

Excimer LASER Coronary Atherectomy in Complex Coronary Lesions: A Contemporary Analysis of Technical Success and Safety

Dr. Arunachalam Esakkiappan¹, Dr. Vijesh Anand Latha Arivudai Nambi²,
Dr. K Sureshkumar³, Dr. P C Ganapathy Shakthivel⁴

¹MD DM, Chief and Senior Interventional Cardiologist, Aruna Cardiac Care, Tirunelveli, Tamilnadu, India.

²MD DrNB, Interventional Cardiologist, Aruna Cardiac Care.

³MD DrNB, Interventional Cardiologist, Aruna Cardiac Care

⁴MD (Anaes), Intensivist, Aruna Cardiac Care

Abstract: ***Background:** Complex coronary lesions, particularly in-stent restenosis (ISR), balloon non crossable and balloon non dilatable lesions, moderately calcified plaques, thrombotic lesions remain major challenges in percutaneous coronary intervention (PCI). Excimer laser coronary atherectomy (ELCA) has re-emerged as a valuable tool in such scenarios. **Aim:** To evaluate the immediate outcomes, safety, and technical success of ELCA in a contemporary cohort of patients with complex coronary artery disease. **Methods:** Fourteen patients undergoing ELCA between April to July 2025 were analysed. Baseline demographics, lesion characteristics, procedural details, and complications were reviewed. Technical success was defined as successful lesion modification permitting subsequent balloon angioplasty and/or stent deployment with TIMI 3 flow. **Results:** The mean age was 62.9 ± 8.5 years; 92.9% had diabetes mellitus, and 50% had chronic kidney disease. Most patients (78.6%) presented with ISR, and 28.6% had calcified lesions. The LAD was the most commonly involved vessel (64.3%). Clinical presentations included NSTEMI (35.7%), anterior wall MI (21.4%), and unstable angina (21.4%). Lasing techniques varied, with saline-blood-saline contrast mix 50%. Coronary dissections occurred in 78.6% (mostly Grade II), and slow flow in 57.1%; all were managed successfully. No major adverse cardiac events occurred peri-procedurally. Optical Coherence Tomography imaging was used in assisting. Technical success and complete revascularization were achieved in 100% of patients. **Conclusions:** In this case series, ELCA demonstrated universal technical success and acceptable safety in highly complex lesions, particularly ISR, balloon non crossable and calcified plaques. These results support ELCA as a valuable adjunctive strategy in contemporary PCI.*

Keywords: Complex coronary lesions, Excimer LASER atherectomy, in stent restenosis, percutaneous coronary interventions.

1. Introduction

Percutaneous coronary intervention (PCI) with stent implantation has revolutionized the treatment of coronary artery disease. However, complex lesions, including ISR, heavily calcified plaques, and chronic total occlusions, remain difficult to treat and are associated with increased risk of restenosis and stent thrombosis¹.

Excimer laser coronary atherectomy (ELCA) works through photothermal, photomechanical, and photochemical mechanisms, producing vapor microbubbles and shockwaves that facilitate plaque modification and stent expansion². Initial studies in the 1990s demonstrated feasibility³, while recent registries have reinforced its safety and efficacy in resistant lesions and ISR⁴⁻⁶.

The present study reports a contemporary single-centre case series evaluating the technical success and safety profile of ELCA in highly complex coronary lesions.

2. Methods

Study Design and Population

A retrospective analysis was conducted on 14 consecutive patients undergoing ELCA at Aruna Cardiac Care during April-August 2025.

Data Collection

Demographics, comorbidities, angiographic lesion characteristics, procedural strategies, and complications were recorded. Left ventricular ejection fraction (LVEF) was assessed by echocardiography. SYNTAX scores were calculated.

Procedural Technique

Standard PCI techniques with dual antiplatelet therapy and unfractionated heparin were used. Nexcimer Philips LASER system was used.

ELCA was performed using varying strategies. In these patients saline alone, blood alone and saline-contrast (50% mix) were used variably. In patients where saline alone is used are labelled as saline alone. In patients where saline and blood lasing were done, labelling was done as saline-blood lasing. In patients where saline lasing, blood lasing and saline-contrast mix lasing were used, labelling was done as saline-blood-contrast lasing. Guide extension catheters and thromboaspiration were used selectively.

