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CASE REPORT

ADVANCED

CLINICAL CASE

First-in-Man Robotic-Assisted Renal Denervation

Konstantinos Bermpeis, MD,[a,b] Hirofumi Ohashi, MD, PhD,[a,c] Dario Tino Bertolone, MD,[a,d] Emanuele Gallinoro, MD,[a,e] Pasquale Paolisso, MD,[a,d] Attilio Leone, MD,[a,d] Jeroen Sonck, MD, PhD,[a] Sofie Brouwers, MD, PhD,[a] Eric Wyffels, MD[a]

ABSTRACT

To the best of our knowledge, this is the first report of robotic-assisted renal denervation. Robotic-assisted renal denervation represents a new frontier in robotic-assisted percutaneous interventions. Robotic assistance provides increased procedural and technical accuracy while minimizing radiation exposure for both the operators and the patients. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:101669) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

A 43-year-old woman with therapy-resistant hypertension was referred to our outpatient clinic. Her medical history included obesity (body mass index 33.2 kg/m^2), diabetes mellitus, and hyperlipidemia. Pharmacologic treatment included amlodipine, olmesartan, nebivolol, and spironolactone. After all secondary causes of hypertension had been ruled out, a renal denervation (RDN) procedure was proposed. Although robotic-assisted percutaneous interventions had been successfully performed in coronary, peripheral vascular, and neurovascular interventions, this technology had never been applied in an RDN procedure.[1,2]

We tested successfully in vitro the compatibility between the Symplicity (Medtronic) catheter and the CorPath GRX (Corindus Vascular Robotics) platform designed for percutaneous coronary interventions. The robotic platform consists of a robot arm with a disposable cassette containing wires and devices and a remote console where the operator uses joysticks to manipulate the devices. The tests performed in vitro confirmed that is possible to manipulate the RDN catheter from the remote console without any dysfunctions of either the denervation catheter or the robotic console.

The procedure was performed with the patient under general anesthesia. The right renal artery was cannulated manually with a 6-F 55-cm guiding catheter, which was connected with the robot arm (**Figures 1A and 1B**). A 0.014 × 190 cm guidewire (Thunder Steerable Guidewire, Medtronic) was

LEARNING OBJECTIVES

- To demonstrate the compatibility between the two devices (robotic platform and robotic-assisted denervation catheter).
- To confirm the feasibility of robotic-assisted renal denervation.

From the [a]Cardiovascular Center Aalst, OLV-Clinic, Aalst, Belgium; [b]Department of Cardiology, AHEPA University General Hospital, Thessaloniki, Greece; [c]Department of Cardiology, Aichi Medical University, Nagakute, Japan; [d]Department of Advanced Biomedical Sciences, University of Naples Federico II, Naples, Italy; and the [e]Department of Translational Medical Sciences, University of Campania "Luigi Vanvitelli," Naples, Italy.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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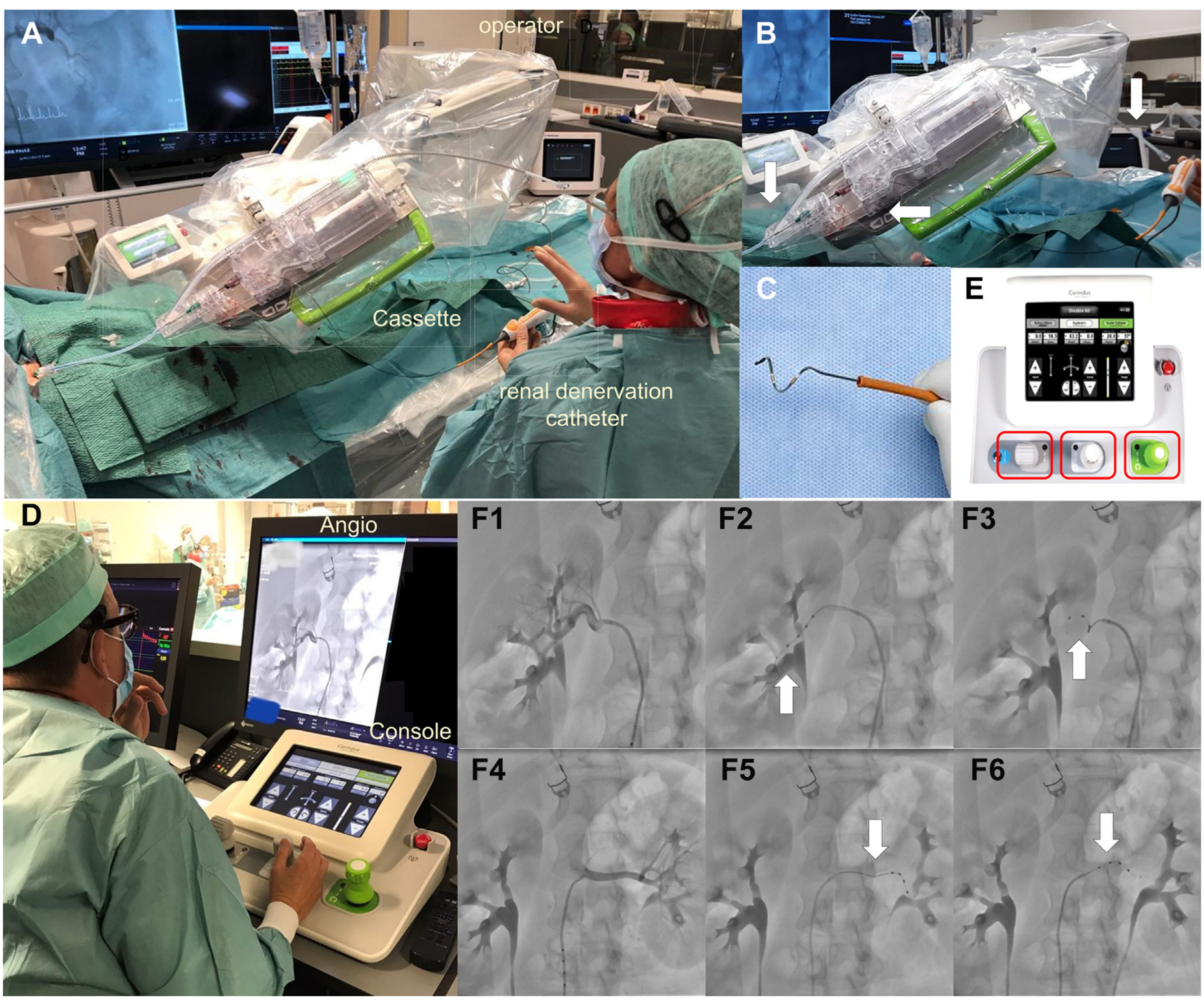
ABBREVIATIONS AND ACRONYMS

