

# Robotic-assisted Revascularization of Femoropopliteal Restenosis After Atherectomy in a Patient With Challenging Vascular Anatomy

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**Abstract:** Robotic assistance is increasingly being used for percutaneous peripheral vascular intervention, but procedures reported to date have been performed using femoral access. Here, we report use of the CorPath GRX Robotic System for revascularization of right-leg critical limb ischemia using a left transradial approach. The ergonomic and radiation-safety impact of robotic assistance, as well as technical suggestions for planning distal-access procedures, are discussed based on observations from the case.

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**Key Words:** Peripheral vascular intervention, transradial arterial access, abnormalities, arterial anatomy, critical limb ischemia, robotics

Since its introduction for robotic-assisted percutaneous coronary intervention (PCI) in 2012,<sup>1,2</sup> the indications for the CorPath Robotic System (Corindus, a Siemens Healthineers Company, Waltham, Massachusetts, USA) have grown to include peripheral vascular intervention (PVI), and the system has been evaluated for utility at an increasing range of anatomical sites.<sup>3-9</sup> Experience with the system has shown that some of the advantages of robotic assistance for PCI and PVI include reduced exposure to radiation and less orthopedic strain for the interventionalist,<sup>1-8,10</sup> as well as more precise lesion measurement and device placement during revascularization procedures.<sup>11</sup>

In the reports published to date, interventionalists have employed femoral arterial access to perform procedures using the robotic system. However, with increasing use of the radial artery and other sites for percutaneous access for PVI, the lack of studies evaluating the robotic system's compatibility with this approach represents a gap in knowledge. The following case report describes a case in which robotic-assistance was used during revascularization of critical limb ischemia in the lower extremity using a transradial approach.

## Case Report

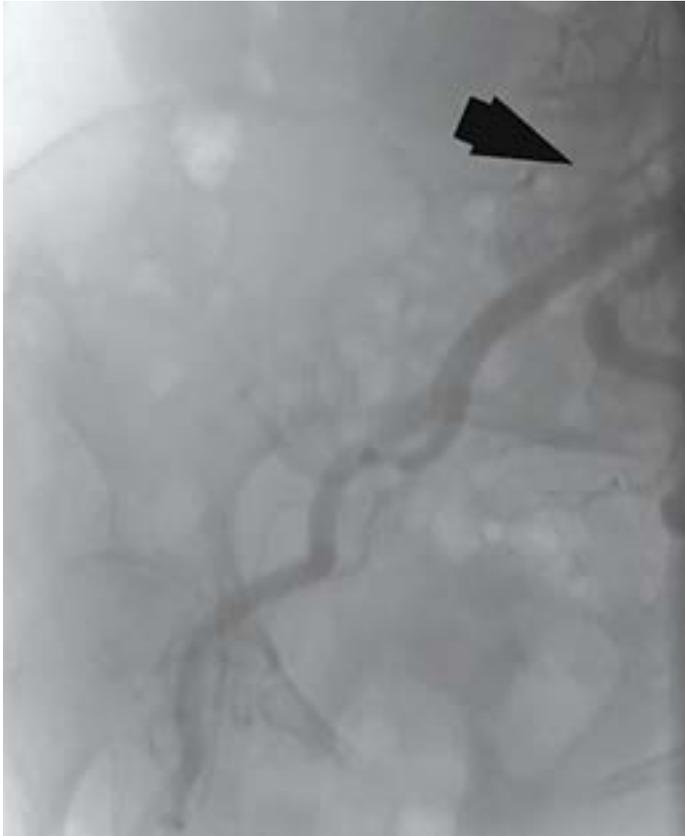
In June of 2020, a 75-year-old female with a history of peripheral vascular disease, below-the-knee amputation of the left leg, and atherectomy of the right popliteal artery 9 months prior presented with right foot pain at rest and a small ulcer on the right foot plantar aspect. Comorbidities included type 2 diabetes, hypertension, hyperlipidemia, and obesity (BMI: 32). Angiography suggested 90% restenosis with total occlusion of the peroneal and posterior tibialis (**Figure 1**).

Based on prior angiography and experience during the previous atherectomy procedure, the patient was known to have unusu-



**Figure 1.** Preprocedural imaging by (A) digital angiography and (B) digital subtraction angiography.

ally tortuous vascular anatomy, including a tortuous and calcified ascending aorta; highly angular, near-horizontal geometry at the distal aorta bifurcation into the iliac arteries; and a near 180-degree turn where the distal aorta transitioned to the right iliac artery (**Figure 2**). Coupled with a large abdominal pannus, her anatomy had previously precluded antegrade right femoral artery access. Pedal access also had not been feasible due to technical constraints related to delivery of a balloon or stents from a pedal approach. Furthermore, in the prior procedure, it had not been possible to use a drug-coated balloon because the device was incompatible



**Figure 2.** Preprocedural digital angiography showing tortuous anatomy where the patient's distal aorta bifurcates into the iliac arteries.

with the long sheath used during the procedure (R2P, Terumo Interventional Systems, Somerset, NJ). Taking into account the restenosis and the known anatomical and technical challenges of the case, stent placement was warranted. After a discussion of treatment options and risks, the patient consented to robotic-assisted peripheral revascularization by way of a left radial approach.