NEXCIMER PHILIPS LASER SYSTEM specifications

Active medium	XeCl
Weight	480 lbs / 217 kg
Wavelength	308 nm
Length	52 in / 132 cm
Catheter output fluence	30-80 mJ/mm ²
Height	42 in / 107 cm
Repetition rate	25-80 Hz
Width	19 in / 48 cm
Pulse width	125-200 ns, FWHM

Outcomes and Definitions

- **Technical success:** Successful lesion modification enabling balloon angioplasty or stenting with TIMI 3 flow.
- **Complete revascularization:** Successful treatment of all significant lesions.
- **Complications:** Included dissection, slow/no-reflow, perforation, myocardial infarction, or death.

3. Results

Patient Characteristics

Mean age: 62.9 ± 8.5 years; male:female ratio 13:1. Diabetes mellitus was highly prevalent (92.9%), followed by CKD (50.0%) and hypertension (42.9%). Prior PCI was recorded in 78.6% patients.

Lesion Complexity

ISR accounted for 78.6% of cases, calcified lesions 28.6%, thrombotic lesions 14.3%, and one case of chronic total occlusion (7.1%). LAD was the most frequent target (64.3%). Mean SYNTAX score: 20.6 ± 8.5.

Clinical Presentation

Patients presented with NSTEMI (35.7%), anterior wall MI (21.4%), unstable angina (21.4%), inferior/posterior MI (14.3%), and inferior MI (7.1%). Median LVEF was 45% (IQR 30–60%).

Procedural Outcomes

- **Lasing techniques:** Saline–blood–contrast mix (50%), saline only (28.6%), saline–blood (14.3%), saline–contrast (7.1%).
- **Adjunctive support:** Guide extension in 14.3%, thromboaspiration pre-ELCA 21.4%.
- **Complications:** Coronary dissections in 78.6% (Grade II: 64.3%, Grade I: 14.3%), slow-flow in 57.1%. No perforations, peri-procedural MI, or deaths.

Success

Technical success: 100% (14/14).

Complete revascularization: 100% (14/14).

Results

Variables		
Age* (Mean - years)	62.9	8.5
M:F	13:01	
Risk factors	Frequency	Percentage
Hypertension	6	42.86%
Diabetes Mellitus	13	92.86%
Dyslipidaemia	0	0.00%
Smoking	4	28.57%
CKD	7	50.00%

Family History	4	28.57%
Previous Procedures		
PCI	11	78.57%
Lesion Type		
In-Stent Restenosis (ISR)	11	78.57%
Calcified Lesions	4	28.57%
Thrombotic Lesions	2	14.29%
Chronic Total Occlusion	1	7.14%
LV Function*	45 (30 – 60)	11.9
Normal (>= 50%)	6	42.90%
Mild Dysfunction (40 – 49%)	1	14.30%
Moderate Dysfunction (30 – 39%)	6	42.90%
SYNTAX Score		
Low (<= 22)	9	
Intermediate (23 – 32)	4	
High (> 32)	1	
Total Syntax Score*	20.6	8.46
Artery involved		
RCA	5	35.71%
LAD	9	64.29%
Symptoms		
NSTEMI	5	35.71%
IPWMI	2	14.29%
IWMI	1	7.14%
AWMI	3	21.43%
Unstable Angina	3	21.43%
Lasing type		
Only Saline 100%	4	28.57%
Saline and Blood	2	14.29%
Saline and 50:50C	1	7.14%
Saline, Blood and 50:50C	7	50.00%
Guide Extension	2	14.29%
Thrombo Aspiration		
Pre ELCA	3	21.43%
Post ELCA	1	7.14%
Complications		
Dissection		
Grade I	2	14.29%
Grade II	9	64.29%
Slow Flow		
Grade II	8	57.14%
Technical Success	14	100.00%
Complete Revascularization	14	100.00%

Patient Demographics and Baseline Characteristics

A total of 14 patients underwent excimer laser coronary atherectomy during the study period. The mean age was 62.9 ± 8.5 years with a predominant male population (male-to-female ratio of 13:1). The patient cohort demonstrated a high burden of cardiovascular risk factors and comorbidities. Diabetes mellitus was present in most patients (92.86%, n=13), representing the most prevalent risk factor. Chronic kidney disease was identified in half of the patients (50.0%, n=7), while hypertension affected 42.86% (n=6) of the study population. Smoking history was documented in 28.57% (n=4) of patients, and a family history of coronary artery disease was present in 28.57% (n=4). Notably, none of the patients had documented dyslipidaemia.

Most patients had a history of previous percutaneous coronary intervention (78.57%, n=11), indicating a population with previously treated coronary artery disease requiring repeat intervention.