RDN = renal denervation

inserted into the cassette and advanced manually close to the guide catheter exit. The RDN multielectrode catheter (**Figure 1C**) was advanced on the guidewire and inserted into the device drive of the robotic cassette (**Figure 1B**). From that time the operator left the catheterization room and was seated in front of the robotic console to perform the RDN (**Figures 1D and 1E**). Also, the second operator left the catheter laboratory room to be protected from radiation (Video 1). The operator advanced the guidewire to a distal branch of the right renal artery (**Figure 1F2**) using the guidewire joystick (**Figures 1D and 1E**). The RDN catheter was advanced using the device joystick (**Figure 1E**), and then the guidewire was pulled back, allowing the spiral reconfiguration to ensure a perfect artery apposition (**Figure 1E**). The RDN generator was activated, allowing simultaneous denervation in 4 different spots. The repositioning of the catheter in another (more proximal part) of the vessel was easily performed after straightening with the guidewire. Rewiring and accessing side branches was easily performed with the use of automated wire movements, which are movements based on artificial intelligence mimicking common wire maneuvers performed by operators in challenging lesions or

FIGURE 1 **Robotic-Assisted Renal Denervation: Catheter Laboratory Setup**



(A) Catheterization laboratory setup. **(B)** Cassette and robotic arm. **(C)** Renal denervation catheter. **(D)** Control room setup. **(E)** Robotic console. **(F)** Procedure angiogram.

anatomic features (Videos 2 and 3). In total, 12 spots were ablated in the right renal artery (**Figures 1F1 to 1F3**). Disengagement of the right renal artery and engagement of the left renal artery were possible with the use of the guide-catheter joystick while the RDN catheter was in the guide (**Figure 1E**) without the need to convert the procedure to manual. In total, 16 spots were ablated in the left renal artery (**Figures 1F4 to 1F6**). The complete procedure was thus performed by the operator at the console. Local hemostasis was performed with the ProGlide device, which was placed manually. The duration of the procedure was 68 minutes, and the fluoroscopy time was 15.1 minutes. The procedure was well tolerated, and the patient was discharged the same day. The antihypertensive therapy remained unchanged after the procedure, and 2 months later an ambulatory blood pressure measurement showed a reduction of 20 mm Hg of the average systolic blood pressure.

To the best of our knowledge, this is the first report of robotic-assisted RDN. This case demonstrates nicely the compatibility between two devices (robotic Platform and RDN catheter) and highlights the feasibility of RDN. The RDN catheter is compatible with the robotic platform and can be easily manipulated with the device joystick. Moreover, engaging and disengaging the renal arteries with the robot is feasible without any manual conversion. Both systems as available on the market can be used together without any adjustments.

Robotic-assisted RDN represents a new frontier in robotic-assisted percutaneous interventions. Robotic assistance provides increased procedural and technical accuracy while minimizing radiation exposure for both the operators and the patients.[3,4] The robotic console provides very precise positioning of the RDN catheter (submillimetric)—a very useful feature for selection of the denervation spots. In addition, the automated robotic techniques allow the operator wiring difficult tortuous anatomies, resulting in a more complete denervation. Furthermore, it offers the potential for real remote procedures and even remote proctoring in challenging cases

Further studies are needed to confirm the efficacy, safety, and durability of this intervention.

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ADDRESS FOR CORRESPONDENCE: Dr. Eric Wyffels, Cardiovascular Center Aalst, OLV-Hospital, Moorselbaan 164, 9300 Aalst, Belgium. E-mail: eric.wyffels@olvz-aalst.be.

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KEY WORDS hypertension, peripheral circulation, robotic surgery

APPENDIX For supplemental videos, please see the online version of this paper.