



PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

ROMA

Centro Congressi
di Confindustria

**Auditorium
della Tecnica**

9ª Edizione

30 Settembre

1 Ottobre

2022

SESSIONI LIVE: CTO

CTO CALCIFICHE

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AOU Policlinico - Catania





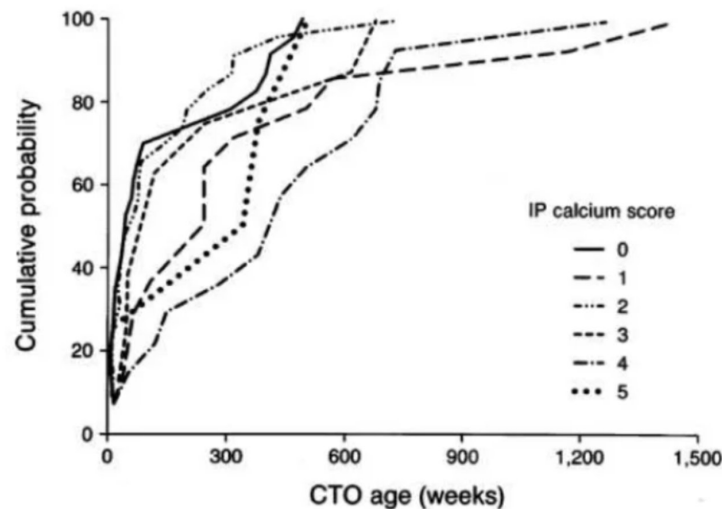
Calcified CTO: definition and prevalence

Heavy calcification: Multiple persisting opacifications of the coronary wall visible in more than one projection surrounding the complete lumen of the coronary artery at the site of the lesion.

Prevalence: 57–59% of CTOs has angiographically moderate or severe calcifications (vs 20.5% in all patients undergoing PCI).



Calcium and CTO age

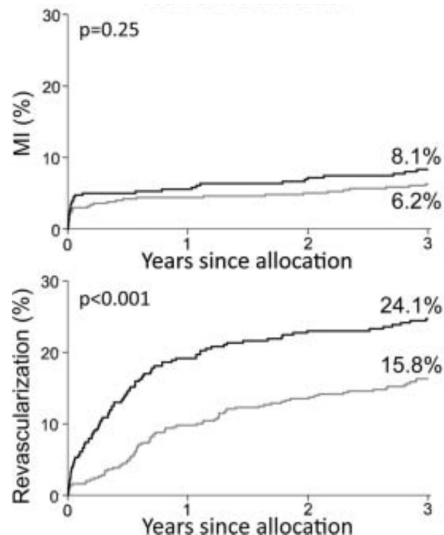
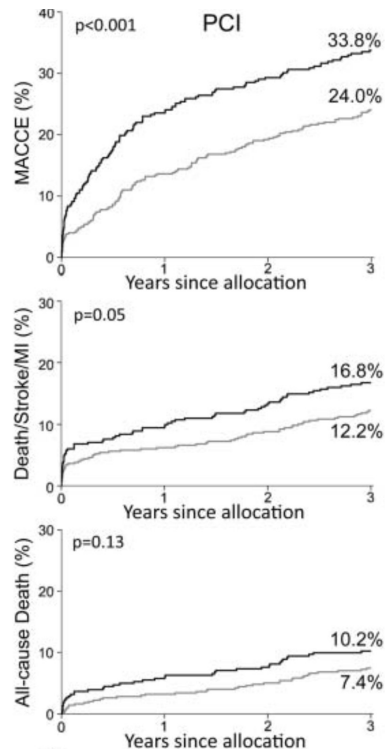


Srivatsa et al. J Am Coll Cardiol 1997;29:955– 63



Incidence, predictors and outcomes of incomplete revascularization after percutaneous coronary intervention and coronary artery bypass grafting: a subgroup analysis of 3-year SYNTAX data†

Stuart J. Head^a, Michael J. Mack^b, David R. Holmes Jr^c, Friedrich W. Mohr^d, Marie-Claude Morice^e, Patrick W. Serruys^f and A. Pieter Kappetein^{a,*}



The presence of CTO is an independent predictor of incomplete revascularization by PCI (OR = 2.46, 95% CI 1.66–3.64, P < 0.001)



Predicting Successful Guidewire Crossing Through Chronic Total Occlusion of Native Coronary Lesions Within 30 Minutes

The J-CTO (Multicenter CTO Registry in Japan) Score
as a Difficulty Grading and Time Assessment Tool

Table 4. Difficulty Score for CTO Lesions (J-CTO Score): 5 Selected Independent Predictors Identified by the Forward/Backward Procedure

Variables	Odds Ratio (95% CI)	Beta Coefficient	Point
Previously failed lesion	0.39 (0.15–0.97)	0.93	1
Blunt stump type	0.32 (0.18–0.55)	1.14	1
Bending	0.34 (0.20–0.58)	1.09	1
Calcification	0.26 (0.15–0.44)	1.36	1
Occlusion length ≥ 20 mm	0.19 (0.09–0.39)	1.65	1

Sum of each point = J-CTO score.

CI = confidence interval; CTO = chronic total occlusion; J-CTO = Multicenter CTO Registry of Japan.



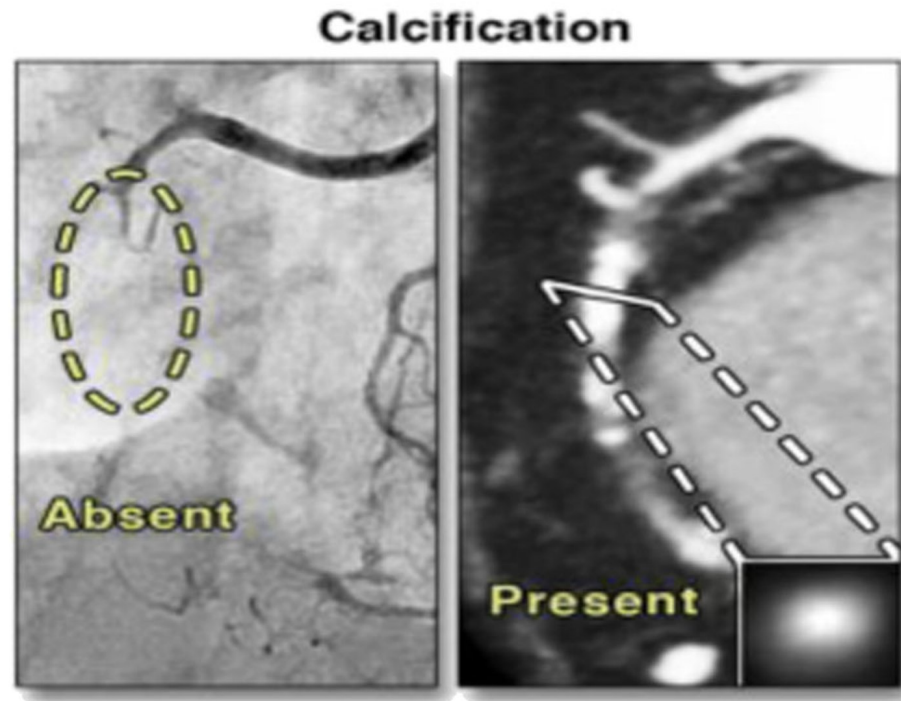
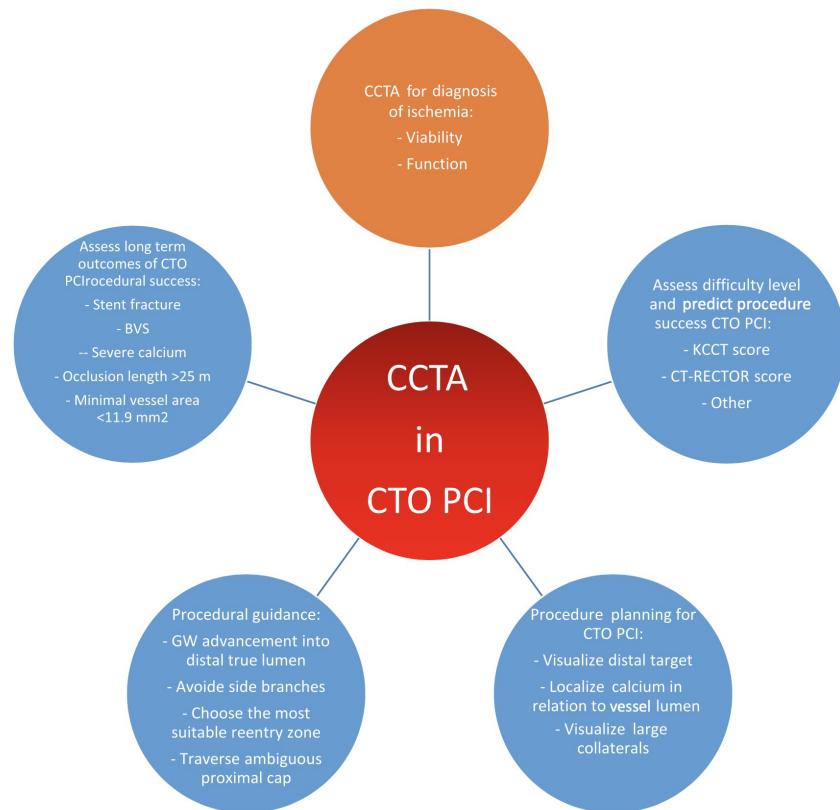
CASTLE Score