Lesion Characteristics and Complexity

The lesion characteristics reflected a high degree of complexity, justifying the use of excimer laser atherectomy. In-stent restenosis (ISR) was the predominant lesion type, accounting for 78.57% (n=11) of cases, highlighting the role of ELCA in treating this challenging clinical scenario. Calcified lesions were present in 28.57% (n=4) of cases, while thrombotic lesions were identified in 14.29% (n=2). One patient (7.14%) presented with chronic total occlusion.

The SYNTAX score distribution demonstrated predominantly low to intermediate complexity lesions: 9 patients had low SYNTAX scores (≤ 22), 4 patients had intermediate scores (23-32), and 1 patient had a high SYNTAX score (>32). The mean total SYNTAX score was 20.6 ± 8.46 , indicating moderate overall coronary complexity.

Regarding vessel distribution, the left anterior descending artery (LAD) was more frequently involved (64.29%, n=9) compared to the right coronary artery (35.71%, n=5).

Clinical Presentation

The clinical presentation varied across the acute coronary syndrome spectrum. Non-ST elevation myocardial infarction (NSTEMI) was the most common presentation (35.71%, n=5), followed by anterior wall myocardial infarction (AWMI) in 21.43% (n=3) of patients. Unstable angina was present in 21.43% (n=3) of cases. Inferior posterior wall myocardial infarction (IPWMI) and inferior wall myocardial infarction (IWMI) were less frequent, occurring in 14.29% (n=2) and 7.14% (n=1) of patients, respectively.

Left Ventricular Function

Assessment of left ventricular function revealed a median ejection fraction of 45% (interquartile range: 30-60%) with a standard deviation of 11.9%. The distribution of left ventricular dysfunction was notable: normal function ($\geq 50\%$) was present in 42.90% (n=6) of patients, while an equal proportion (42.90%, n=6) demonstrated moderate dysfunction (30-39%). Only one patient (14.30%) had mild dysfunction (40-49%), indicating a bimodal distribution between normal and moderate dysfunction.

Procedural Characteristics

The excimer laser atherectomy procedures employed various lasing techniques based on clinical requirements. The most used approach was a combination of saline, blood, and 50:50 contrast (50.0%, n=7), reflecting the complexity of the treated lesions. Saline alone was used in 28.57% (n=4) of cases, while saline and blood combination was employed in 14.29% (n=2) of procedures. The least frequently used technique was saline with 50:50 contrast (7.14%, n=1).

Guide extension catheters were utilized in 14.29% (n=2) of cases to provide additional support. Thrombotic aspiration was performed in selected cases: pre-ELCA thrombotic aspiration in 21.43% (n=3) of patients and post-ELCA aspiration in 7.14% (n=1).

Complications and Safety Profile

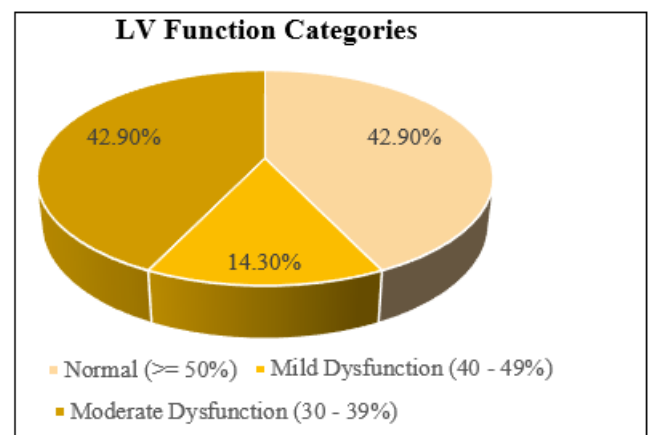
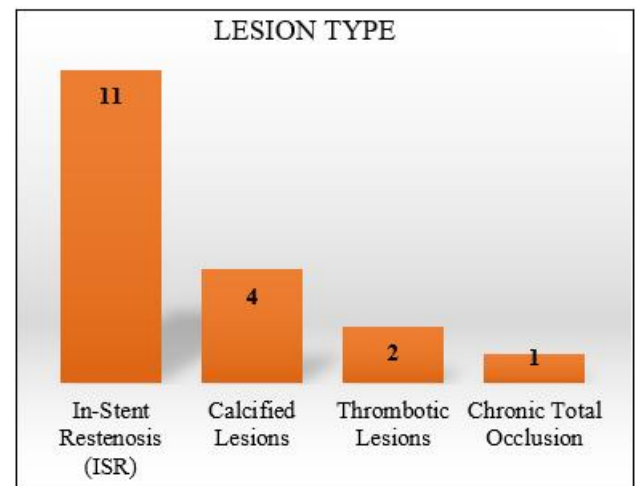
The procedural complication profile demonstrated acceptable safety outcomes. Coronary dissection was the most frequently observed complication, with Grade II dissections occurring in 64.29% (n=9) of patients and Grade I dissections in 14.29% (n=2). These dissections were managed successfully without adverse clinical outcomes.

