

ACADEMY JOURNAL



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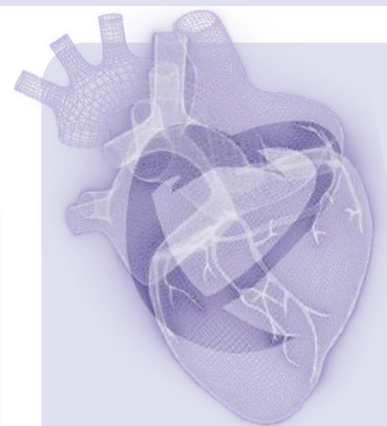
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MASTERING CTO INTERVENTIONS: HIGHLIGHTS OF THE 2nd WORKSHOP ON CROSSING ALGORITHMS

The ML CTO Academy is set to host the second edition of its highly anticipated "Crossing Algorithms Workshop", a premier educational event designed for interventional cardiologists eager to master the complex techniques of chronic total occlusion (CTO) recanalization.

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BE PART OF THE CONVERSATION.

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More than 2,300 members are getting involved!



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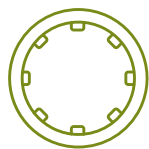
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a. More clinical studies including larger number of patients reporting clinical outcomes with longer follow-up time than BeGraft Coronary Stent Graft System; b. Compared to Jostent Graftmaster; 1. BIOTRONIK data on file; 2. Al-Lamee R, et al. Incidence, Predictors, Management, Immediate and Long-Term Outcomes Following Grade III Coronary Perforation. JACC: Cardiovasc Interv. 2011 Jan; 4(1):87-95; 3. Hernandez-Enriquez M, et al. Outcomes after use of covered stents to treat coronary artery perforations. Comparison of old and new-generation covered stents. J Interv Cardiol. 2018; 1-7; 4. Nagaraja V, Schwarz K et al. Outcomes of patients who undergo percutaneous coronary intervention with covered stents for coronary perforation: A systematic review and pooled analysis of data. Catheter Cardiovasc Interv. 2019; 1-7. DOI: 10.1002/ccd.28646; 5. Birkemeyer R, Olivecrona G.K, Hellig F et al. Sealing of coronary perforations with a second-generation covered stent graft - Results from the PAST-PERF registry. Cardiovascular Revascularization Medicine. 2020; doi: 10.1016/j.carrev.2020.10.012; 6. Hernandez-Enriquez et al. Use and outcomes of the PK Papyrus covered stent in France: SOS PK Papyrus registry. Catheter Cardiovasc Interv. 2020; doi: 10.1002/ccd.29328; 7. Kandzari DE, Birkemeyer R. PK Papyrus covered stent: Device description and early experience for the treatment of coronary artery perforations. Catheter Cardiovasc Interv. 2019; 1-5. doi.org/10.1002/ccd.28306; 8. Kandzari D.E, Sarao R.C. and Waksman R. Clinical experience of the PK Papyrus covered stent in patients with coronary artery perforations: Results from a multi-center humanitarian device exemption survey, Cardiovascular Revascularization Medicine. 2022. doi: 10.1016/j.carrev.2022.04.009; 9. Waiha W, Januszek R, Kotodziejczak M, Kuźma Ł, Tajstra M, Figatowski T et al. Procedural and 1-year outcomes following large vessel coronary artery perforation treated by covered stents implantation: Multicentre CRACK registry. PLoS ONE. 2021; 16(5): e0249698. doi: 10.1371/journal.pone.0249698; 10. Bossard, M., Maria Cioffi G., et al. "Burying" covered coronary stents under drug-eluting stents: A novel approach to ensure long-term stent patency. Cardiology Journal, 2023, 30(2), 196-198. https://doi.org/10.5603/CJ.a2022.0116; 11. Harnek J, James SK, Lagerqvist BO, et al. Very long-term outcome of coronary covered stents: a report from the SCAAR registry. EuroIntervention. 2019; 14: 1660-1667. doi: 10.4244/EIJ-D-18-00855; 12. Jurado-Roman A et al. Clinical outcomes after implantation of polyurethane-covered cobalt-chromium stents. Insights from the Papyrus-Spain registry. Cardiovascular Revascularization Medicine 2020 Aug; S1553-8389(20)30486-3. doi: 10.1016/j.carrev.2020.08.017. Online ahead of print; 13. Kufner S et al. Outcome after new generation single-layer polytetrafluoroethylene-covered stent implantation for the treatment of coronary artery perforation. Catheter Cardiovasc Interv. 2018; 1-9. DOI: 10.1002/ccd.27979; 14. Voll F, Koch T, Tölg R, Lenz T, Schroeter M, Lenders G, Hokken R, Cassese S, Xhepa E, Schunkert H, Kastrati A, Kufner S. Clinical safety and efficacy of new-generation single-layer polytetrafluoroethylene covered coronary stents. Cardiovasc Revasc Med. 2023; 1-7; 15. Azzalini, L., Poletti, E., Ayoub, M., Ojeda, S., Zivelonghi, C., La Manna, A., Bellini, B., Lostalo, A., Luque, A., Venuti, G., Montorfano, M., Agostoni, P., Pan, M., Carlino, M., & Mashayekhi, K. Coronary artery perforation during chronic total occlusion percutaneous coronary intervention: Epidemiology, mechanisms, management, and outcomes. EuroIntervention. 2019. https://doi.org/10.4244/EIJ-D-19-00282; PK Papyrus is a trademark or registered trademark of the BIOTRONIK Group of Companies.



BE PART OF THE CONVERSATION.
BE PART OF THE ML CTO ACADEMY.

More than 2,300 members are getting involved!

Join us in shaping the future of CTO interventions. Your expertise and participation can make a significant difference in the field of interventional cardiology.

Empowering Cardiologists

In the evolving field of interventional cardiology, particularly in the treatment of coronary chronic total occlusions (CTO), continuous education and collaboration are paramount. The ML CTO Academy stands at the forefront of this endeavor, dedicated to enhancing patient care through education, research, and clinical practice.



Member Opportunities

- 1 GLOBAL COMMUNITY:**
Join an international network of professionals dedicated to CTO PCI, facilitating information and experience sharing.
- 2 RESEARCH PARTICIPATION:**
Contribute to and access data from registries like HostiumCTO and JetCTO, enhancing the collective understanding of CTO interventions.
- 3 EDUCATIONAL RESOURCES:**
Gain priority access to events, digital programs, and workshops.
- 4 SCIENTIFIC CONTRIBUTION:**
Submit your clinical cases and research topics for discussion, publication, and presentation at ML CTO Academy events.



Get Involved

Becoming a member is straightforward and free of charge. By joining, you become part of a community committed to advancing CTO PCI practices and improving patient outcomes.



BECOME A MEMBER

Celebrating a Decade of Innovation: A CONVERSATION WITH DR. MAX AMOR

As the ML CTO Annual Course marks its 10th anniversary, we take a moment to reflect on its remarkable journey — from its ambitious beginnings to becoming a landmark educational event in the field of complex coronary interventions. At the heart of this evolution is **Dr. Max Amor, an internationally renowned interventional cardiologist whose vision and dedication helped shape the course into what it is today.**

We sat down with Dr. Amor to discuss the origins of the course, the evolution of CTO techniques over the past decade, and what lies ahead for the next generation of interventional cardiologists.

Dr. Amor, throughout your career you have witnessed numerous technical innovations and major breakthroughs in interventional cardiology. Could you walk us through these milestones and explain how they led to the creation of ML CTO?

Over the course of my thirty-year career, I have been fortunate to witness and contribute to the rise of numerous technical innovations. In 1990, there was the Heart Technology Rotablator; in 1992, Juan Parodi's pioneering percutaneous abdominal aortic prosthesis; in 1995, carotid angioplasty with Jacques Theron; and in 2000, the aortic valvuloplasty led by Alain Cribier, whose perseverance—despite skepticism—culminated in the first TAVI implantation in 2002.

I have personally experienced incredulity, skepticism, and even outright resistance and hostility. One of the most effective responses to such challenges, as taught by Andreas Gruentzig, has always been live case transmission—sharing knowledge in real time.