- CABG (previous)
- Age (> 70 years)
- Stump anatomy (blunt or no)
- Tortuosity (severe)
- Length of CTO (> 20 mm)
- Extent of calcification (> 50% of the segment)

Each CASTLE parameter was assigned a value of 0 or 1, depending on patient characteristics, and the score was calculated by adding up the total, for a potential risk score of 0 to 6. At a score of 0, the mean predicted risk of failure of CTO PCI was 5.8%. At a maximum score of 6, the predicted risk of failure was 56.5%.



Role of CTCA in CTO PCI





Role of CTCA in CTO PCI

Univariate and multivariate regression analyses for the prediction of PCI-failure.

	H.R.	C.I.	p-value
Univariate regression analysis			
<i>Conventional predictors</i>			
Duration of CTO	1.05	1.01–1.09	0.028*
Stump calcification	7.92	2.24–28.00	0.001*
Tapered stump	0.08	0.02–0.29	<0.001*
<i>MDCT-related predictors</i>			
Lesion length	1.03	0.99–1.10	0.028*
RCa score	14.6	3.46–61.31	<0.001*
RCa volume	19.8	4.23–92.76	<0.001*
RCa equivalent mass	14.6	3.46–61.31	<0.001*
% Ca area/CSA	30.3	2.64–348.92	0.006*
Multivariate regression analysis			
Stump calcification	13.4	0.89–201.46	0.061
% Ca area/CSA	18.5	1.19–283.96	0.037*

Ca indicates calcium and CSA indicates cross-sectional area.

* $p < 0.05$.



Crossing techniques in calcified CTOs

- **Wire advancement:**

Use of stiff, tapered-tip guidewires (such as Conquest Pro 12 or Hornet 14)

- **Use of coil-based and penetrative microcatheters:**

Corsair Pro (Asahi Intecc), Mamba (Boston Scientific) and Turnpike Spiral (Teleflex)

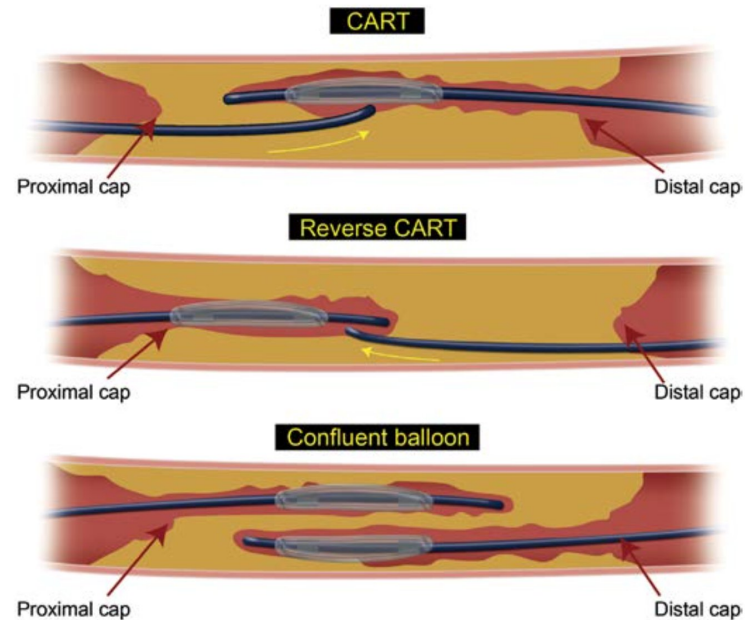
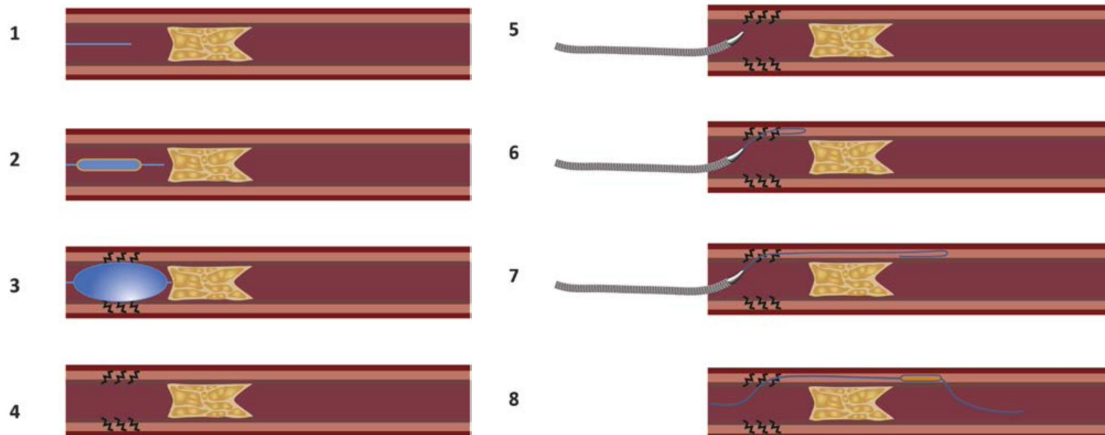
- **Use of dissection/reentry techniques:**

Scratch and go, BASE, power knuckle, Carlino's technique



DISSECTION AND REENTRY

BASE





Am J Cardiol. 2017 Jul 1;120(1):40-46. doi: 10.1016/j.amjcard.2017.03.263. Epub 2017 Apr 13.

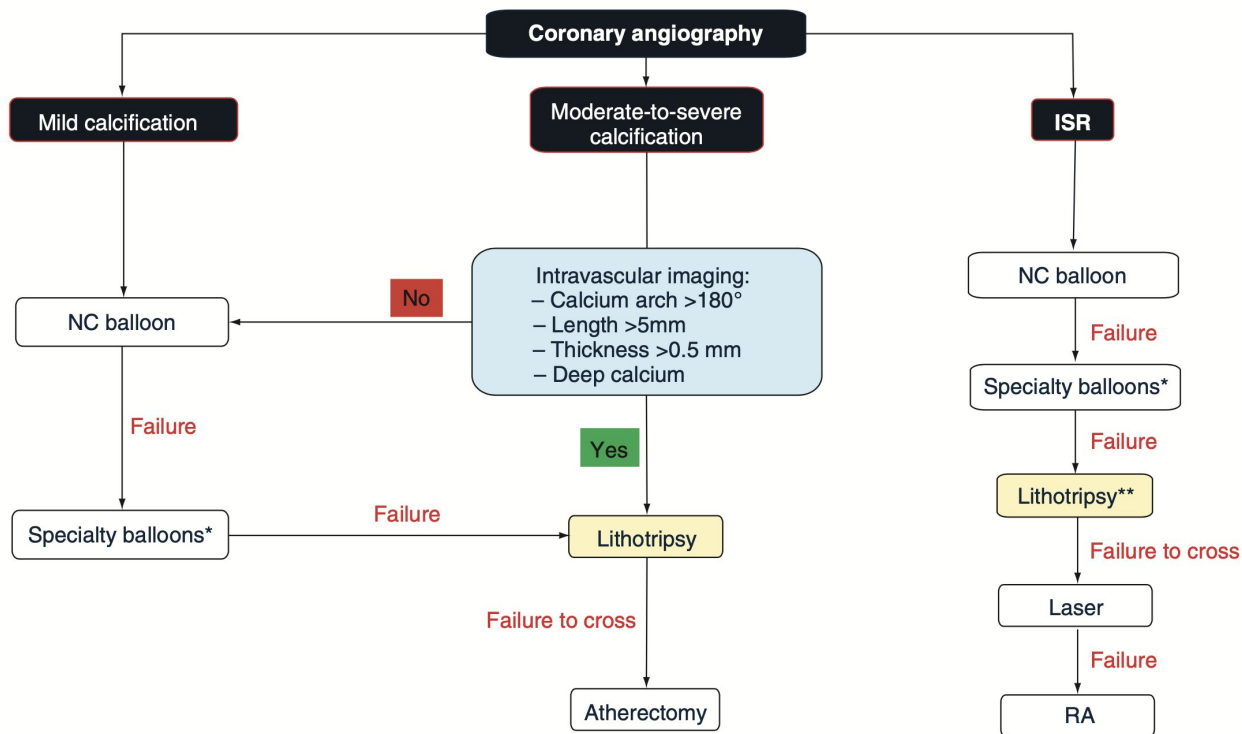
Impact of Calcium on Chronic Total Occlusion Percutaneous Coronary Interventions.

