumping terminated
Day 16		Extubation
Day 31		Discharge home

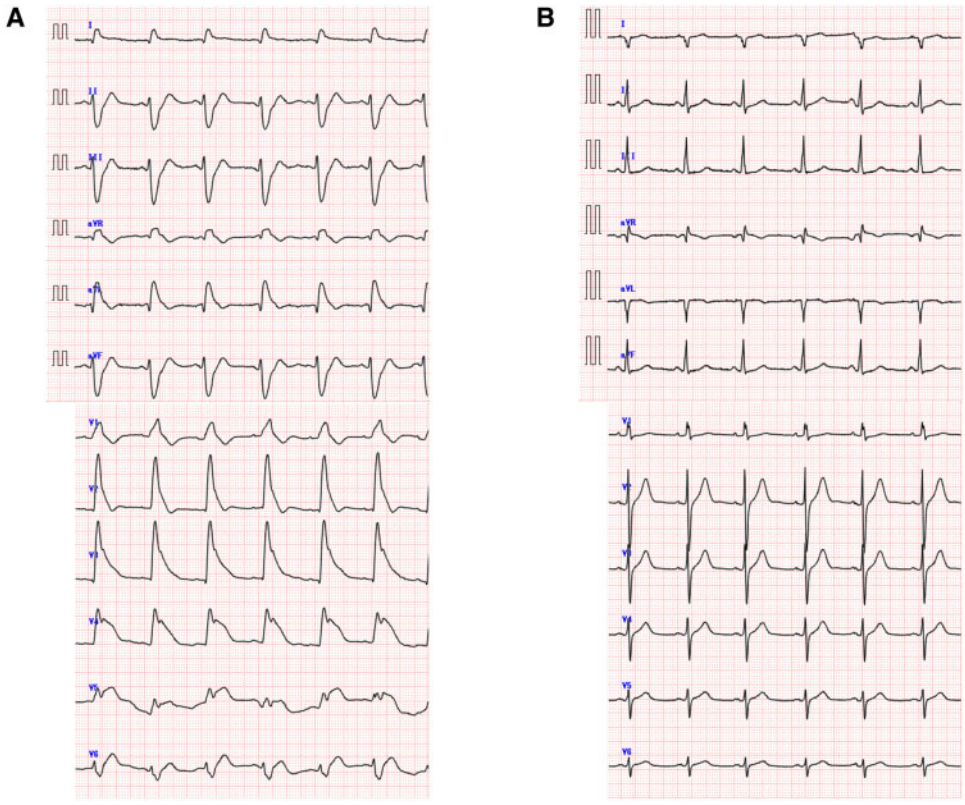

Figure 1 (*A*) The initial electrocardiogram on arrival at the emergency department. (*B*) Post-ECG obtained on the next day after primary percutaneous coronary intervention.

toward LAD after the kissing balloon technique (KBT) (*Figure 2G and H*). The proximal optimization technique was performed for LMCA (*Figure 2I*), and the final angiography showed TIMI 3 flow (*Figure 2J*).

Case 2

A 79-year-old man presented with chest pain and vomiting. He had a history of hypertension and dyslipidaemia. His blood pressure was 88/64 mmHg, pulse was 106/min, and respiratory rate was 30/min with oxygen saturation of 95% in room air. At auscultation, coarse crackles were heard on chest examination and chest X-ray showed severe pulmonary congestion. Electrocardiogram showed ST-segment elevation in aVR (*Figure 4*). Angiography revealed total occlusion of LMCA with initial TIMI 0 flow (*Figure 5A and B*, Supplementary material online, *Video S5*). Ablation was performed using a 0.9-mm ELCA, resulting in slightly improved TIMI 1 flow (*Figure 5C and D*, Supplementary material online, *Videos S6* and *S7*). Consequently, we proceeded to KBT toward LMCA–LAD and LCX (*Figure 5E*). Using a modified jailed balloon technique, a 3.0/23 mm EES was implanted in LMCA toward LAD (*Figure 5F*). The left circumflex artery was occluded after stenting; hence, we repeated KBT after re-crossing the guidewire toward LCX (*Figure 5G*). The final angiography showed TIMI 3 flow (*Figure 5H*).