The first time I saw Alex Avran tackle chronic total coronary occlusions, I realized we were crossing a new frontier. Alex conceived the idea of a structured course in three levels, from beginner to expert. Drawing on my own experience, and with the support of Com&Co and Morgane Airaudi, the Multi Level CTO—ML CTO—was born.

It was again Alex who had the brilliant idea to bring Stéphane Rinfret and Kambis Mashayekhi into the project. This exceptional trio was formed. In poker terms, we call that a “three of a kind”—but in this case, it was three aces. In French Un Breelan d’AS.

What were the main challenges you encountered in the early years of ML CTO Course?

As with all such ventures, it was essential to gather the best operators, regardless of their continent or background, and to find the right format, setting, and time of year. Initially, experienced operators were few and far between, and industry partners were hesitant.

It wasn't until the third ML CTO meeting that the situation truly unlocked, allowing us to envision the event's long-term future. We all came to recognize that CTO intervention is an essential technique that is here to stay.

In your opinion, what are the main factors that have contributed to ML CTO's success and international reputation over the past decade?

Success is multifactorial: the introduction of new devices that facilitate recanalization (catheter extensions, innovative wires and microcatheters), new approaches (the retrograde route, the Ping Pong technique, etc.), and the continuous development of techniques like IVUS and re-entry, all of which have increased success rates and improved complication management.

But above all, it is the sincerity, humility, and expertise of the operators, their therapeutic courage, and the richness of the discussions that have built a loyal and passionate audience.

ML CTO has thus become the must-attend event for anyone wishing to learn CTO techniques, refine their skills, demonstrate their expertise, or simply share their experience.

“ **ABOVE ALL, IT IS THE SINCERITY, HUMILITY, AND EXPERTISE OF THE OPERATORS, THEIR THERAPEUTIC COURAGE, AND THE RICHNESS OF THE DISCUSSIONS THAT HAVE BUILT A LOYAL AND PASSIONATE AUDIENCE.** ”

How has ML CTO contributed to advancing CTO techniques and operator skills, and what makes the educational experience at ML CTO so unique and valuable for participants?

I may be repeating myself, but I have witnessed continuous progress in technique selection, always with patient success and safety as the ultimate goals. Attending ML CTO means gaining confidence and knowledge, engaging in open debate, and finding answers to both personal and audience questions.

The experts—handpicked by the ASK (or KAS) trio—work on carefully selected cases, creating a dynamic and captivating pace. Regardless of one's experience level, there is always something to learn, and never a dull moment. The attention in the plenary hall is palpable.

Witnessing a retrograde approach, a re-entry, an IVUS, or a recanalization via an old bypass for the first time are powerful moments that broaden our therapeutic horizons.

These experiences push us to question ourselves, to progress, to challenge our own practices, and, inevitably, to improve.

The journey is not easy: CTO is not accessible to everyone, for a variety of reasons. But ML CTO offers a unique opportunity to learn how to use different devices and techniques. The medical industry plays a major role in disseminating and developing new tools—without its support, none of this would be possible.

ML CTO is the ideal forum to discover these innovations and stay at the cutting edge, all for the direct benefit of our patients. And when you see, with your own eyes, a patient improves after a difficult recanalization, you know the struggle was truly worth it—both in effort and expense.

Why was it important to create the ML CTO Academy alongside the annual meeting?

The idea of an ML CTO Academy is not only justified, it is essential. The field is evolving constantly and cannot be confined to a single annual meeting. Providing regular updates, organizing tailored workshops—these have become necessities in such an innovative domain.

Looking ahead, how do you see the future of CTO PCI evolving, and what is your perspective on balancing innovation with the often misunderstood precautionary principle?

I believe the precautionary principle, enshrined in constitutional law, is often misunderstood. The absence of certainty should never hinder action. This principle is not meant to glorify established therapies simply because they are tried and tested, sometimes despite their limitations. We must never stop innovating, for the benefit of our patients.

Throughout my career, I have too often encountered physicians who, lacking the necessary skills, preferred to say “it shouldn't be done”—sometimes adopting even more negative stances. One of my mentors used to

say: “When I don't know how to do something, I say it shouldn't be done.” In a career like mine, this attitude is all too familiar.

In all likelihood, MLCTO will continue to tackle ever more complex cases, while simplifying and securing procedures. We will see what the 10th MLCTO has in store for us this year.

Finally, what message would you like to share with the younger generation of interventional cardiologists, and what makes ML CTO a unique place for them to learn and be inspired?

This extraordinary field is made for the new generation of interventionalists. By mastering CTO techniques, they will inevitably excel in everyday angioplasty.

ML CTO is the ideal place to learn, meet international experts, and find inspiration.

When, like me, you have had the privilege of seeing Gruentzig, Parodi, Marco, Buchbinder, Cribier, the KAS trio, and so many other stars innovate and push boundaries, these are unforgettable memories that give you the courage to dare and the certainty that you are on the right path, in the right place.

And honestly, what better setting than the Côte d'Azur in June.





REFLECTIONS ON THE GUIDEWIRES & MICROCATHETERS WORKSHOP:

A Hands-On Success

In 2024, the ML CTO Academy successfully hosted its inaugural **Guidewires & Microcatheters Workshop**, a groundbreaking educational event designed to provide cardiologists with hands-on training in the use of guidewires and microcatheters for chronic total occlusion (CTO) procedures. Held in two iconic French cities—Nice and Paris—the workshop brought together 20 participants from around the world, offering a comprehensive, skills-focused learning experience.

From Fundamentals to Advanced Mastery

The workshop was carefully structured into two sessions, each tailored to different expertise levels:

• **JUNE 26, 2024 - Nice**
(Basic/Intermediate Level)

Participants explored the essential principles of guidewire and microcatheter selection and manipulation, gaining confidence through direct practice.

• **NOVEMBER 16, 2024 - Paris**
(Advanced Level)

Advanced participants tackled complex cases, refining their skills under the guidance of international CTO PCI experts.

Panel of experts



Alexandre
AVRAN
Valenciennes, France



Stéphane
CARLIER
Mons, Belgium



Thomas
HOVASSE
Massy, France



Gregor
LEIBUNDGUT
Basel, Switzerland



Kambis
MASHAYEKHI
Lahr, Germany



Stéphane
RINFRET
Atlanta, United States



Masahisa
YAMANE
Toghigi, Japan

An Immersive, Interactive Experience

Divided into small groups, participants engaged in:

• PRODUCT EXPLORATION:

Testing and comparing a wide range of guidewires and microcatheters, understanding which were best suited for various lesion types.

• HANDS-ON SIMULATIONS:

Practicing on state-of-the-art models in a realistic simulation zone, where they learned to navigate complex occlusions.

• DIRECT MENTORSHIP:

Receiving personalized coaching from renowned faculty members, who shared their expertise and best practices.

Global Expertise and Industry Collaboration

This workshop was made possible thanks to the collaboration between the ML CTO Academy and leading experts in the field, as well as partnerships with top industry players. Such collaboration ensured that participants accessed the latest knowledge, products, and techniques in CTO PCI.

Exceptional Feedback and Lasting Impact

The feedback from participants was overwhelmingly positive. Many highlighted the value of the practical, small-group format, which provided direct access to expert insights. The combination of theoretical knowledge and hands-on training proved to be a transformative experience for many attendees.

Building on Success: Looking Ahead

The success of this first Guidewires & Microcatheters Workshop has strengthened the ML CTO Academy's commitment to providing world-class education for interventional cardiologists. Plans are already underway to expand these training opportunities, ensuring that more professionals can benefit from this unique, practical learning experience.

Stay Connected

If you missed the 2024 workshop, keep an eye out for future educational events from the ML CTO Academy. Join our community, enhance your skills, and become part of a global network dedicated to excellence in CTO interventions.

Mastering CTO Interventions: HIGHLIGHTS OF THE 2nd WORKSHOP ON CROSSING ALGORITHMS

The ML CTO Academy is set to host the second edition of its **highly anticipated** "Crossing Algorithms Workshop", a premier educational event designed for interventional cardiologists eager to master the complex techniques of chronic total occlusion (CTO) recanalization.