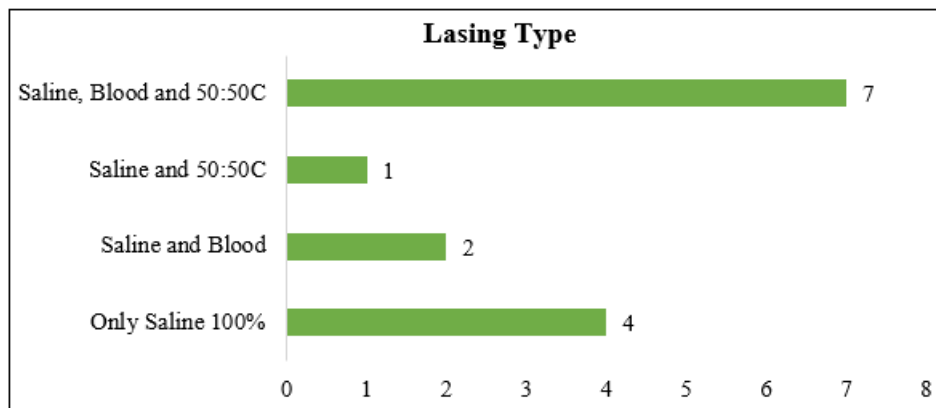
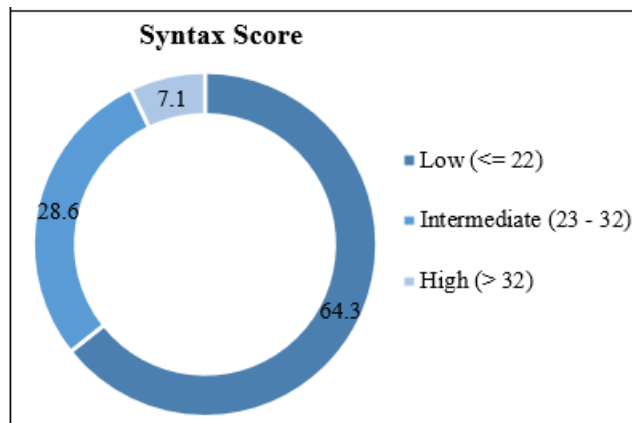
Slow flow phenomenon (Grade II) was documented in 57.14% (n=8) of patients following the procedure. Despite these flow-related complications, no major adverse cardiac events occurred during the procedural period.

Technical and Clinical Success

Excimer laser coronary atherectomy demonstrated excellent technical outcomes in this complex patient cohort. Technical success, defined as successful lesion modification enabling subsequent balloon angioplasty or stent placement, was achieved in 100% (n=14) of cases. Furthermore, complete revascularization was accomplished in all patients (100%, n=14), indicating comprehensive treatment of the target coronary lesions.

The universal technical success rate, despite the high prevalence of complex lesion characteristics including in-stent restenosis and calcified lesions, demonstrates the efficacy of excimer laser atherectomy in challenging coronary interventional scenarios.





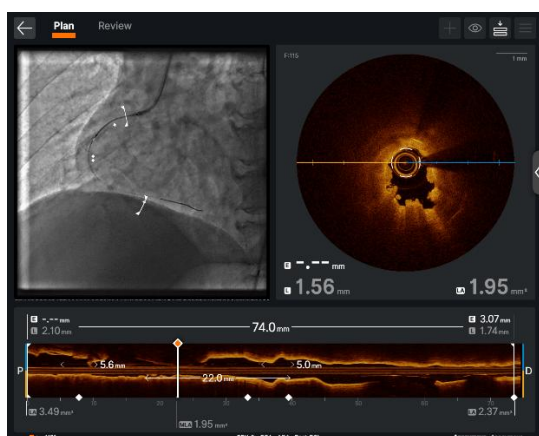
Case 1 (ISR)



