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Advancements in robotic PCI technology: time to tackle the complex lesions!

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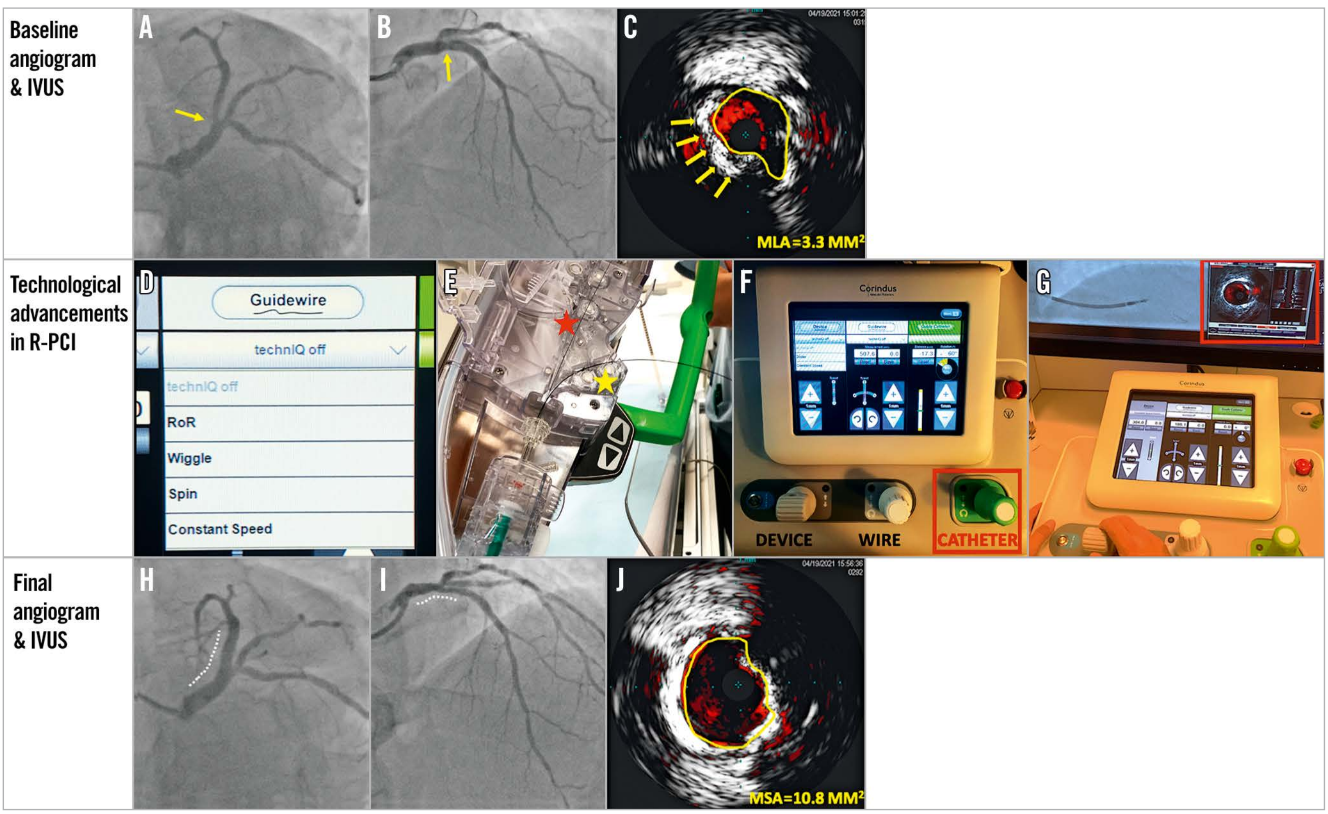