Karacsonyi J¹, Karmpaliotis D², Alaswad K³, Jaffer FA⁴, Yeh RW⁵, Patel M⁶, Mahmud E⁶, Lombardi W⁷, Wyman MR⁸, Doing A⁹, Moses JW², Kirtane A², Parikh M², Ali Z², Kandzari D¹⁰, Lembo N¹⁰, Garcia S¹¹, Danek BA¹², Karatasakis A¹², Resendes E¹², Kalsaria P¹², Rangan BV¹², Ungi I¹³, Thompson CA¹⁴, Banerjee S¹², Brilakis ES¹⁵.

- Observational, multicenter study. 1476 consecutive CTO PCIs in 1453 pts.
- Moderate or severe calcification present in 57.7% of CTO lesions and 840 of the 1,453 patients (57.8%)
- Technique success rate: AWE (41%), Retrograde (26%) and ADR (24%).
- In **moderate-severe** calcified CTOs, the **successful crossing strategy** was more often **retrograde**, while AWE and ADR were less successful in calcified lesions
- Vessel preparation:
 - 68,7% overall with POBA (mod-sev 65% vs none-mild 73%)
 - 3,5% overall with RA (mod-sev 5,7% vs none-mild 0,5%)
 - 2,8% overall with laser (mod-sev 4,1% vs none-mild 1%)
 - Angiosculpt, Tornus and OA were used in a few cases

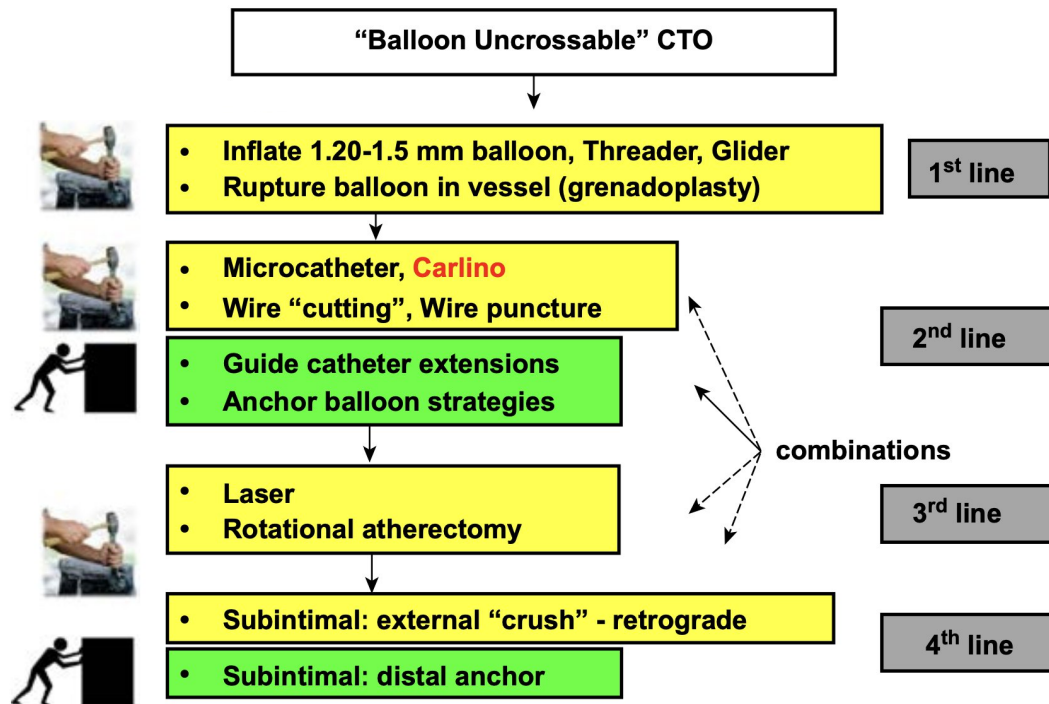


Algorithm to approach calcified lesions





How to approach uncrossable lesions

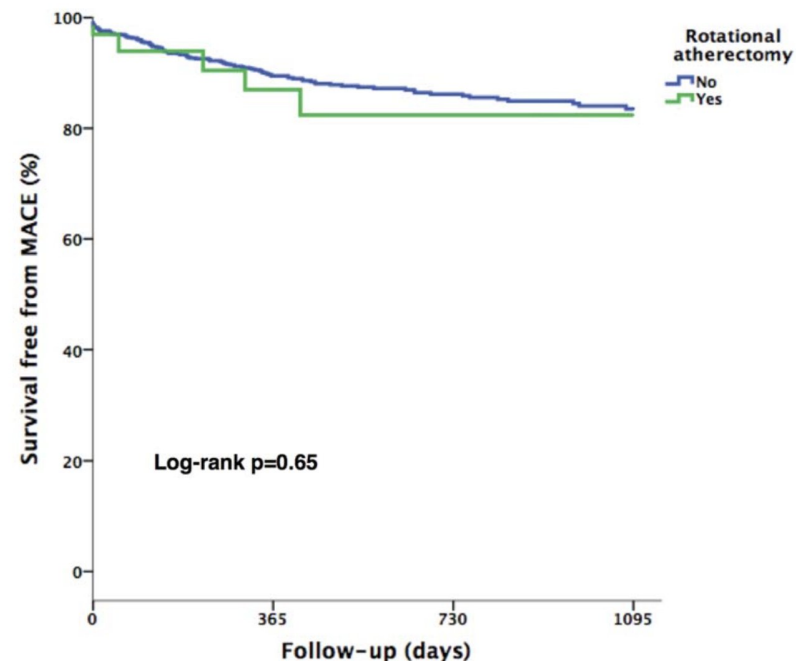




Rotational atherectomy in CTO PCI

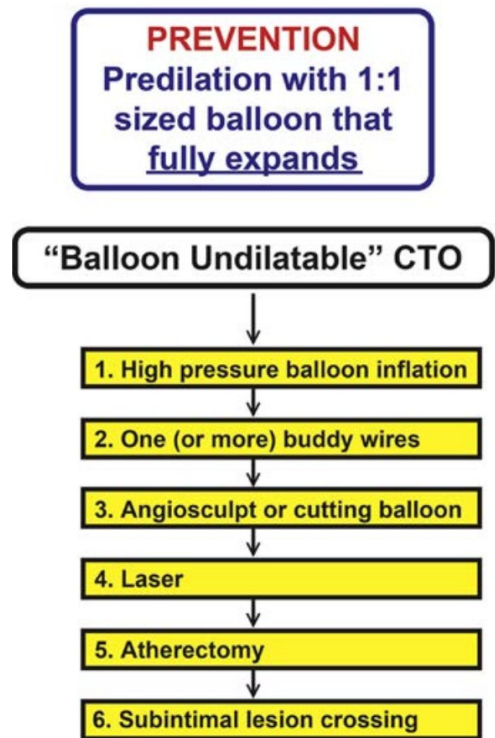
TABLE II. Angiographic characteristics and procedural data