Coronary Angiogram showing ISR in RCA



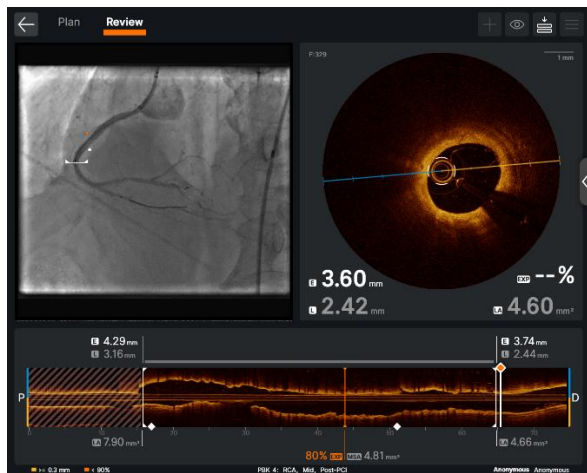
OCT image of RCA post Lasing



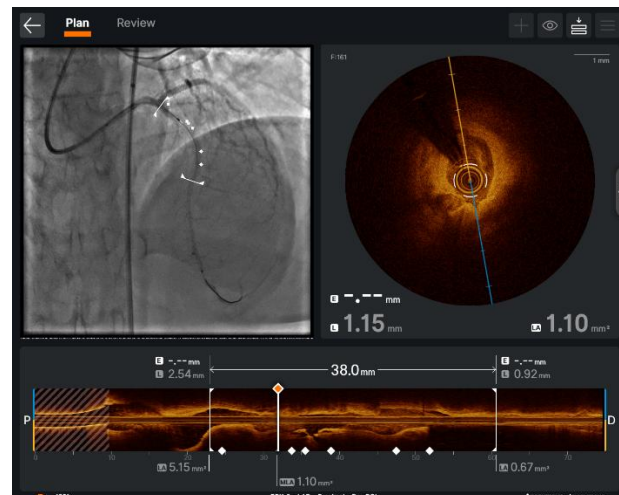
OCT image of RCA



CAG of RCA post stenting



OCT image of RCA post stenting



OCT after LASER

Case 2 (CALCIUM)

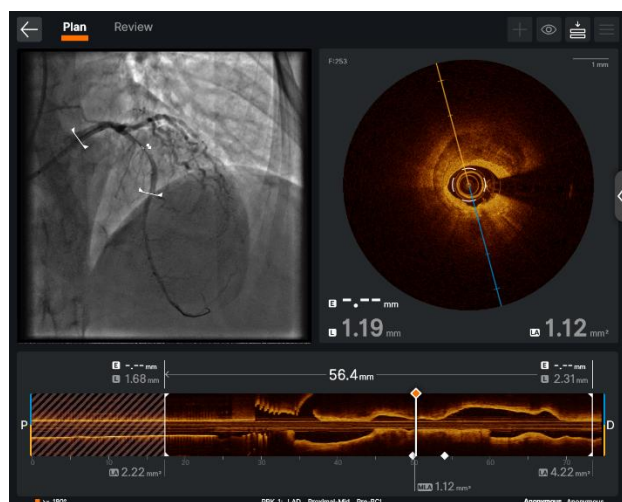
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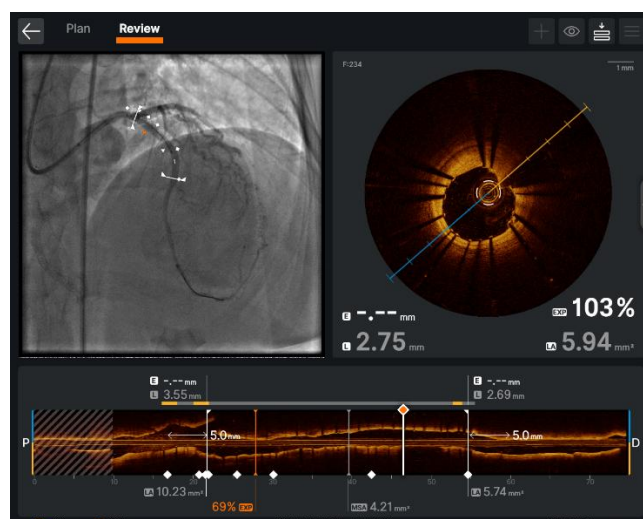
CAG- showing calcified lesion in proximal LAD