The patient was prepped in usual sterile fashion and lidocaine (2%) was administered at the access site. Conscious sedation was given. Access to the left radial artery was gained manually under ultrasound guidance using a 5F Glidesheath Slender (Terumo). A J tip, 0.035-in wire was advanced manually from the wrist to the ascending aorta. The Glidesheath was then removed and replaced with an R2P Destination Slender sheath (6F x 119 cm; Terumo), which was advanced through the tortuous transition from the distal aorta into the right external iliac artery. Heparinization was administered to achieve a target activated clotting time greater than 250.

To prepare for the robotic-assisted portion of the procedure, the tableside arm of the CorPath GRX Robotic System was brought into position and a single-use cassette was installed into the robotic drive unit. The proximal end of the R2P Destination guide catheter was connected to the Y-connector component of the robotic system, which was then loaded into the appropriate guide-catheter track. The J tip guidewire was exchanged for a Glidewire Advantage (0.018 in x 300 cm; Terumo) and the



**Figure 3.** (A) Balloon expansion and (B) post-balloon imaging showing suboptimal revascularization of the lesion.



**Figure 4.** (A) Stent placement and (B) post-procedure imaging showing patent vessel with restoration of flow to the lower leg.

proximal end of the new guidewire was loaded into the guidewire track of the robotic cassette. The interventionalist was then seated at the shielded workstation.

Using robotic assistance, the guidewire was advanced under fluoroscopic guidance down the superficial femoral artery and past the distal lesion, which extended to the distal superficial femoral artery. The wire was placed at the mid-distal level of the anterior tibial artery. A R2P Metacross balloon (5 mm x 80 mm; Terumo)

was then advanced to the lesion and inflated at nominal pressures (**Figure 3**). An R2P Misago RX self-expanding peripheral stent was selected to address the restenosis; a decision was made to advance the stent manually using a pin-and-pull technique (**Figure 4**). Another Metacross balloon (6 x 100 mm) was delivered robotically for post-dilation after stent placement. Successful stent deployment and expansion with restored flow to the patient's lower leg were confirmed on final angiography (**Figure 4**). Once all devices were removed, hemostasis at the access site was achieved with a radial compression device (TR Band; Terumo). There were no complications during or after the procedure.

The patient was discharged home with standard after-care instructions and remained on dual antiplatelet therapy.

## Discussion

Previous literature has described use of the CorPath Robotic System for assistance with percutaneous vascular intervention in the coronary, carotid, renal, lower-extremity, and even intracranial circulations.<sup>1-8</sup> However, to our knowledge, the present case report is the first published use of the robotic system with interventional devices for robotic-assisted peripheral revascularization by a transradial approach.

The documented advantages of transradial arterial access over the traditional, transfemoral approach for percutaneous procedures include reductions in access-site bleeding complications, net clinical adverse events, and hospital stays.<sup>12</sup> The transradial approach has also been shown to be cost-effective, is preferred by patients, and allows interventional procedures to be performed in fully anticoagulated patients without increased bleeding risk.<sup>12</sup>

Left-sided radial access, however, presents physical challenges to the operator, as the setup of the typical angiography suite and the conformation of essential equipment are traditionally oriented around working from the patient's right side. Working from the left is ergonomically uncomfortable, causing neck strain and operator fatigue.<sup>13,14</sup> These problems can be further exacerbated when a patient has a large body habitus, such as in the present case.

In the current case, use of robotic assistance mitigated this issue and provided several other advantages. While access and cannulation steps were still performed manually, the majority of the procedure was performed while the operator was seated at the control cockpit, which has high-definition monitors permitting detailed visualization of the wires, balloons, and stents. The radiation shielding around the cockpit provides a safety advantage, as has recently been demonstrated in the RAPID II study reported by Mahmud and colleagues. That study demonstrated that use of robotic assistance resulted in a 96.9% reduction in radiation exposure to the primary operator while treating femoropopliteal lesions with rapid-exchange interventional devices.<sup>15</sup> Additionally, the robotic system's measuring function was useful for selecting the stent most appropriate to the lesion length, consistent with published findings.<sup>11</sup>

An important consideration for interventionalists wishing to use robotic assistance with alternative access sites is that, although the CorPath GRX System is indicated for PVI, it is not universally

compatible with all available guidewires, catheters, and interventional devices. Operators will need to carefully plan procedures in advance, taking into account the system's compatibility with the sizes and working lengths of various interventional devices commonly used during PVI procedures. Device working lengths and balloon diameters may push the limits of the system's capability, as seen in the current case, in which distal access in one extremity was used to treat a distal lesion in another extremity. Planned use of manual manipulation for specific procedure steps may be necessary in such cases but, in the author's opinion, this does not negate the overall advantages of using robotic assistance. Users should consult the operator's manual for compatible device information prior to conducting any case with the system.

## Conclusion

Radial access is associated with clinical advantages, but the left-sided approach presents new, ergonomic challenges to the operator. With careful planning and an understanding of device compatibility, the CorPath GRX Robotic System can be used to improve operator comfort and safety during revascularization of the lower extremities from a left-radial approach.

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## Disclosure

The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. The authors report no financial relationships or conflicts of interest regarding the content herein.

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