Variable	Overall (n = 1003)	Rotational atherectomy (n = 35)	Conventional PCI (n = 968)	P value
Number of narrowed coronary arteries	1.8 ± 0.8	2.1 ± 0.8	1.8 ± 0.8	0.06
Target-vessel CTO				
Left anterior descending	290 (29%)	15 (43%)	275 (29%)	0.11
Circumflex	183 (18%)	3 (9%)	180 (19%)	
Right coronary artery	526 (53%)	17 (49%)	509 (53%)	
Blunt stump	451 (45%)	18 (51%)	433 (45%)	0.46
Moderate or severe calcifications	443 (44%)	30 (86%)	413 (43%)	<0.001
>45° bending	294 (30%)	11 (31%)	283 (30%)	0.82
Lesion length >20 mm	453 (46%)	18 (51%)	435 (46%)	0.50
Retry	230 (23%)	10 (29%)	220 (23%)	0.42
J-CTO score	1.9 ± 1.2	2.5 ± 1.1	1.8 ± 1.2	0.003
J-CTO score ≥2	587 (59%)	28 (80%)	559 (58%)	0.009
Radial access ^a	406 (41%)	12 (34%)	394 (41%)	0.44
Successful crossing technique				
Antegrade wire escalation	482 (53%)	26 (74%)	456 (53%)	0.08
Antegrade dissection/re-entry	145 (16%)	2 (6%)	143 (17%)	
Retrograde wire escalation	87 (10%)	2 (6%)	85 (10%)	
Retrograde dissection/re-entry	189 (21%)	5 (14%)	184 (21%)	
Tornus	105 (11%)	9 (26%)	96 (10%)	0.003
Cutting balloon	28 (3%)	4 (11%)	24 (3%)	0.002
Mother-and-child catheter	127 (13%)	7 (21%)	120 (13%)	0.17





Algorithm for dilating an undilatable CTO





ESC

European Society
of Cardiology

European Heart Journal (2018) **00**, 1–96

doi:10.1093/eurheartj/ehy394

ESC/EACTS GUIDELINES

2018 ESC/EACTS Guidelines on myocardial revascularization

“Lesion preparation is critical for successful PCI. In addition to plain balloon angioplasty (with standard or non-compliant balloons), **cutting or scoring balloon angioplasty** or **rotational atherectomy** may be required in selected lesions—particularly those with **heavy calcification**—in order to adequately dilate lesions prior to stent implantation. However, studies investigating the systematic use of these adjunctive technologies, such as **rotational atherectomy**, have failed to show clear clinical benefit.”



Role of intravascular imaging

«Calcified coronary artery disease is associated with higher rates of procedural failure and still remains an important cause of stent under-expansion, which is a possible trigger for stent thrombosis, in-stent restenosis (ISR) and target lesion revascularization. A meticulous lesion preparation, followed by a careful stent optimization, is crucial to accomplish better PCI results»¹

«Intravascular imaging helps to assess **calcium distribution, localization and thickness** (the combination of large calcium angle [$>270^\circ$] and thickness [$>670\ \mu\text{m}$] predicts suboptimal or ineffective lesion preparation) and its use is strongly encouraged at every step of the procedure»¹



Role of intravascular imaging

FIGURE 1 Comparison of Imaging Techniques for Coronary Calcium Detection, Characterization, and Quantification

Diagnostic Accuracy	Angiography	IVUS	OCT
Severe LHCC	● ● ●	● ● ●	● ● ●
Mild/Moderate LHCC	●	● ●	● ● ●
Deep calcium	●	● ● ●	● ●
Calcium arch	✗	● ● ●	● ● ●
Calcium thickness	✗	✗	● ● ●
Longitudinal calcium length	✗	●	● ● ●
Non-homogeneous plaque / Necrotic core	✗	● ● ●	●

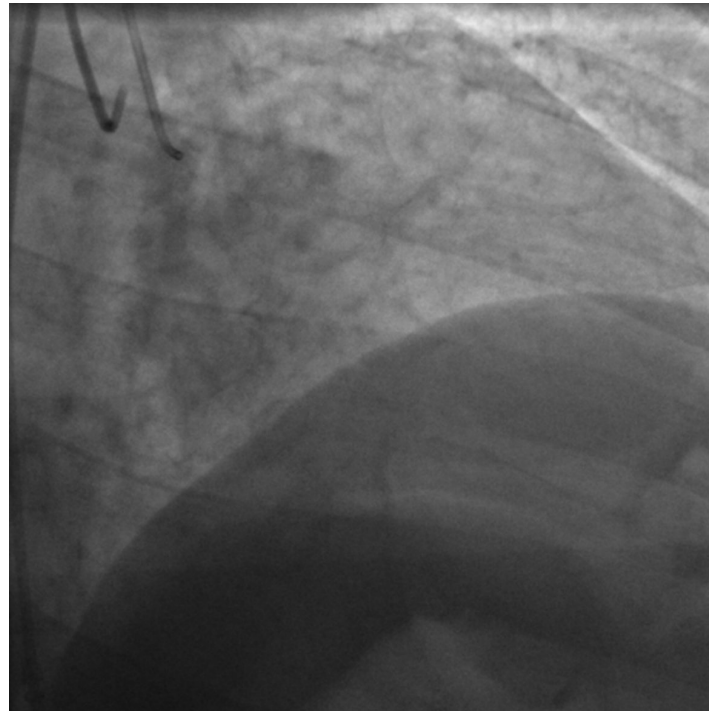
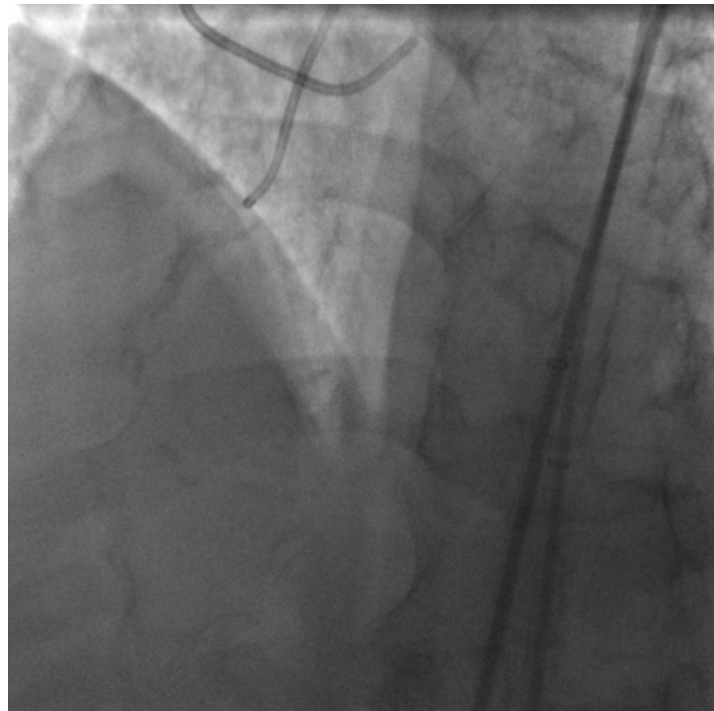
● ● ● Optimal ● ● Moderate ● Modest

Comparison of imaging techniques (angiography, intravascular ultrasound, and optical coherence tomography) for coronary calcium detection, characterization, and quantification. IVUS = intravascular ultrasound; LHCC = lesion with high calcium content; OCT = optical coherence tomography.

De Maria GL, Scarsini R, Banning AP. Management of Calcific Coronary Artery Lesions: Is it Time to Change Our Interventional Therapeutic Approach? *JACC Cardiovasc Interv.* 2019 Aug 12;12(15):1465-1478. doi: 10.1016/j.jcin.2019.03.038. PMID: 31395217.