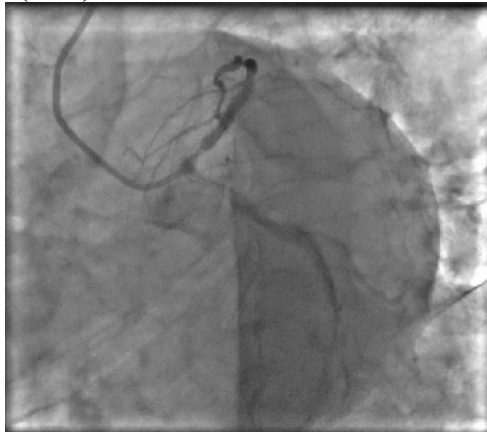
CAG post stenting



OCT- 360 degree calcium



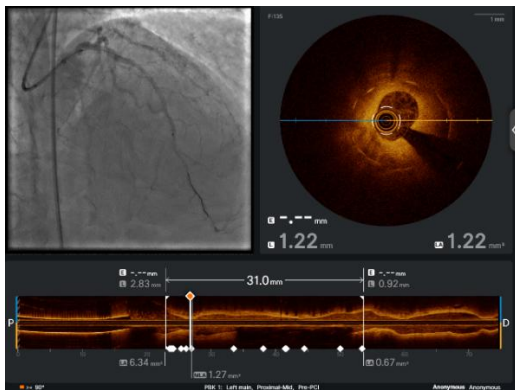
Final OCT post stenting

CASE 3 (DEB):

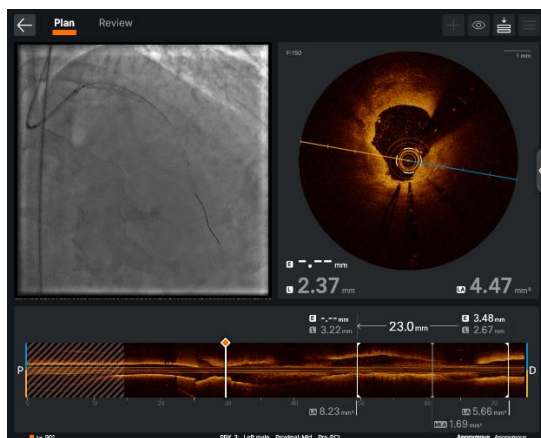
CAG – proximal LAD lesion



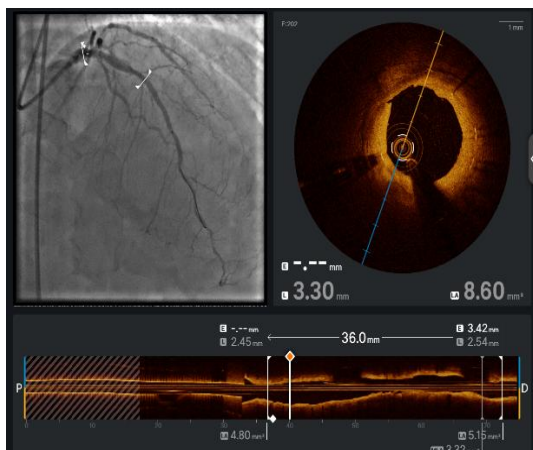
Post DEB CAG



OCT prior to Lasing



OCT image post Lasing



DEB to proximal LAD

4. Discussion

This series highlights ELCA's ability to manage complex coronary lesions, especially ISR and calcification, in high-risk patients. Despite a high burden of diabetes and CKD, ELCA achieved 100% technical and procedural success with no peri-procedural major adverse cardiac events.

Our findings are consistent with larger registries. Wacinski et al. reported procedural success in 100% of patients with non-dilatable calcified lesions using ELCA with contrast mix, with 6-month target lesion revascularization of 8.2%⁴. The ELLEMENT registry similarly confirmed ELCA effectiveness in non-dilatable stents⁵. Early reports by Goldberg et al. and Noble et al. described its utility in balloon-refractory ISR^{3,6}.

While dissections and slow flow were frequent, they were manageable and did not impact final outcomes. Importantly, the use of saline–blood–contrast mix in half of our cases reflects growing adoption of contrast-enhanced ELCA to augment plaque modification, as also described in recent series⁴.

5. Limitations

Small sample size, retrospective design, and absence of long-term follow-up limit generalizability. Nevertheless, these results support ELCA as an adjunctive tool in contemporary PCI.

6. Conclusion

ELCA provides a safe and effective option for treating resistant ISR and calcified coronary lesions. This series demonstrates universal technical success with acceptable safety, supporting its role as an adjunct in modern interventional cardiology.

References

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