Case series

Between February 2016 and May 2019, we conducted PCI using ELCA for six patients with ACS-ULMCA. Details of the patients are presented in *Table 1*. Their age ranged from 23 to 79 years, and initial TIMI 0/1 flow and cardiogenic shock were seen in five of the six patients. All patients needed intra-aortic balloon pumping (IABP), and half of them needed percutaneous cardiopulmonary support (PCPS) prior to PCI. We did not use GPIIbIIIa inhibitors because they have not been approved in our country. All patients were prescribed prasugrel (20 mg) and aspirin (200 mg) orally or through a nasogastric tube. They received unfractionated heparin to achieve an activated clotting time of >250 s. We initially performed ELCA after crossing the guidewire to LMCA lesion, following which TIMI flow grade improved in all cases except Case 2. Although the coronary slow flow phenomenon, which is caused by microembolism, occurred in two cases, final TIMI 3 flow was achieved in almost all cases. In our series, five patients survived and one died 34 days after primary PCI (*Figure 6*).

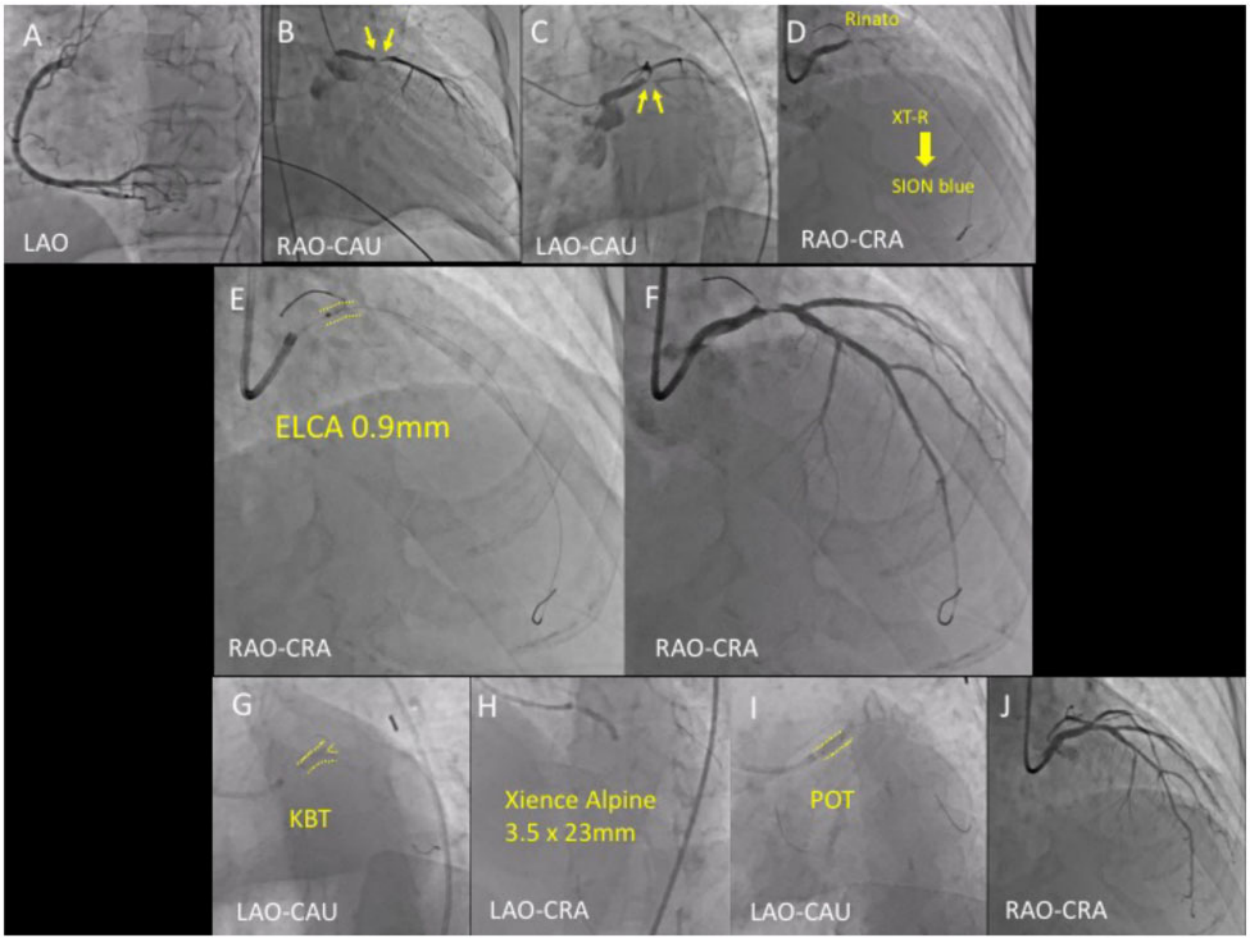

Figure 2 Angiography of Case 1. (*A–C*) Angiogram shows the true bifurcation lesion on left main coronary artery (yellow arrow). (*D*) XT-R advanced toward left anterior descending artery. (*E*) 0.9-mm excimer laser coronary angioplasty was conducted from left main coronary artery toward left anterior descending artery (dots line). (*F*) The coronary blood flow improved up to thrombolysis in myocardial infarction 3 flow after excimer laser coronary angioplasty. (*G, H*) Everolimus-eluting stent was implanted in left main coronary artery toward left anterior descending artery after kissing balloon technique. (*I*) Proximal optimization technique was performed in left main coronary artery. (*J*) Final