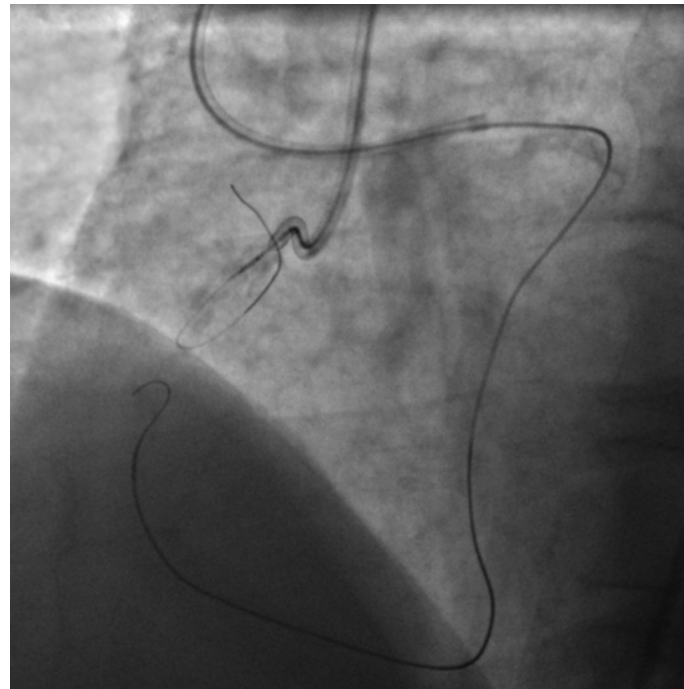
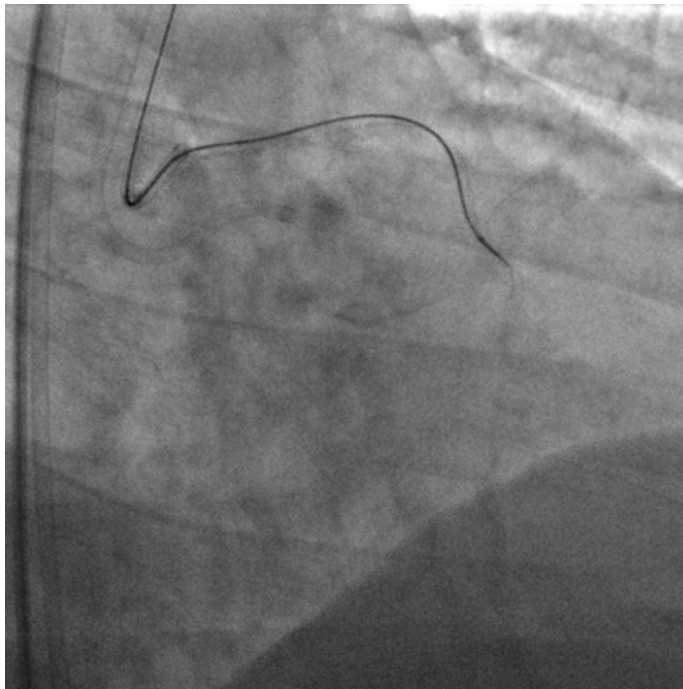


Clinical case



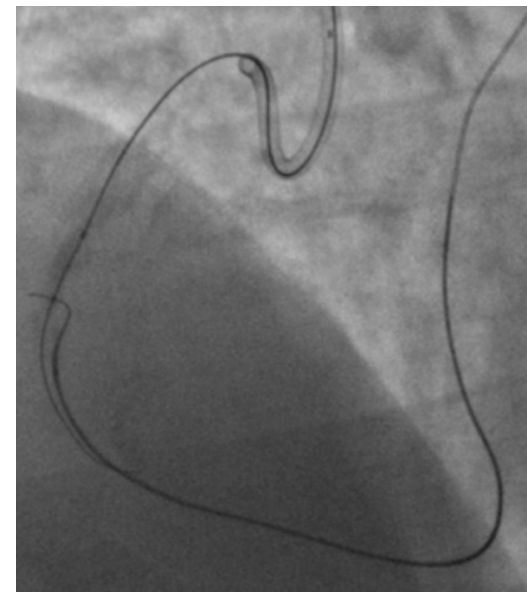
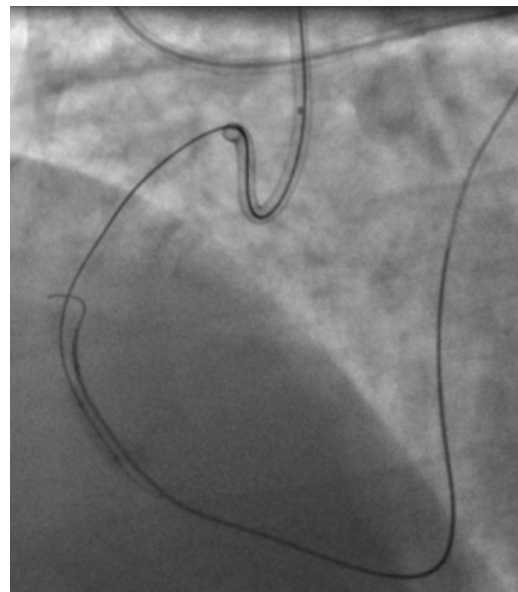
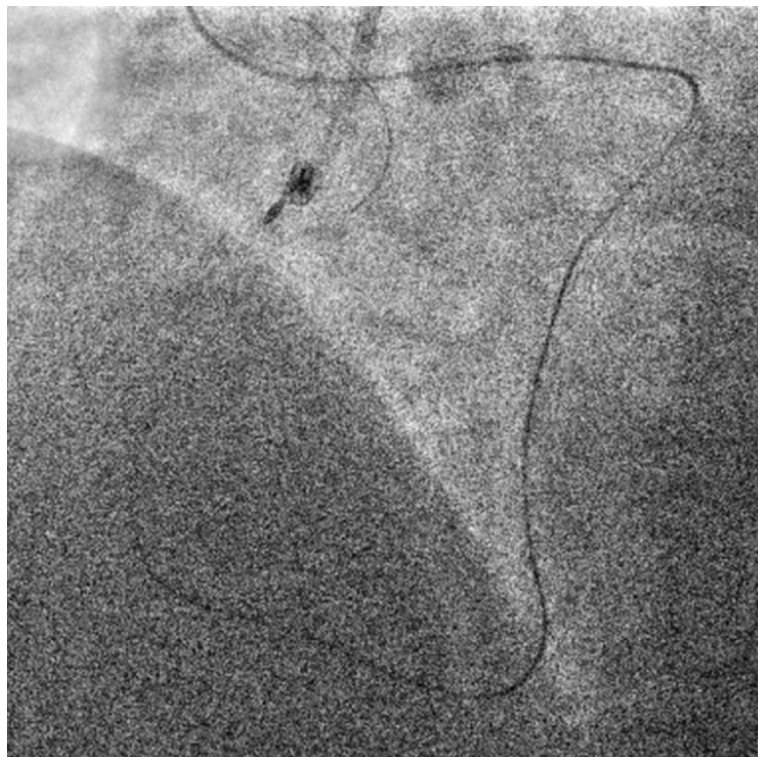