Two Dates, Two Levels

JUNE 25th, 2025 – NICE

Basic/Intermediate Level

NOVEMBER 29th, 2025 – PARIS

Advanced Level

A Unique Learning Experience

CTO recanalization remains one of the most challenging procedures in interventional cardiology. For young CTO operators, mastering the various crossing strategies is essential for improving procedural success and optimizing patient outcomes. This workshop provides a unique opportunity to deepen knowledge and hands-on skills in CTO crossing techniques.

KEY TOPICS COVERED:

- A comprehensive step-by-step approach to both antegrade and retro-grade CTO crossing.
- Advanced techniques in wire escalation, parallel wiring, and dissection-reentry.
- Case-based discussions with experienced CTO operators, offering valuable insights and troubleshooting strategies.
- A dedicated simulation corner with bench tests for hands-on practice.

A Commitment to Excellence in CTO Education

The ML CTO Academy remains dedicated to advancing the field of CTO interventions through high-quality education, research, and practical training. This workshop is part of that mission, equipping participants with the tools and confidence needed to excel in complex procedures.

Stay Informed About Our Initiatives

The "Crossing Algorithms Workshop" is just one of many educational activities organized by the ML CTO Academy. Although registration is now closed, you can learn about our future events and training opportunities by visiting our official website: academy.mlcto.com

Panel of experts



Alexandre
AVRAN

Valenciennes,
France



Emmanouil
BRILAKIS

Minneapolis,
USA



Stéphane
CARLIER

Mons,
Belgium



Kambis
MASHAYEKHI

Lahr,
Germany



Stéphane
RINFRET

Atlanta,
United States

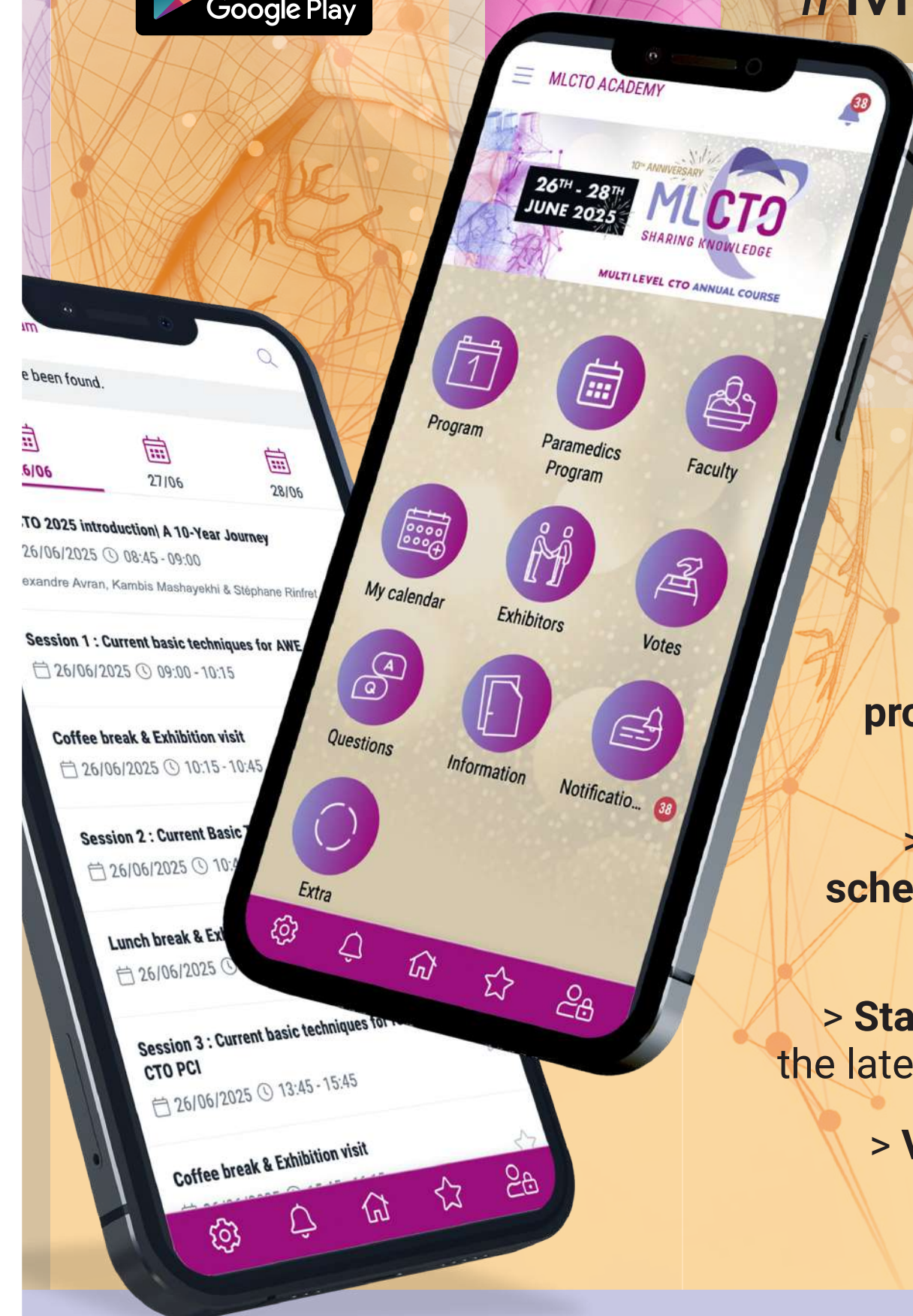


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- > Create your own daily schedule that will guide you through the day
- > Stay informed and receive the latest messages and news
- > Vote and ask questions during sessions

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INTERVIEW WITH DR. LUCA PAOLUCCI:

Recipient of the
MLCTO Academy 2024
Training Grant and Fellowship



We are delighted to introduce Dr. Luca Paolucci, the distinguished recipient of the MLCTO Academy's 2024 Training Grant and Fellowship. This prestigious award provides a grant of €10,000 for a clinical fellowship in interventional cardiology at the renowned ICPS – l'Institut Cardiovasculaire Paris Sud (Massy, France), a leading center in interventional cardiology. Under the mentorship of Dr. Thomas Hovasse, a CTO PCI expert and member of the ML CTO Scientific Committee, Dr. Paolucci will have the unique opportunity to advance his clinical skills and experience in complex interventional cardiology.

The MLCTO Academy Training Grant and Fellowship is designed to support young cardiologists who have completed most of their training in interventional cardiology but have not yet secured a permanent or senior position. The goal is to enhance their expertise in CTO PCI, empowering them to bring advanced knowledge and skills back to their home countries.

In this exclusive interview, Dr Paolucci shares his insights, experiences, and aspirations as he embarks on this transformative journey. His perspectives offer valuable inspiration to peers and aspiring cardiologists committed to advancing patient care through innovation and excellence.

We invite you to delve into Dr Paolucci's journey and gain a deeper understanding of his contributions to the field.

Could you tell us a little about yourself and your background in the field?

I'm 32 years old and I come from Rome, Italy. I did my residency at the Campus Biomedico University in Rome, mostly focusing on coronary revascularization. After my residency, I spent one year as consultant interventional cardiologist at Clinica Mediterranea Hospital, in Naples, led by Dr. Carlo Briguori.

After that experience, I decided to prioritize my formation and started a three years-long clinical/research fellowship in interventional cardiology at Hospital Clinico San Carlos, Madrid, under the tutoring of Prof. Javier Escaned and Dr. Nieves Gonzalo. During my years of studying, I split my time 50/50 on

both the clinical and research activities. Specifically, I had the opportunity to join research projects on periprocedural myocardial infarction, fractional flow reserve guided coronary revascularization, acute kidney injury prevention and complete revascularization in patients with acute coronary syndrome and

bystander non culprit chronic total occlusions. Currently, I have started my PhD project focused on invasive physiological assessment of coronary vasomotor function and myocardial oxygen consumption, at the Complutense University here in Madrid.