angiogram shows thrombolysis in myocardial infarction 3 flow in the left coronary artery. CAU, caudal view; CRA, cranial view; ELCA, excimer laser coronary angioplasty; KBT, kissing balloon technique; LAD, left anterior descending artery; LAO, left anterior oblique; LMCA, left main coronary artery; RAO, right anterior oblique; TIMI, thrombolysis in myocardial infarction.

Discussion

Acute coronary syndrome caused by unprotected left main coronary artery has a higher rate of in-hospital death than non-ACS-ULMCA, with initial TIMI 0/1 flow being a strong prognostic factor of poor outcome even without cardiogenic shock.[1,2] In ACS-ULMCA, it is important to prevent both capillary obstruction (no reflow) and microembolism (slow flow), which easily lead to severe adverse events after PCI[6]; these events are emphasized with initial TIMI 0/1 flow because of a high thrombus burden. Distal embolic protection and aspiration have not been recommended because of their complex manoeuvre given the unstable haemodynamic status of ACS-ULMCA. Furthermore, aspiration is associated with an increased risk of stroke in the perioperative period[7] and is controversial for lesions close to the aorta such as LMCA.

Excimer laser coronary angioplasty has an excellent crossability and is particularly effective in debulking and ablation of both plaques and thrombi.[4,5] Laser emission is transmitted via flexible catheters to the target lesion, resulting in bioabsorption and debulking of irradiated plaques and thrombi.[8] Further, ELCA can reduce platelet aggregation in a phenomenon called the 'stunned platelet' phenomenon.[9] Despite the considerable length of time required to set up the machine body, a 0.9-mm ELCA catheter requires 10 s per sequence to cross the culprit lesion within a few cycles of ablation, i.e., <30 s.