Clinical case





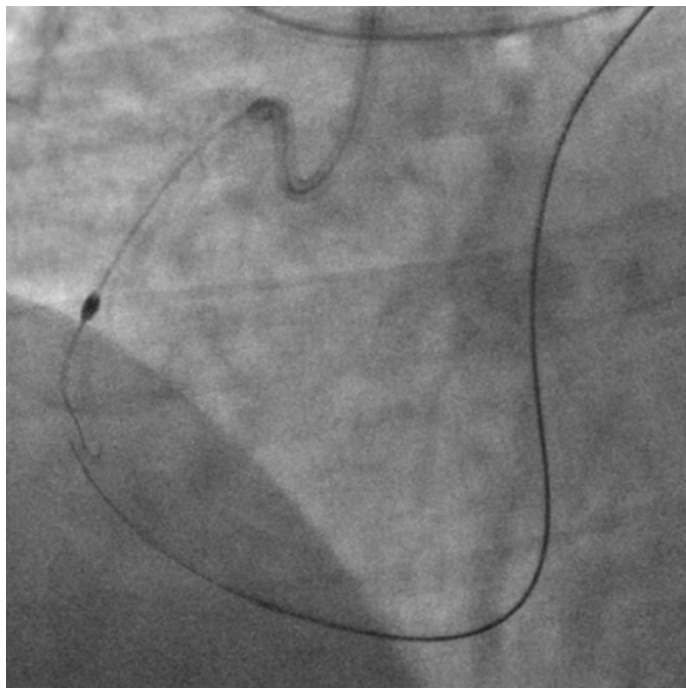
Clinical case



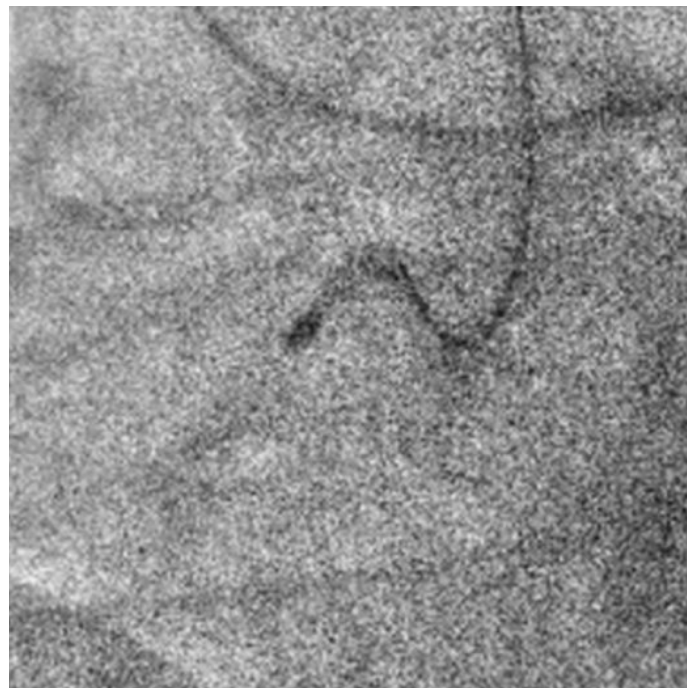
1.50 Burr rotablation



Clinical case



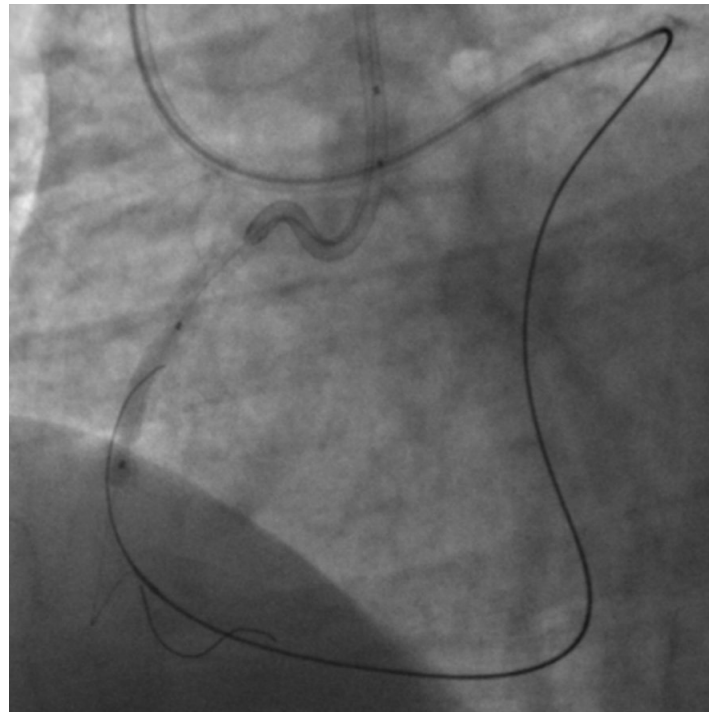
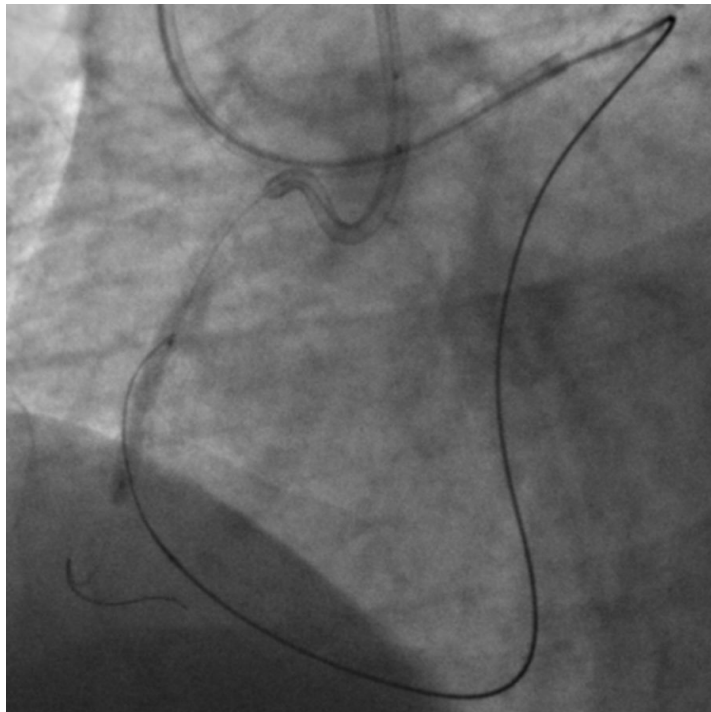
1.75 Burr rotablation



Burr Entrapment

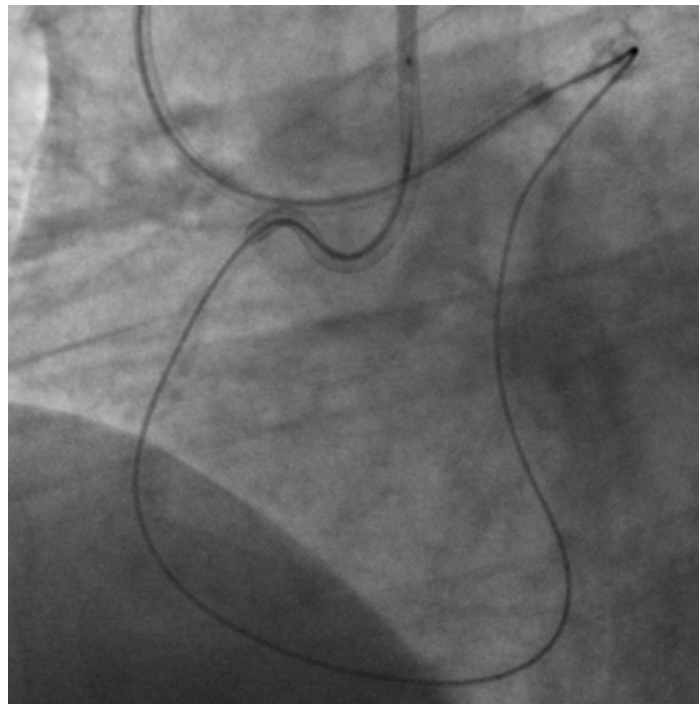
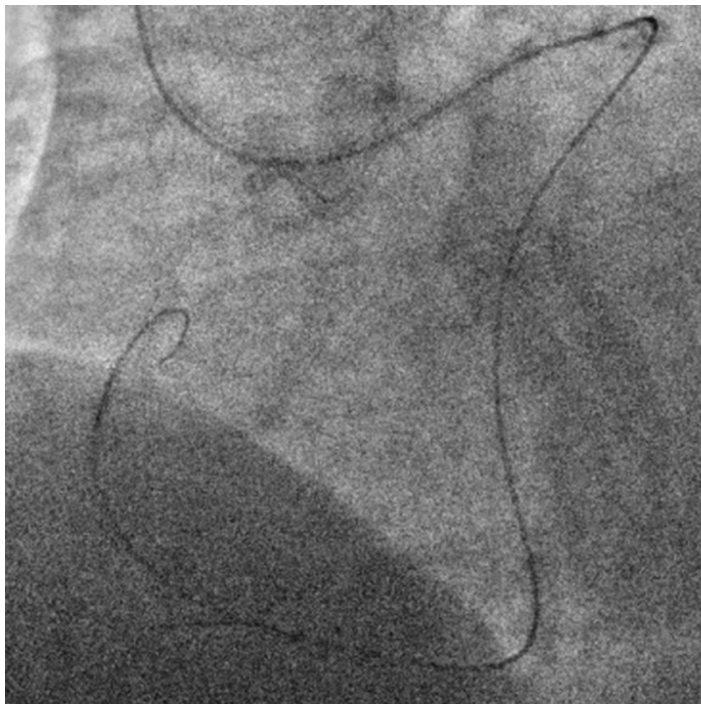