What inspired you to apply for the ML CTO Academy Training Grant and Fellowship?

During my formation, I understood that tutoring and mentoring are fundamental to improve your skills and guide your growth. The educational commitment of the ML CTO Academy was for me tremendously appealing. The opportunity to work side by side with international experts fully committed to clinical and research teaching was for me the strongest reason which led me to apply for this grant.

How do you plan to utilize the training and resources provided by this fellowship in your career?

My main interest is to end my training with the ability to understand the best strategy to achieve successful coronary revascularization in complex settings as CTOs. Beside this, I'm willing to start new research projects focused on unanswered questions regarding the prognostic value of coronary revascularization in this setting. Therefore, having the chance to connect at international level is more than mandatory to achieve these purposes.

Can you describe any challenges you've faced in your academic or professional journey, and how you overcame them?

As many in this field, full commitment is needed to reach any kind of objective. During my early career, I had to face several

setbacks in terms of professional and academic perspectives. Most of these are related to the fact that it can be extremely difficult to find someone who is willing to invest his own time in your growth. Regarding this, I'm more than happy with my experience with the ML CTO, because for the first time I felt unconditional support which I was not used to receiving. For this, I feel extremely honoured.

**“ THE
EDUCATIONAL
COMMITMENT
OF THE ML CTO
ACADEMY
WAS FOR ME
TREMENDOUSLY
APPEALING. ”**

What advice would you give to other young professionals or students who are looking to advance in this field?

I personally believe that we have only one major tool to reach our objectives, which is our commitment to our own passion. We have the luck to spend our time in an extremely fascinating field for both clinical practice and research, and I think that the best way to achieve our purposes is to enjoy our work, regardless of the issues that can occur.

What are you most excited about as you begin this fellowship, and what are you hoping to accomplish?

What excites me the most is the chance to work near to international experts in the field which I like the most. I hope that this experience will give me a wider comprehension of my professional activity, improving my approach to major clinical and research challenges in the future years.



A CARDIOVASCULAR CONTRACT RESEARCH ORGANIZATION



Our academic involvement and cardiovascular methodological expertise are your advantage

Are you looking for a cardiology-focused Contract Research Organization (CRO) to support your next device study? ML CTO Academy provides a full range of clinical research services with a specialization in interventional cardiovascular medical devices.

Quality principles



1.
PRODUCE
HIGH-QUALITY
CLINICAL DATA



2.
CONDUCT
ETHICAL
RESEARCH



3.
CONDUCT CLINICAL
RESEARCH IN AN
EFFICIENT & COST-
EFFECTIVE MANNER



4.
PROVIDE A
VALUABLE SERVICE
TO OUR MEMBERS

“OUR STRENGTH IS THE ABILITY TO OFFER SUPERIOR MANAGEMENT SERVICES, COMBINING OPERATIONAL EXCELLENCE WITH SCIENTIFIC AND ACADEMIC LEADERSHIP.”

Some solutions offered by ML CTO Academy include:

- Access to some of the world’s leading interventional cardiologists.
- Complete clinical registry management support: data management, statistical services, clinical research monitoring,...
- Clinical registry services to developers of cardiovascular devices: protocol development, trial design, statistical analysis,...
- Access to patients: KOLs and high-performing clinical sites, allowing for more efficient patient recruitment and retention.
- Improved outcomes: helping to ensure that the trial is designed and executed to maximize the potential for positive outcomes.

A structure facilitating the design and conduct of clinical registries

This ML CTO Academy initiative between thought leaders in the field of interventional cardiology creates an opportunity for multicenter, multinational investigator-initiated studies.

Several multicenter randomized clinical registries sponsored by ML CTO Academy are currently being conducted by means of scientific grants from leading industries.

JETCTO REGISTRY



A retrospective, multi-center registry evaluating the clinical and angiographic outcome of covered stents for the treatment of coronary perforation during CTO procedures.

Coronary perforation occurring during a CTO PCI is a rare complication with potential major adverse cardiac events. The long-term clinical and angiographic outcome of such perforation that needs sealing with a covered stent, must be refined in a large international registry. The purpose of this study, sponsored by the University of Mons with an unrestricted educational grant from the ML CTO Academy, is to describe in a large international collaborative network the occurrence and outcome of coronary perforations complicating a CTO procedure.

PRIMARY ENDPOINT:

To assess the long-term (≥ 6 months) clinical follow-up of patients suffering from a coronary perforation during a CTO procedure.

SECONDARY ENDPOINT:

1. Angiographic patency of any covered stent used to seal the perforation;
2. Rate of complications (composite of cardiac death, myocardial infarction, major bleeding and cardiac tamponade) of the index procedure.

HOSTIUMCTO REGISTRY



A retrospective, multi-center registry for the evaluation of the clinical outcome following ostial RCA CTO procedures.

The prevalence of ostial CTO lesion of the RCA is the most prevalent and constitutes an increased challenge during PCI owing to the difficult engagement of the lesion as well as the use of the retrograde approach. The long-term clinical and angiographic outcome of such lesions need to be refined in a large international registry.

PRIMARY ENDPOINT:

To assess the long-term (>6 months) clinical follow up of patients who underwent a CTO procedure of an ostial RCA.

SECONDARY ENDPOINT:

1. Angiographic patency of any stent implanted during the procedure;
Rate of complications (composite of cardiac death, myocardial infarction, major bleeding and cardiac tamponade) of the index procedure.



REVIEW OF TRIAL'S RESULTS



Message of the co-director

WELCOME TO THE 10th MLCTO!

We are excited this year again to provide you with the best lectures and live cases one can possibly hope for. While ML CTO focuses largely on “how” to perform CTO PCI, we are taking an opportunity, with this edition of the Journal, to discuss about “why” we should not let them close in many cases, and we have good data to talk about.

Several observational studies and meta-analyses have reported an adverse effect of a failed CTO PCI or medical therapy for a CTO patients as compared to successful CTO revascularization, with PCI or CABG. However, randomized controlled trials have not yet confirm those findings. Should we be surprised? We don't think so. In the DECISION CTO study, despite a high cross-over rate, the long-term mortality with complete revascularization including CTO PCI was 1.9% versus 3.6% with non-CTO PCI alone, which obviously did not reach statistical significance due to low power. Although this 47% relative risk reduction in mortality could be easily dismissed, it was strikingly similar to the one observed in the latest meta-analysis of observational studies. If one would be planning a trial based on such an effect size, a 3,000-patient trial would be required to test the hypothesis of a reduction in mortality with CTO PCI. The DECISION-CTO trial could not reach their targeted sample size of 1,200 patients in over 6 years. Therefore, demonstrating the effect of CTO PCI on harder endpoints with a well-powered RCT will remain extremely difficult, if not impossible. All other trials were also clearly underpowered for clinical endpoints, including the EuroCTO trial which however demonstrated improved QOL with CTO PCI as compared to non-CTO PCI only.

However, evidenced-based medicine is not randomized-trial medicine! It is a medicine based on the best evidence available, which can sometimes be observational. Also, sub-studies of larger trial with focus on patients with CTOs can also inform on the benefits of revascularization.

I therefore asked 2 of my previous fellows, who both have become independent and high-volume CTO operators and scientists, Dr Ybarra and V-Julien, to discuss in a Journal Club format very interesting findings from 2 recent publications that both support an adverse impact of unrevascularized CTO on harder outcomes.

Welcome to MLCTO 2025 and enjoy the reading!!

Stéphane Rinfret
on behalf of the co-directors

Exploring the relationship between chronic total occlusions and mortality in coronary artery disease

Joakim Sundström et al. Cardiovascular Revascularization Medicine 2025, in press

BACKGROUND:

Chronic total occlusions (CTOs) are common in coronary artery disease (CAD) and are known to impact survival, especially in acute myocardial infarction and cardiac arrest. However, their impact on long-term survival across the broader population with CAD remains less studied. We studied the association between the number, location, and severity of CTOs and long-term survival in a large, unselected cohort.