Although the effectiveness of ELCA compared with that of aspiration of thrombus in ACS cases has been reported,[3] the strategy of intervention for ACS-ULMCA is not still established. Regarding lesions that have relatively little thrombi or plaques, direct stent implantation may be possible. However, the cases of ACS-ULMCA with TIMI 0/1 flow are rich in thrombi and plaques. In most of these

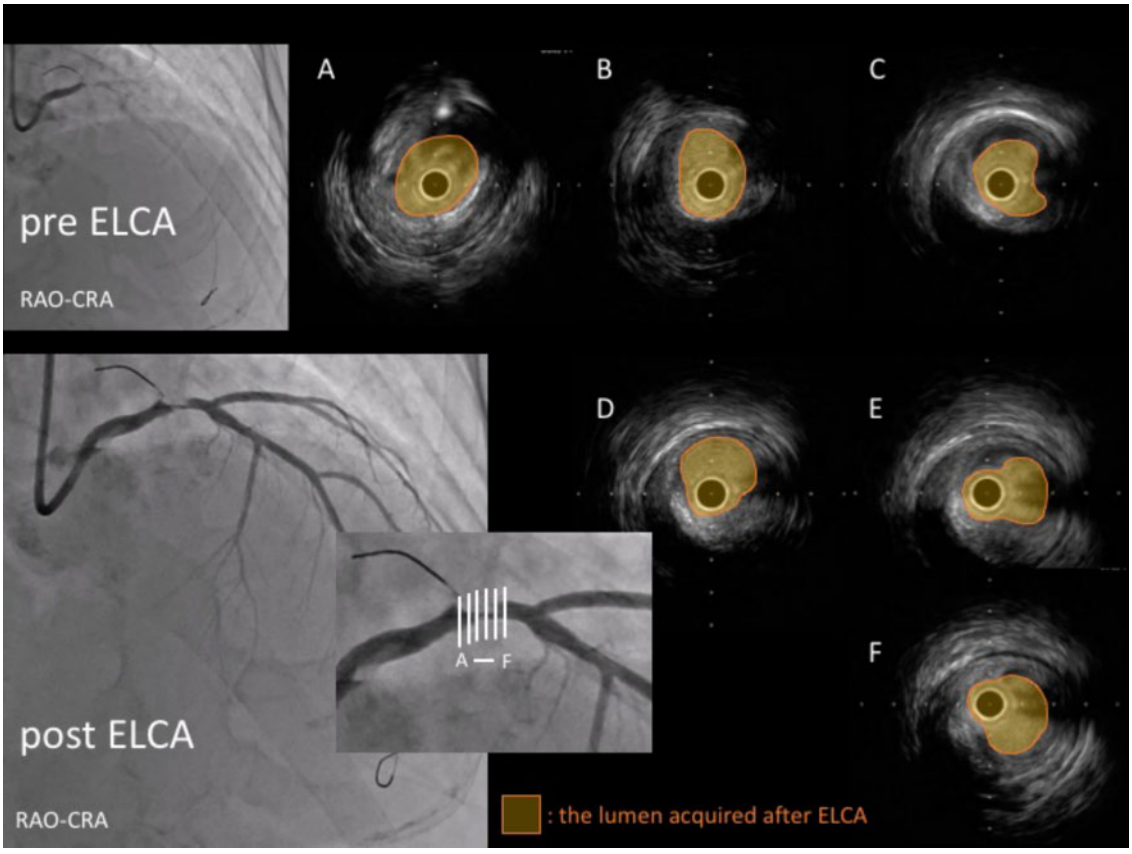

Figure 3 Intravascular ultrasound imaging acquired after excimer laser coronary angioplasty in case 1. Intravascular ultrasound revealed debulking of the plaque burden and thrombus by excimer laser coronary angioplasty. CAU, caudal view; CRA, cranial view; ELCA, excimer laser coronary angioplasty; IVUS, intravascular ultrasound; KBT, kissing balloon technique; LAD, left anterior descending artery; LAO, left anterior oblique; LMCA, left main coronary artery; AO, right anterior oblique; TIMI, thrombolysis in myocardial infarction.