Clinical case



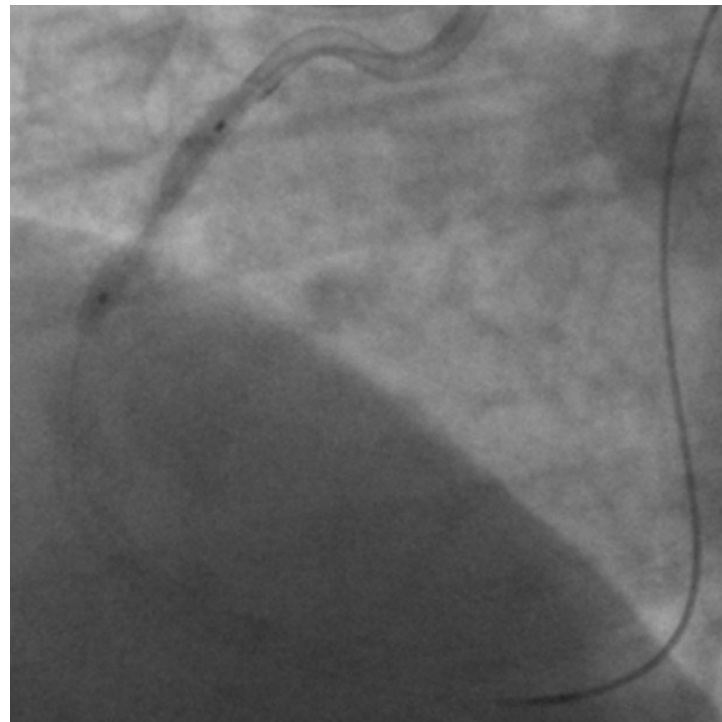
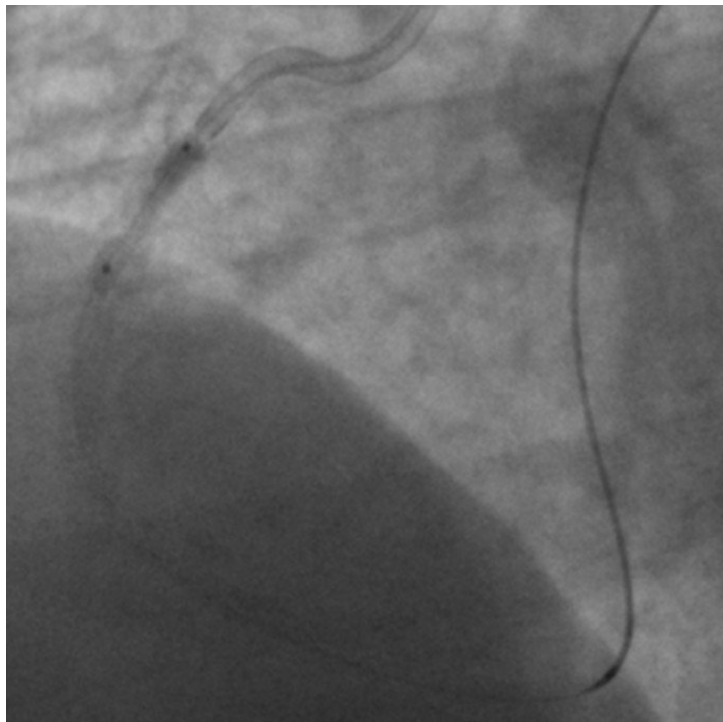


Clinical case



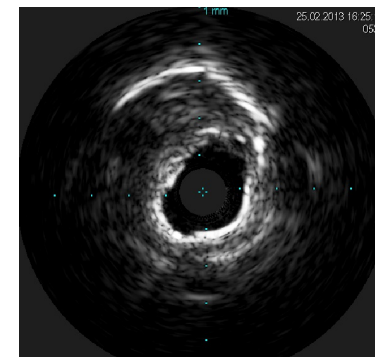
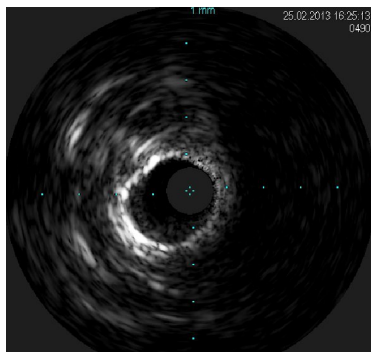
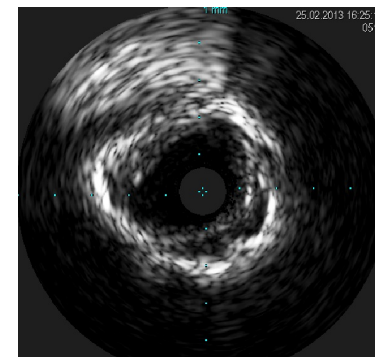
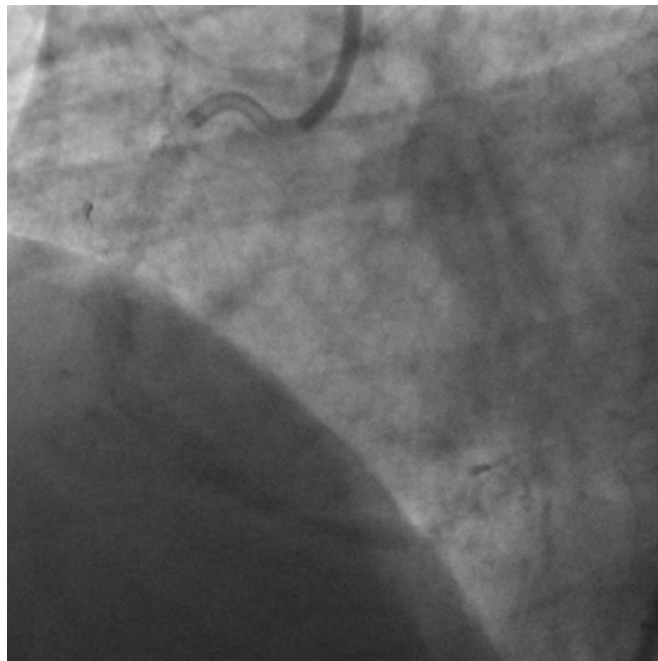
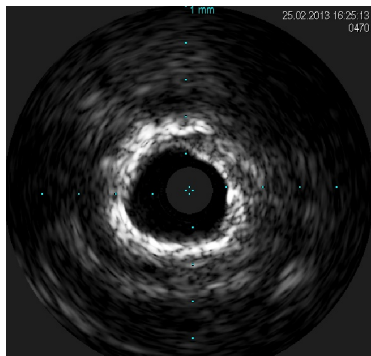