METHODS:

Patients undergoing coronary angiography in Sweden between July 2015 and December 2021 were identified from the Swedish Coronary Angiography and Angioplasty Registry (SCAAR). Individuals with prior CABG were excluded. Patients were categorized by the number of CTOs (none, 1, or ≥ 2) and location (LAD, LCX, or RCA). Survival was assessed using Kaplan–Meier and Cox proportional hazards models.

RESULTS:

Of 202,191 patients, 88.0 % had no CTO, 9.8 % had 1 CTO, and 2.1 % had ≥ 2 CTOs. Survival worsened with increasing CTOs ($p < 0.0001$). Compared to no CTO, hazard

ratios were 1.69 (95 % CI, 1.63–1.76; $p < 0.001$) for 1 CTO and 2.27 (95 % CI, 2.13–2.42; $p < 0.001$) for ≥ 2 CTOs. Adjusted HRs by location were 1.31 (95 % CI, 1.24–1.38; $p < 0.001$) for LAD, 1.59 (95 % CI, 1.52–1.66; $p < 0.001$) for RCA, and 1.28 (95 % CI, 1.21–1.35; $p < 0.001$) for LCX.

Conclusions: The presence, number, and location of CTOs significantly influence long-term survival. This provides long-term risk stratification for patients with CTO, which may improve patient selection for interventions.

MY EDITORIAL COMMENT:

THE UNACCEPTABLE RISK OF CHRONIC TOTAL OCCLUSIONS: WHEN MEDICAL TREATMENT IS SIMPLY NOT ENOUGH



Louis Verreault-Julien, MD, MPH, FRCPC, DRCPC

Montefiore Medical Center, Albert Einstein College of Medicine, Bronx, New York, USA

Coronary artery disease (CAD) remains a leading cause of death worldwide despite advances in medical treatment over the last decades, with more extensive and complex disease being associated with worse prognosis. At the apex of complexity, chronic total occlusions (CTO) represent both a technical and a mental challenge. On one hand, their revascularization is associated with lower success rates and a higher risk of complications compared to non-CTO PCI¹. On the other hand, CTOs have been associated with incomplete revascularization, especially with PCI, leading to much worse outcomes compared to completely revascularized patients².

Using the Swedish Coronary Angiography and Angioplasty Registry (SCAAR), a prospective national registry in Sweden, Sundström et al. sought to determine the association between the number of CTOs, their location, and long-term survival³. In this study including a total of 202,191 patients, compared to patients with no CTO, patients with 1 CTO ($n=19,938$) had a 69% higher risk of mortality (HR 1.69, 95% CI 1.63 to 1.76), and patients with 2 or more CTOs had a 127% higher mortality risk (HR 2.27, 95% CI 2.13 to 2.42). Of all the CTOs, the most frequent location

was the RCA (45.9%), followed by the LAD (27.9%) and circumflex (26.2%). Additionally, while all locations were associated with a higher risk of mortality compared to patients with no CTO, the RCA was associated with the worse prognosis with a 59% increased risk of mortality (HR 1.59, 95% 1.52 to 1.66). This could be explained by survival bias, with patients developing a severe LAD stenosis who may not survive long enough to develop a CTO.

This study adds to the overwhelmingly large body of evidence supporting that CTOs are associated with a higher risk profile and overall worse prognosis in real world practice. However, it does not inform on whether CTO revascularization is beneficial to reduce the risk of hard endpoints such as mortality. In fact, in this study, the mere presence of a CTO at baseline was enough to portend a bad prognosis, but revascularization status was not reported. Does it mean that the risk associated with a CTO cannot be mitigated? Not necessarily. Does it mean that the risk associated with a CTO remains unchanged regardless of the revascularization status? Most likely not. In a large Canadian registry of 1,624 patients with at least 1 CTO and followed for at least 9.75 years, patients were compared based on their revascularization status⁴. Compared to patients treated medically, patients who were revascularized to non-CTO vessels only had a similar mortality rate. However, patients who had their CTOs revascularized had a lower risk mortality, and this was true for both CABG, with grafting including the CTO vessel (HR 0.60, 95% CI 0.46 to 0.78) and CTO PCI (HR 0.71, 95% CI 0.51 to 0.998). Like most data about CTOs and their prognostic, this study was observational in nature, and it is difficult to establish a causal relationship between CTO revascularization and improved clinical outcomes in this context. We might, however, never have a large enough randomized clinical trial to prove that such a relationship exists. In the EURO-CTO trial including 396 patients, one of the largest RCTs to date, the success rate was 86.6% in the CTO PCI group (effectively crossing over to optimal medical therapy) and 17.5% crossed over to the PCI group from the optimal medical therapy group within 3 years⁵. If the study was able to show symptoms improvement, it was not able to demonstrate a difference in terms of mortality or non-fatal myocardial infarction, highlighting the difficulty of conducting such trials because of significant crossovers between groups. As shown in the current study, patients with more CTOs are usually much more symptoma-

tic based on their CCS class. On one hand, this makes it difficult to keep patients on optimal medical therapy, knowing that revascularization has symptomatic benefits. On the other hand, CTO PCI success rates must be high enough not to dilute the effect of the treatment in such a trial, but also in real life practice so our patients have the best chances to derive the benefits of a successful CTO PCI. Among expert operators, a success rate $> 90\%$ is nowadays the target, which hopefully will continue to increase over time as techniques and devices become more effective⁶.

With the current available data, including this recent publication by Sundström et al., we should have serious conversations with our CTO patients and inform them about the worse prognosis associated with this condition. We can also confidently tell them that a successful CTO PCI can achieve similar long-term outcomes as patients undergoing PCI of non-CTO lesions⁷. Whether we should offer CTO PCI to all CTO patients remains unclear. The ongoing ISCHEMIA-CTO trial, which is randomizing patients to either CTO PCI or optimal medical treatment, might shed some light on this question, albeit the slow recruitment of the patients in this study is already raising the question of selection bias of lower risk patients, the others (large ischemia, severe symptoms) being treated outside the trial. Strong observational data such as the one presented here may be the only available one on which clever clinicians will have to take their most informed decisions for years to come.

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Invasive vs Conservative Management of Patients with Chronic Total Occlusion

Results From the ISCHEMIA Trial

Sripal Bangalore S et al; the ISCHEMIA Research Group. JACC. 2025;85:1335–1349

BACKGROUND:

Randomized trials of chronic total occlusion (CTO) revascularization vs medical therapy have yielded inconsistent results.

OBJECTIVES:

The aim of this study was to evaluate outcomes with an initial invasive strategy (INV) vs an initial conservative strategy (CON) in patients with coronary computed tomographic angiography (CCTA)-determined CTO in the ISCHEMIA (International Study of Comparative Health Effectiveness With Medical and Invasive Approaches) trial.

METHODS:

Participants in ISCHEMIA who underwent CCTA evaluated for CTO by the core laboratory (3,113 of 5,179 randomized patients [60%]) were categorized into subgroups with (100% stenosis) and without (<100% stenosis) CTO. Primary analysis compared outcomes in those randomized to INV vs CON using an intention-to-treat approach. Secondary analyses compared outcomes using inverse probability weighting to model successful CTO revascularization (REV) in all INV participants vs CON participants.

RESULTS:

Of the 3,113 CCTA-evaluable participants, 1,470 had at least 1 CTO (752 INV and 718 CON). INV did not reduce cardiovascular (CV) death or myocardial infarction (MI) (5-year difference -3.5%; 95% CI:

-7.8% to 0.8%) and resulted in more procedural MIs (2.5%; 95% CI: 1.0%-4.0%) but fewer spontaneous MIs (-6.3%; 95% CI: -9.7% to -3.2%) than CON. CTO REV modeled across INV had a high probability (>90%) of any lower CV death or MI, MI, spontaneous MI, unstable angina, and heart failure counterbalanced by a higher rate of procedural MI. CTO REV significantly improved angina-related quality of life (mean difference 4.6 points), Rose Dyspnea Scale score (rescaled) (mean difference 5.3 points), and EQ-5D visual analog scale score (4.6 points).