Figure 1. *Robotic IVUS-guided complex PCI. A-B) Baseline angiography and (C) IVUS showing a critical calcified lesion (yellow arrow) in the ostium of the LAD, involving the left main stem and proximal LAD. D) A choice of four different automated wire controls (TechnIQ) are available to the operator. E) In addition to the "active" wire (red star), multiple additional wires and devices can be parked in the passive drive (yellow star). F) Integration of intracoronary imaging with the R-PCI system, allowing precise control of the IVUS catheter with real-time visualisation. G) The addition of guide catheter control (red box) represents a key technological development in the second-generation CorPath GRX R-PCI system. H-I) Following successful lesion predilatation, a 4.0×36 mm drug-eluting stent (Supraflex Crux) was implanted, followed by post-dilatation and proximal optimisation, yielding a good final angiographic and (J) IVUS result (Moving image 6, Moving image 7). Final procedure time was 60 minutes, fluoroscopy time 30 minutes, radiation dose 1.67 Gy and contrast volume used was 150 mls. IVUS: intravascular ultrasound; LAD: left anterior descending; R-PCI: robotic-assisted percutaneous coronary interventions*

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Robotic-assisted percutaneous coronary interventions (R-PCI) represent a new frontier for interventional cardiology **(Supplementary Figure 1)**. In this image, we showcase the key technological developments in the latest-generation robotic CorPath GRX system (Corindus Vascular Robotics, Siemens Healthineers), which facilitated an intravascular ultrasound (IVUS)-guided PCI of a complex left main to the left anterior descending (LAD) artery lesion **(Figure 1, Moving image 1, Moving image 2)**.

Lesion wiring can now be performed with the use of automated wire movements (termed TechnIQ in the CorPath GRX system), which use artificial intelligence technology to replicate common wire manoeuvres performed by operators. In this case, the critically calcified lesion was safely crossed using the "wiggle" feature, and the "spin" feature was used to advance the wire distally **(Moving image 3, Moving image 4)**. Further automations include "rotate on retract" and "constant speed". The ongoing NAVIGATE-GRX randomised clinical trial (ClinicalTrials.gov: NCT04883008) will compare the safety and effectiveness of using these automated wire controls. Additionally, the "dotter" and "constant speed" automations can be used to assist in the advancement of devices (balloons or stents).

Precise control of the guiding catheter is now possible, with the ability to advance, retract and rotate the guiding catheter. This allows for multiple adjustment and stabilisation manoeuvres to be performed during balloon/stent delivery and retrieval. In addition, precise control of the guiding catheter-facilitated visualisation of the entire left main stem (LMS) during IVUS pull-back. The integration of IVUS into R-PCI systems means interventionists can now optimally treat more complex lesion subtypes. However, not all IVUS catheters are compatible with the CorPath GRX system. In our case, IVUS was performed robotically using the Eagle Eye Platinum catheter (Philips) **(Moving image 5)**.

These technological improvements in wire manipulation, guide catheter control and IVUS imaging demonstrate how R-PCI systems are evolving to overcome the challenges of contemporary PCI.

Conflict of interest statement

D. Dudek is a speaker for Siemens Healthineers. The other authors have no conficts of interest to declare.

Supplementary data

Supplementary Figure 1. Catheterisation laboratory set-up for robotic-assisted PCI.

Moving image 1. Baseline angiogram in left anterior oblique/caudal projection demonstrating the lesion arising from the distal left main extending to proximal LAD.

Moving image 2. Baseline angiogram in anteroposterior (AP) cranial projection demonstrating the lesion arising from the distal left main extending to proximal LAD.

Moving image 3. Ex-vivo demonstration of the TechnIQ automated wire movement called spin. As the wire is advanced, it performs three clockwise and three anti-clockwise rotations in succession.

Moving image 4. Ex-vivo demonstration of the TechnIQ automated wire movement called wiggle. As the wire is advanced, it performs rapid alternating movements.

Moving image 5. Demonstration of how the IVUS imaging catheter (EagleEye Platinum, Philips) is used with the CorPath GRX R-PCI system.

Moving image 6. Final procedural angiogram in left anterior oblique/caudal projection.

Moving image 7. Final procedural angiogram in AP cranial projection.

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Supplementary Figure 1. Catheterisation laboratory set-up for robotic-assisted PCI

The cardiac catheter lab is optimised to enable the primary operator (yellow arrow) to perform the procedure sat at the interventional cockpit without wearing any radiation protection devices, whilst still being able to survey and visualise the entire catheter lab. The second operator (orange arrow) is positioned at the bedside to control and load the robotic arm which is connected to the distal end of the guiding catheter. It should be noted that different catheter lab arrangements are possible, with the possibility of keeping the interventional cockpit outside the catheter lab.