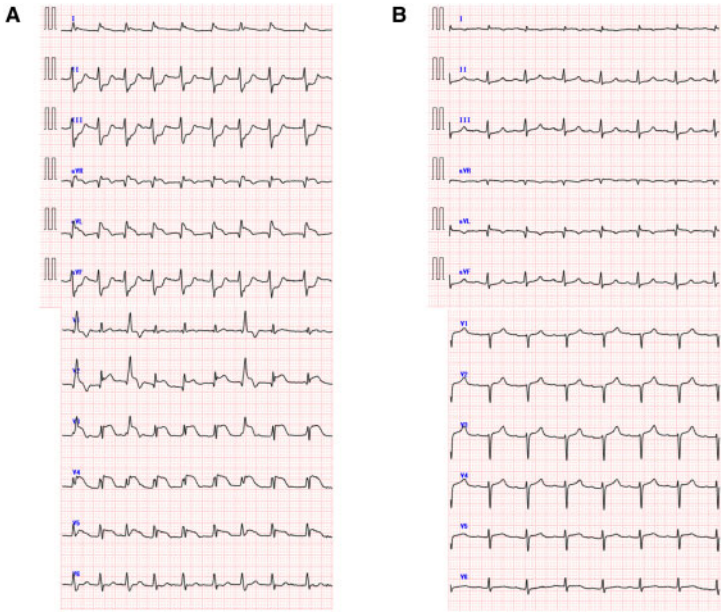

Figure 4 (*A*) The initial electrocardiogram on arrival at the emergency department. (*B*) Post-electrocardiogram obtained on the day after primary percutaneous coronary intervention.