CONCLUSIONS:

In the ISCHEMIA trial, the risks and benefits of INV compared with CON were similar among patients with and without CCTA-determined CTO (more frequent procedural MI, less frequent spontaneous MI, and significantly improved angina and dyspnea-related quality of life). In an observational comparison, successful CTO REV was associated with a high probability of lower CV death or MI (driven by lower MI) compared with CON.

MY EDITORIAL COMMENT:

WHERE ISCHEMIA LEAVES US: ELEVATING CTO PCI PRACTICE IN 2025 AND BEYOND



Luiz F. Ybarra, MD, PhD, MBA, FSCAI

The optimal approach to chronic total occlusions (CTOs) continues to challenge interventional cardiology. While successful revascularization is intuitively appealing—and often clinically rewarding—the evidence remains conflicted.

The recent CTO-focused sub analysis of the ISCHEMIA trial by Bangalore et al., published earlier this year in JACC, offers the largest dataset to date examining randomized outcomes of invasive versus conservative strategies in patients with CTOs, this time interestingly identified with Coronary Computed Tomography Angiography (CCTA). This substudy provides much-needed nuance into a field long dominated by underpowered trials and observational inference, but it also raises important methodological and clinical questions deserving close scrutiny.

Bangalore et al. analyzed 1,470 ISCHEMIA participants with at least one CTO on core-lab CCTA. Of these, 752 were previously randomized to an initial invasive strategy (INV-CTO) and 718 to a conservative approach (CON-CTO). At five years, INV-CTO was associated with fewer spontaneous myocardial infarctions (-6.3% absolute risk) but more procedural MIs (+2.5%), with no reduction in cardiovascular death or the composite of CV death/MI (-3.5%; 95% CI -7.8 to 0.8%). In a modeled analysis using inverse-probability weighting, successful CTO revascularization was associated with >90% posterior probability of reducing CV death/MI and improving angina, dyspnea, and quality of life, with a mean SAQ-7 gain of about 5 points.

The sub study arrives at a critical time for complex PCI. Enthusiasts of CTO revascularization can highlight fewer spontaneous MIs and meaningful angina relief in patients with successfully recanalized vessels, while skeptics can still underscore harm: spontaneous MI prevented are partially offset by iatrogenic procedural MI, and no mortality benefit emerged over the time period.

This raises a provocative question: how can CTO PCI reduce spontaneous MI if the vessel is already occluded? In an editorial comment, Ziad Ali and colleagues offered a mechanistic hypothesis: successful CTO PCI may reduce collateral flow and lower hyperemic flow in dominant donor vessels, thereby reducing shear stress and stabilizing plaques elsewhere in the coronary tree. Alternatively, successful PCI may lower the risk of type 2 (demand-related) MI.

Several design elements further temper enthusiasm. First, reliance on CCTA (which was only 73% accurate in identifying angiographic CTOs) risks misclassifying subtotal stenoses as occlusions, potentially inflating procedural success and benefit. Second, randomization was not stratified by CTO status, raising concerns about chance imbalances. Third, the “successful revascularization” analysis, though statistically elegant, remains observational and vulnerable to confounding: patients with more favorable anatomy and treated by higher-skill operators may inherently fare better.

The CTO sub-analysis of the ISCHEMIA trial comes after two landmark RCTs. In the DECISION-CTO (834 patients), PCI + OMT was not superior to OMT alone for major adverse events, despite a 91% procedural success rate. However, large

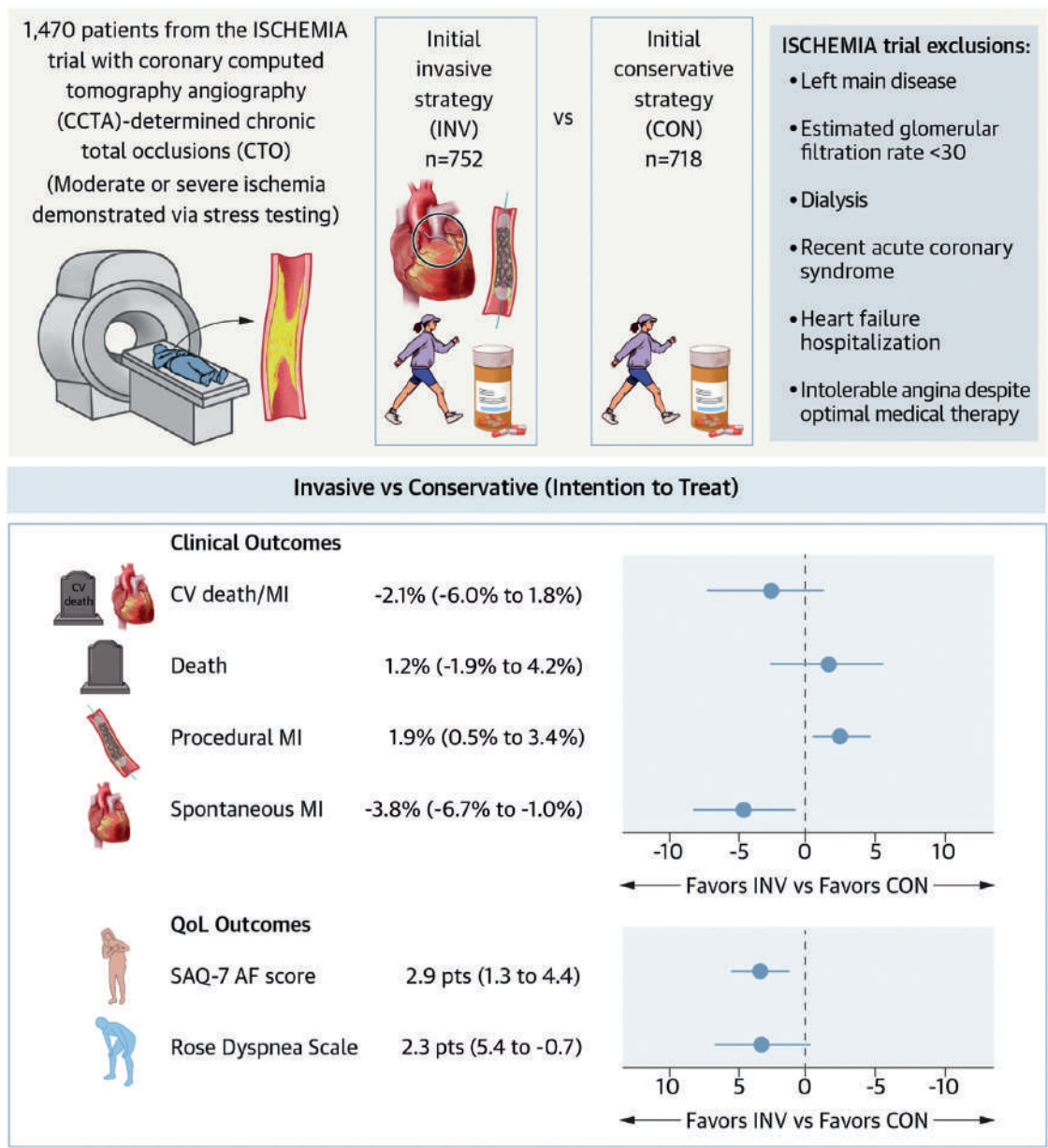
crossover and underpower strongly limited the strength of the neutral findings. In contrast, EURO-CTO (396 patients) showed improved angina-free survival and lower MACCE at three years in the PCI arm, which had an 86% success rate. When CTO PCI is technically successful, patients feel and function better. To affect prognosis, CTO PCI needs to achieve high success consistently, in higher-risk patients, and at sufficient scale.

Of note, in ISCHEMIA, only 54% of attempted PCIs and 63% of CABG procedures successfully revascularized CTOs. These rates dilute treatment signals and bias the results towards the null hypothesis. By contrast, the PROGRESS-CTO registry reported success rates rising from 81.6% in 2016 to 88.1% in 2021 across >10,000 procedures, with a stable 2.1% in-hospital MACE rate. Many high-volume centers now exceed 90% success rate in their CTO PCI attempts. The difference between 54% and 90% is not academic. It may be the difference between consistent symptom relief, improved clinical outcomes or clinical futility. For the patient, it can determine whether CTO PCI delivers tangible benefit or procedural harm.