Clinical case



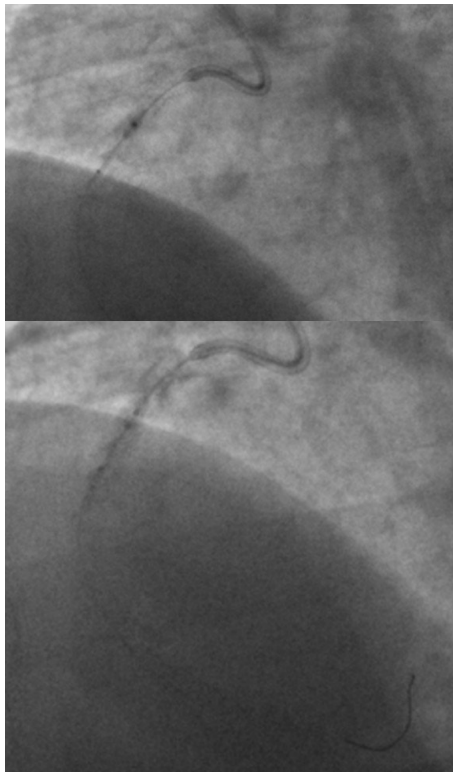


Clinical case

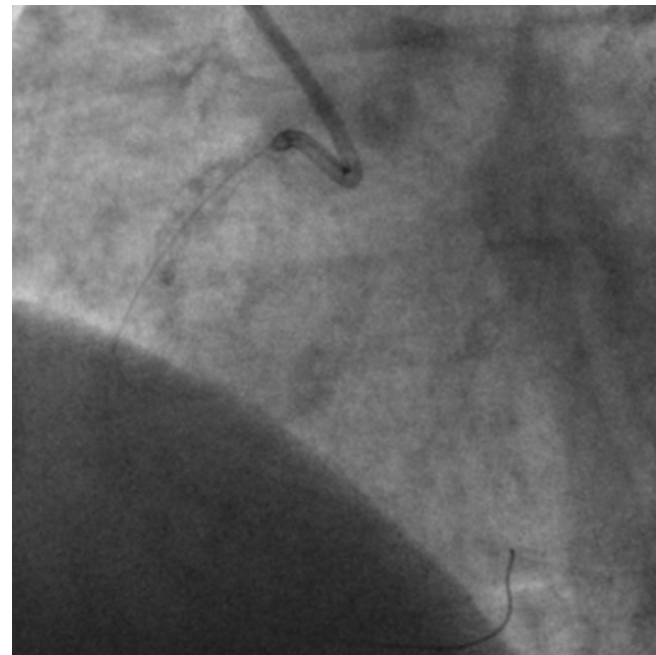




Clinical case

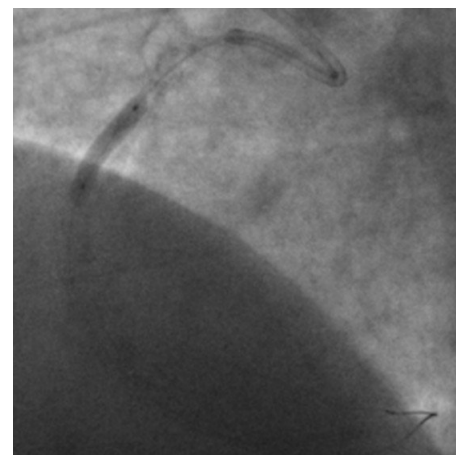
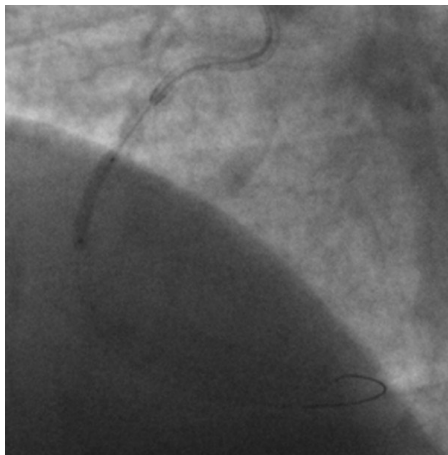
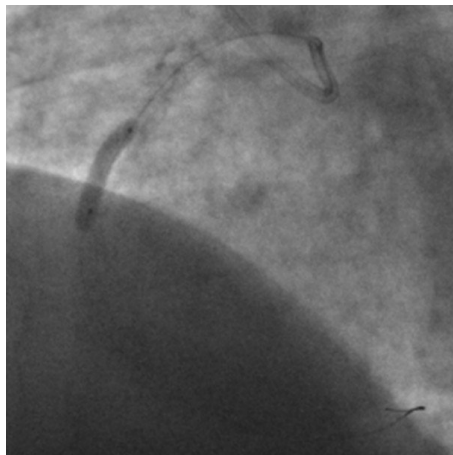
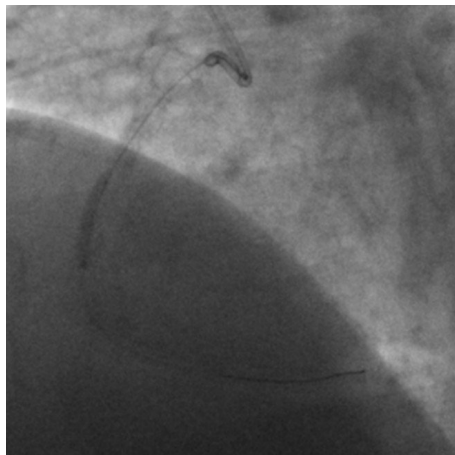


IVL therapy with 4 cycles
(10 pulses each)





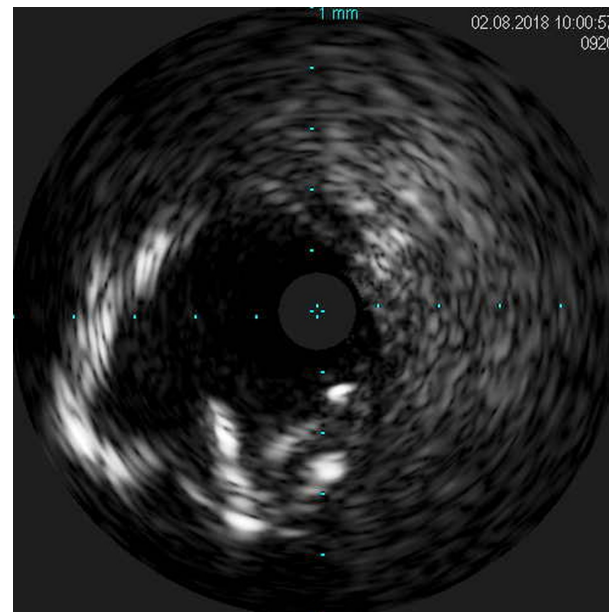
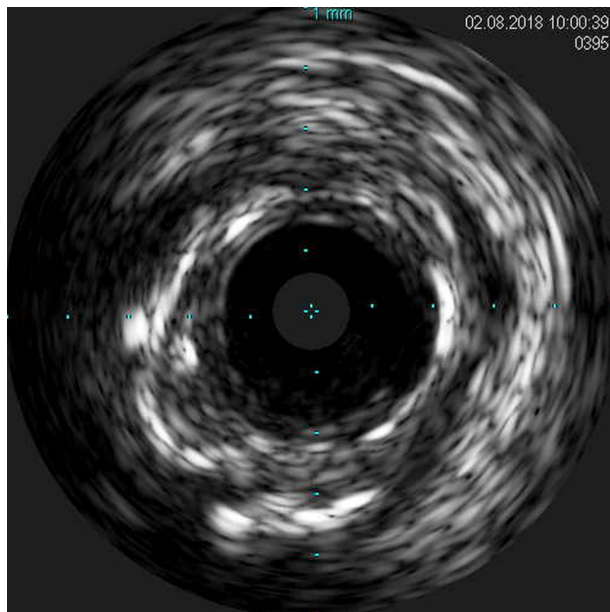
Clinical case



Lesion preparation with 3.0 and 3.5 NC Balloons



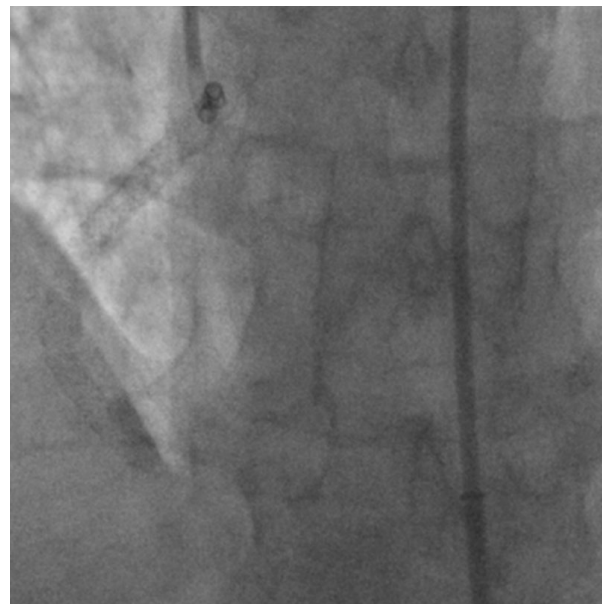
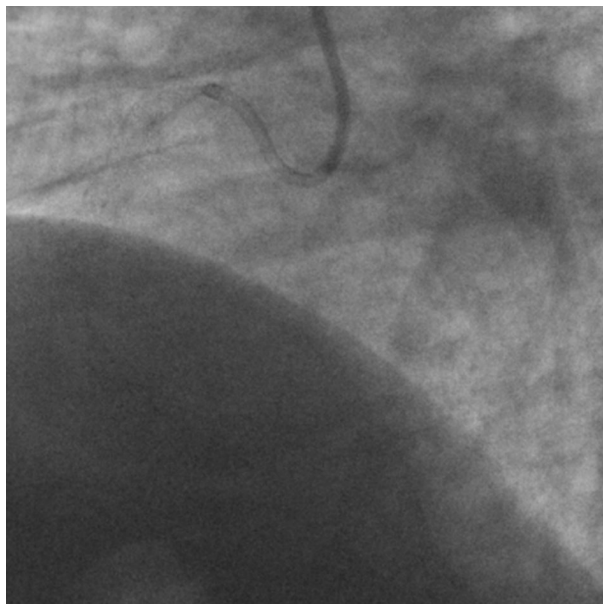
Clinical case



IVUS showing calcium rings breakage



Clinical case



3 overlapping DES (3.5, 4.0 and 5.0 mm) from distal segment to the ostium with optimal expansion



Take home messages

- Calcifications in chronic total occlusion may prevent guidewire and microcatheter crossing, making CTOs even more challenging
- Proximal cap modification and dissection-reentry techniques may help the physicians to overcome uncrossable lesions
- The use of dedicated devices such as rotational/orbital atherectomy or IVL, alongside intravascular imaging, increases the likelihood of optimal stent expansion that is crucial to ensure better outcomes



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Thank you!

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