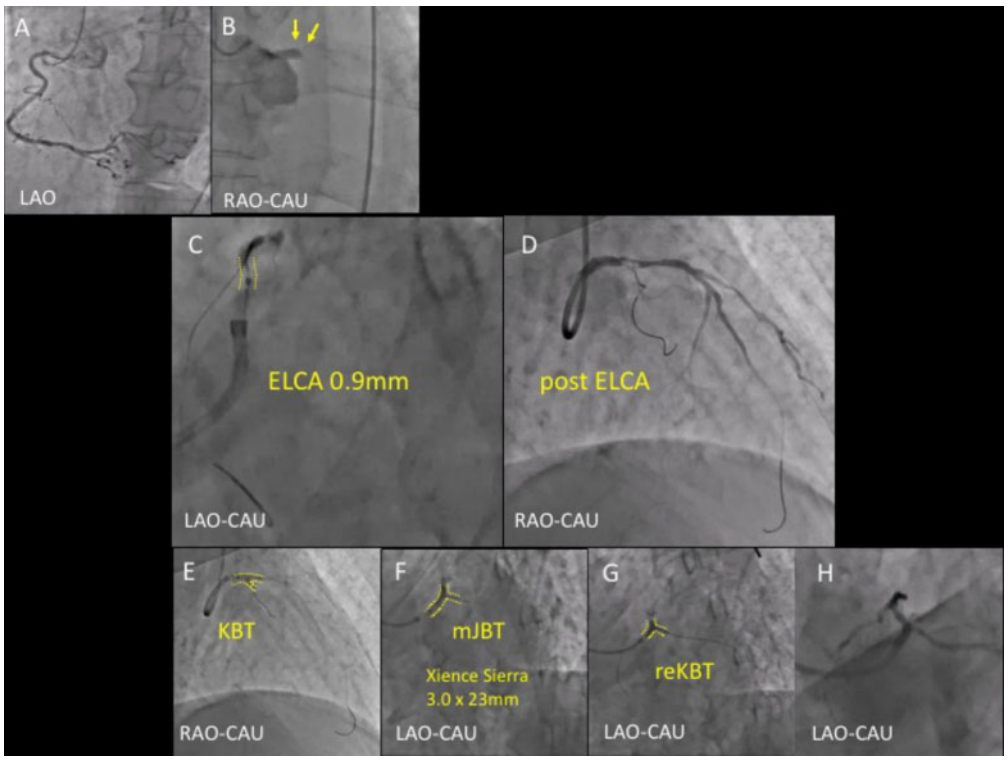

Figure 5 Angiography of Case 1. (*A*, *B*) Total occlusion seen in left main coronary artery (yellow arrow). (*C*, *D*) 0.9-mm excimer laser coronary angioplasty was conducted toward left anterior descending artery (dots line) that improved the coronary blood flow up to thrombolysis in myocardial infarction 1 flow. (*E*) Kissing balloon technique was performed toward left main coronary artery–left anterior descending artery and left circumflex artery. (*F*) Everolimus-eluting stent was implanted in left main coronary artery toward left anterior descending artery with modified jailed balloon technique. (*G*) Kissing balloon technique was repeated after re-crossing the guidewire to left circumflex artery. (*H*) Final coronary blood flow improved up to thrombolysis in myocardial infarction 3 flow. LCX, left circumflex artery.

Table 1 **Six cases of ACS-ULMCA using ELCA in our hospital between February 2016 and May 2019**

Case	1	2	3	4	5	6
Age (years old)/ sex	65/Male	79/Male	72/Male	78/Male	23/Male	79/Male
Presentation	Chest pain	Chest pain	VT	Chest pain	VF	PEA
Cardiogenic shock	Pre-cathlab	Pre-hospital	Pre-hospital	-	Pre-hospital	Pre-hospital
Antithrombotic therapy	Prasugrel 20 mg/aspirin 200 mg	Prasugrel 20 mg/aspirin 200 mg	Prasugrel 20 mg/aspirin 200 mg	Prasugrel 20 mg/aspirin 200 mg	Prasugrel 20 mg/aspirin 200 mg	Prasugrel 20 mg[a]
Initial TIMI	1	0	0	2	0	1
Post-ELCA TIMI	3	1	1	2	2	2
Final TIMI	3	3	2	3	3	3
Slow flow	+	+	-	-	-	-
ELCA size (mm)	0.9	0.9	1.7	1.7	1.7	1.7
Ablation cycle	4	1	1	2	2	2
Procedure	KBT/POT	mJBT	KBT/POT	KBT	Direct stenting	Direct stenting
Mechanical support	IABP	IABP	IABP/PCPS	IABP	IABP/PCPS	IABP/PCPS
Intubation	+	+	+	-	+	+
Door to balloon	75	77	122	87	101	116
Procedure time	88	81	129	84	48	32
Complication	-	-	-	-	-	-
Outcome	Alive	Alive	Alive	Alive	Alive	Dead

Aspirin had been already prescribed due to the history of cerebral infarction.
IABP, intra-aortic balloon pumping; KBT, kissing balloon technique; mJBT, modified jailed balloon technique; PCPS, percutaneous cardiopulmonary support; PEA, pulseless electrical activity; POT, proximal optimization technique; VF, ventricular fibrillation; VT, ventricular tachycardia.