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CENTRAL ILLUSTRATION Effect of INV vs CON on Clinical and QoL Outcomes in Patients With CCTA-Determined CTO in the ISCHEMIA Trial



Bangalore S, et al. JACC. 2025;85(12):1335-1349.

In the intention-to-treat analysis, the invasive strategy (INV) reduced spontaneous myocardial infarction (MI), increased procedural MI, and improved angina- and dyspnea-related quality of life (QoL) compared with the conservative strategy (CON). In an observational analysis modeling patients in the INV group in which the chronic total occlusion (CTO) was revascularized with either percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG), there was a higher posterior probability of lower cardiovascular (CV) death or MI, lower spontaneous MI, and improvement in angina- and dyspnea-related QoL compared with CON. AF = angina frequency; CCTA = coronary computed tomographic angiography; ISCHEMIA = International Study of Comparative Health Effectiveness With Medical and Invasive Approaches; SAQ-7 = 7-item Seattle Angina Questionnaire.

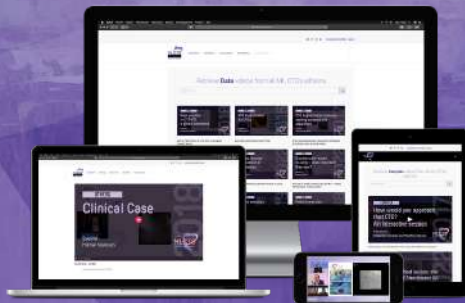
Educational opportunities

> Digital Programs

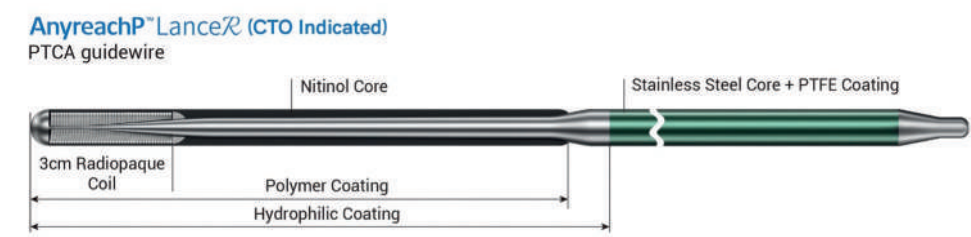
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Access to the MLCTO Video Library for a wealth of CTO PCI Knowledge & retrieve videos from all editions on ADR, antegrade, complications, imaging, retrograde and much more. +380 videos!



Successful Recanalization of RCA CTO with APT CTO Solutions: A Case of Complex Comorbidities



By



We would like to share a case performed by Dr. Gan, which shows that with the help of APT CTO solutions -- Anyreach PTCA guidewire, Elong™ microcatheter, CONQUEROR™ balloon, an RCA CTO was successfully treated.

PATIENT INFO:

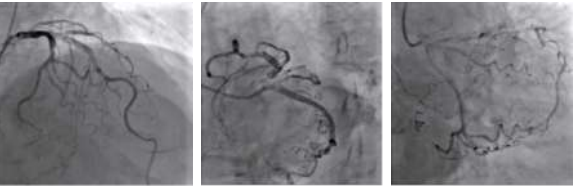
68-year-old female

Complaint: Chest tightness and dyspnea for 3 days

History: Coronary atherosclerotic heart disease; Hypertension, Grade 2, high-risk group; Post-cerebral infarction sequelae; Renal insufficiency

Diagnosis: Coronary atherosclerotic heart disease; ischemic cardiomyopathy, Class III heart function.

Angiography showed: There is approximately 40-50% stenosis in the LAD ostium, and there is collateral circulation originating from the mid-to-distal segment of the right coronary artery.

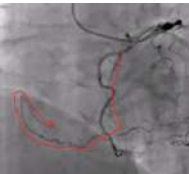


The mid-RCA occlusion with a right ventricular branch originating from the mid-RCA. A few collateral vessels were visible to the mid and distal segments, with the LAD supplying blood retrogradely to the mid and distal segments of the RCA.



THINKING

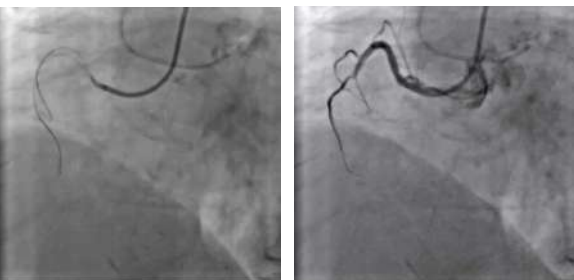
Since the patient had good collateral circulation, why did she still have symptoms of chest tightness and dyspnea?



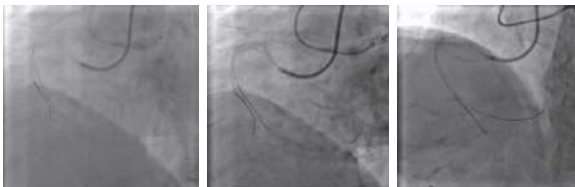
It is proposed that the main blood supply to the mid-RCA comes from the LAD, so the narrow LAD ostium leads to relatively insufficient blood supply to the RCA, which makes revascularization meaningful.

HERE IS HOW THIS CASE WAS TREATED:

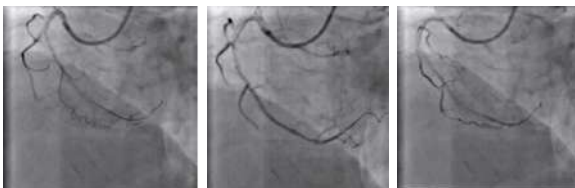
With the support of an Elong™ 2.6F microcatheter, one guidewire was navigated to enter a small segment, but could not proceed further. It was considered that the entry segment tissue was relatively loose. Since the Elong™ microcatheter was slightly to the left, an AnyreachP™ LanceR 6.0 guidewire with preshape tip was directly used. The proximal end was appropriately shaped with a second bend to ensure it could enter the area navigated by the former wire. After entering, the Elong™ microcatheter was advanced to break through a small segment, followed by super selective angiography for confirmation.



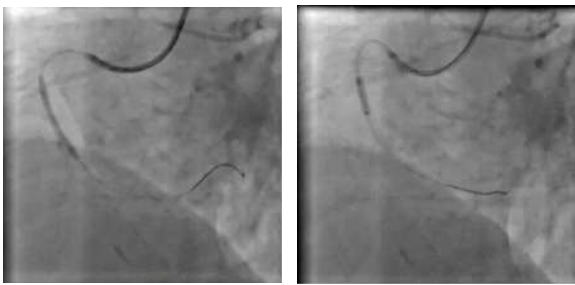
The AnyreachP™ LanceR guidewire tip was appropriately adjusted to the right, and it smoothly broke through with good tactile feedback. The contralateral super-selective angiography revealed that the guidewire had been advanced distally, entering various branches that overlapped with the contrast media, which indicated the precise retrograde pathway.



The Elong™ microcatheter was advanced for guidewire exchange. A 1.5x15 mm and a 2.0x15 mm Conqueror SC balloon were used sequentially for dilation, followed by angiography showing intact branches.

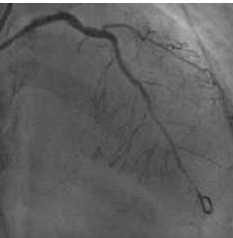


A 2.5x29 mm stent was implanted, followed by post dilation with a 2.5x12 mm CONQUEROR™ NC balloon.



FINAL RESULTS

Final result, RCA blood flow recovered, TIMI grade 3.



In summary, AnyreachP™ Lancer guidewire demonstrated excellent penetration, maneuverability, and curve retention. Its pre-shaped design enhanced the efficiency of CTO-PCI. The Elong 2.6F Microcatheter features a long, tapered tip and enhanced braided metal & stainless steel coil design that can be rotated forward. The excellent trackability and support make the Elong 2.6F an optimal choice for a CTO with calcium. The Conqueror small balloon catheter has a low entry and crossing profile, which is optimal for the narrow lesion's pre-dilation.