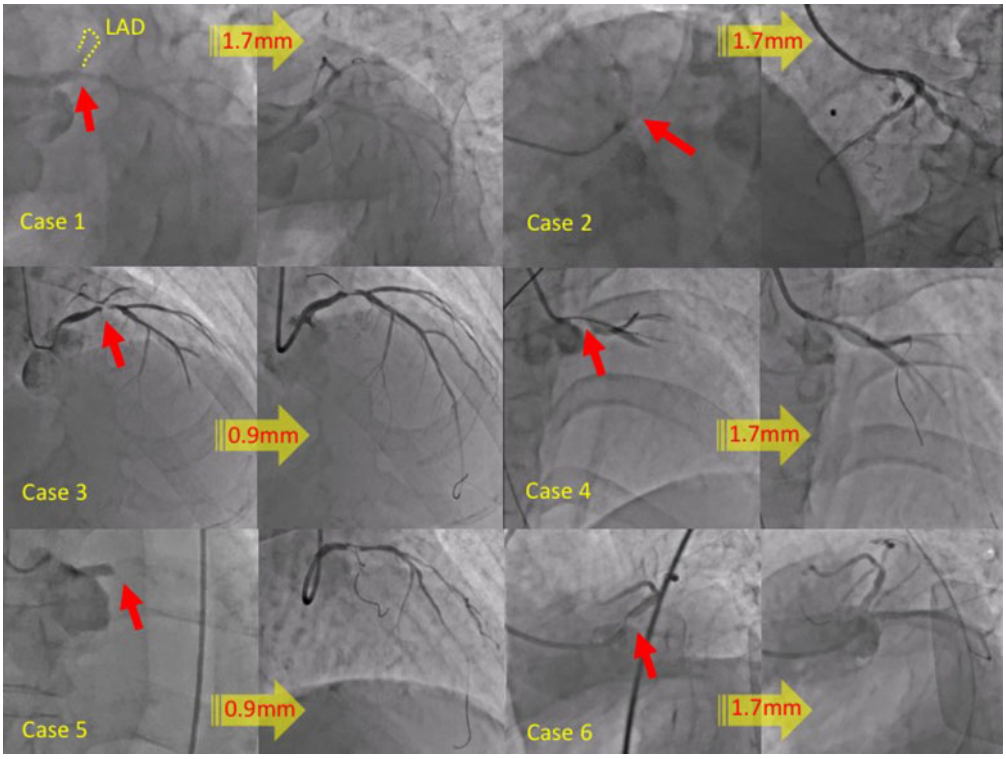

Figure 6 Coronary angiography of six cases of unprotected left main coronary artery. Our cases of unprotected left main coronary artery used of excimer laser coronary angioplasty reached up to six. Red arrows on the left side of each case show stenosis or occlusion of ULM. The pictures on right side of each case showed improvement of coronary blood flow just after excimer laser coronary angioplasty.

cases, it the coronary blood flow does not commonly improve by simple guidewire crossing but needs pre-dilatation before stenting. Regarding reducing thrombi, ELCA is thought to be effective in preventing microembolism after pre-dilatation because the use of GPIIbIIIa inhibitors has not been approved at our institute.

In our case series, five out of six patients survived with the use of ELCA. However, between March 2004 and May 2018, 17 patients died within 30 days after PCI without ELCA out of 40 patients with STEMI whose culprit lesion was LMCA at our institute. In consideration of previous reports that the mortality due to ACS-ULMCA with shock approaches 40%,[2] our strategy using ELCA might be a feasible and acceptable option for patients with STEMI whose culprit lesion is LMCA.

In the first study conducted in 2009, it was reported that of 20 patients with ACS treated using ELCA,[10] only 1 had ULMCA. Therefore, to the best of our knowledge, this is the first study to report that ELCA was effective in a total of six patients with ACS-ULMCA whose haemodynamics were unstable. After establishing IABP or PCPS and stabilizing haemodynamics, lesion crossing and stent implantation proceeded successfully and no critical complications associated with ELCA occurred in the periprocedural period in any of our cases. Furthermore, ELCA has been reported to improve myocardial salvage in patients with STEMI in terms of long-term outcome[11]; hence, based on its rapidity and crossability, ELCA might be an alternative option for patients with ACS-ULMCA, particularly for vulnerable patients with large thrombi who required immediate flow improvement.

Conclusion

Excimer laser coronary angioplasty could be a good option for effective and safe improvement of the coronary blood flow. It may also improve the clinical outcomes of patients with ACS-ULMCA.

Lead author biography

Dr Takuro Imaoka is a cardiology fellow in Ogaki Municipal Hospital, Gifu, Japan. He graduated from Gifu university of Japan in 2016.He is interested in ischemic heart disease and intervention for acute coronary syndrome.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patients in line with COPE guidelines.

Conflict of interest: none declared.

Funding: none declared

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