Innovation Meets Complexity APT CTO PCI Solution

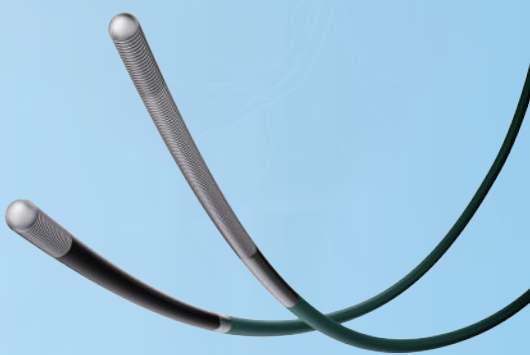
AnyreachC™ & AnyreachP™

PTCA Guidewire

Workhorse 0.3g / 0.6g / 1.0g

Retrograde 0.3g

CTO indicated 1.5g / 3.0g / 6.0g



Elong™

Microcatheter

Straight tip 1.7F/1.9F

Tapered tip 2.6F

Dual lumen 3.2F

* Preloaded extension wire



Expressman™

Guiding Extension Catheter

Side holes design

Tapered version

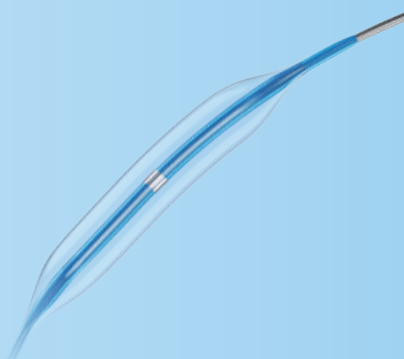


CONQUEROR™

PTCA Balloon Catheter

1.0mm SC balloon

special design for CTO lesions



ALEX&FRIENDS: WHERE FRIENDSHIP MEETS EXPERTISE IN CARDIOLOGY

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In the world of interventional cardiology, where precision and expertise are paramount, Alex&Friends stands out as a unique series that blends friendship, humor, and world-class medical insights. Created by the charismatic Dr. Alexandre Avran, this 13-episode series offers viewers a refreshing mix of heartfelt conversations and cutting-edge professional demonstrations.



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With
Ahmed ElGuindy



Ep. 2

Ostial LAD Occlusion with left main/ Cx megatron stent

With
Roberto Garbo



Ep. 3

Long RCA occlusion: antegrade or retrograde approach?

With
Thomas Hovasse



Ep. 4

A lesson of IVUS

With
Stéphane Carlier



Ep. 5

A complex ostial LAD occlusion in a 67 years old man

With
Masahisa Yamane



Ep. 6

Blunt proximal LAD occlusion

With
Pierfrancesco Agostoni



Ep. 7

Proximal RCA occlusion with ipsi and contralateral collateral

With
Kambis Mashayekhi



Ep. 8

Ostial LCX occlusion through left main LAD struts - beware of complication

With
Stéphane Rinfret



Ep. 9

Nothing is simple

With
Cedric Kowalski



Ep. 10

Where is my guidewire? Only IVUS knows - A story about an ambiguous RCA proximal cap

With
Alessandro Scalia



Ep. 11

Retry of an ostial LAD CTO, previous antegrade failure with Gaia family

With
Francesco Paolo Ariano



Ep. 12

Everything you wanted to know about Recross without having to ask

With
Georges El Hachem



Ep. 13

2 brains, 4 hands, 2 CTO

With
Paul Knaapen
& Alexander Nap



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IVUS 123 Essentials: A Structured Approach to Intravascular Imaging for Optimised PCI Outcomes

By



Intravascular ultrasound (IVUS) is an established imaging technique that improves the precision of percutaneous coronary intervention (PCI). A great body of literature¹⁻⁷ supported the ESC's decision to update their guidelines recommendation to use IVUS-guided PCI to I A in long lesions and Left Main Bifurcations¹. Patient benefits include reductions in restenosis, stent thrombosis, and target vessel failure.

Using IVUS effectively in your daily practice allows direct visualisation of lesion morphology, vessel size, and stent deployment quality. The IVUS 123 Essentials framework provides a clear, structured approach to applying IVUS pre-PCI, during-PCI and post-stent implantation.

STEP BY STEP FRAMEWORK FOR IVUS APPLICATION

The IVUS 123 Essentials protocol is a step-by-step process that covers the pre-PCI and post-stent phases of PCI.

Step 1: Pre-PCI Assessment

This step guides lesion evaluation and stent planning. It includes three main components:

- 1. Lesion length:** Identify suitable landing zones by evaluating the length of the lesion. These zones should have less than 50% plaque burden to minimise the risk of edge complications.
- 2. Plaque morphology:** Characterise the type of plaque (lipidic, fibrotic, or calcified). This helps determine if and which lesion preparation devices are needed.
- 3. Vessel diameter:** Measure the vessel and lumen diameters at reference sites to choose the correct stent size. The distal reference is often preferred to avoid errors from positive or negative remodeling.

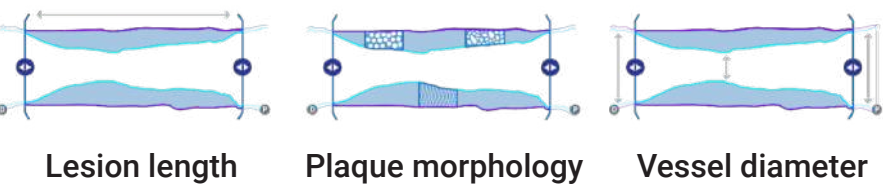


Figure 1. IVUS 123 Pre-PCI workflow

Step 2: Post-Stent Evaluation

This step confirms whether the stent is properly placed and expanded. It includes the following checks:

- 1. Stent Edges:** Assess for geographic miss and edge dissection. Avoiding landing zones with >50% plaque burden and detecting edge tears >3 mm can reduce complications.

- 2. Stent Apposition:** Ensure that the stent struts are well apposed to the vessel wall. Malapposition can lead to thrombus formation.
- 3. Stent Expansion:** Evaluate the minimal stent area (MSA). Aim for MSA $\geq$ 90% of the distal reference lumen or at least 5.0 mm². This reduces the risk of restenosis and is supported by clinical data.

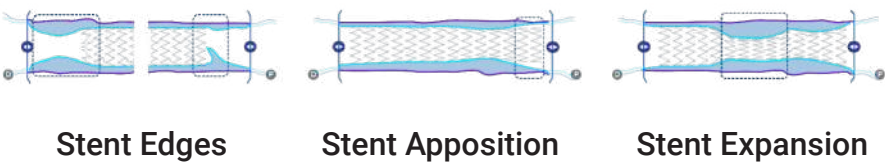


Figure 2. IVUS 123 Post-stent workflow

CLINICAL EVIDENCE AND VALIDATION

The ULTIMATE trial demonstrated that applying three post-stent criteria (no edge dissection >3 mm, MSA $\geq$ 90% of distal reference or >5.0 mm², and <50% plaque at stent edges) reduces target vessel failure. Over three years, IVUS-guided procedures had better outcomes than angiography-guided ones.⁵

Also, many studies have shown that stent underexpansion is a key risk factor for restenosis and thrombosis.⁶⁻⁷

The power of the AVVIGO™+ Multi-Modality Guidance System will make it easier and faster to apply IVUS 123 thanks to the latest AI-enhanced technologies. The patented Automated Lesion Assessment was clinically tested and validated by two studies, proving clinical accuracy in the lesion assessment.^{8,9}

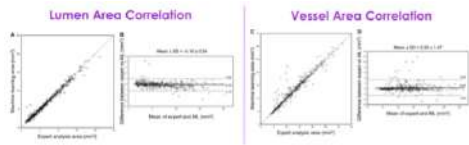


Figure 3. AI Accuracy of IVUS-Based Machine Learning of Coronary Artery Dimensions.⁸

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