Transcatheter valve implantation for pure severe native aortic valve insufficiency (AI) without aortic stenosis has recently been described in a small series of inoperable or high-risk patients.1 We describe first transcatheter aortic valve replacement in a man using a novel caval-aortic approach in a high-risk patient with severe AI, who was deemed unsuitable for surgical aortic valve replacement.

Case Description
A 72-year-old man with severely dilated ischemic cardiomyopathy (ejection fraction, 20%) was admitted because of decompensated heart failure. A cardiac catheterization revealed nonobstructive coronary artery disease and severe (>4) AI. His Society of Thoracic Surgeons score was 12.4% mainly because of age, low ejection fraction, New York Heart Association class IV, peripheral arterial disease, severe chronic obstructive pulmonary disease, diabetes mellitus on insulin, and chronic kidney disease stage 3. Given his aforementioned comorbidities, he was deemed high-risk candidate for surgical valve replacement. Because of severe peripheral arterial disease and maximum subclavian diameter <5 cm, he was not amenable for conventional transfemoral or subclavian arterial approach. He was, therefore, planned for transcaval retrograde transcatheter aortic valve replacement with 31-mm self-expandable Medtronic CoreValve ReValving system (Figures 1 and 2).

An informed consent was obtained and the procedure was performed under general anesthesia with unfractionated heparin as anticoagulant. The procedural steps are described in Figures 3 to 5. At 6-month follow-up, echocardiogram showed trace AI with good valve position. The patient remained free from rehospitalization and noted a significant improvement in functional capacity.

Discussion
The transcaval approach to aorta has recently been described in swine by Halabi et al;2 however, the experience with this approach in humans is limited.3 This caval-aortic access approach holds promise for patients with difficult arterial accesses that require large transcatheter aortic valves. The veins being larger and more distensible can accommodate bigger catheter sheaths. In this case, it provided the same degree of control as direct transfemoral approach for valve deployment, retrieval, and performing a valve-in-valve procedure in our patient with severe AI. We think that with further device improvement this percutaneous technique will evolve and serve as an alternative to surgical (nontransfemoral) accesses such as transaortic and transapical especially in frail and elderly population.

Possible complications of this approach include aortic dissection, aortic thrombosis, retroperitoneal hemorrhage, caval thrombosis and venous thromboembolism, lymphatic injury, and migration or embolization of the device used to close the caval-aortic tract. Greenbaum et al4 recently described their experience with this approach in humans with Edwards SAPIEN valve in aortic stenosis; however, they reported high rates of vascular and bleeding complications with ≈80% of the patients requiring blood transfusions. The 22 to 24F sheaths used during the procedures may have played a role. Transcaval approach has not been described with CoreValve in which the use of 18F sheath may be associated with fewer vascular complications. Halabi et al5 tested intentional failure to close the 18F tract in 4 pigs and did not experience any retroperitoneal hematomas. In addition, the aorto-caval fistula was well tolerated acutely and subacutely and remained simple to cross and close with occluder devices.6 We used a buddy wire across the caval-aortic tract during closure in case embolization of the occluder device occurred (Figure 5; Movie IV in the Data Supplement). This wire was then removed once the position of the device was confirmed and no extravasation of contrast was noted.

Transcatheter implantation of CoreValve for severe AI has been described in a small series of patients by Roy et al7 with a success rate of 74.4%. Deployment of transcatheter 2 valves while treating AI in our report is consistent with the findings of Roy et al7 who reported that 20% of patients required valve-in-valve. This can be multifactorial because of valve malposition from the regurgitant jet of AI, compromised fixation of the valve because of less calcification when compared with that in patients in aortic stenosis, and dilated
aortic root and ascending aorta. We noticed migration of the valve toward the ventricle during deployment; however, once deployed it provided excellent fixation for the second valve, which was implanted marginally above the first valve, leading to complete resolution of paravalvular regurgitation.

We describe a unique case where caval-aortic access was used successfully to perform a transcatheter aortic valve implantation for severe native AI. This access also allowed complete retrieval and acute deployment of a second valve inside the first because of malposition. Prospective assessment of the safety and efficacy of this uncomplicated and rapid novel technique warrants further study with larger number of patients.

Disclosures
None.

References

Figure 1. Preprocedure computed tomographic planning. A, Aortic annulus of 29.3 mm (perimeter 9.2 cm). B, Sinotubular junction of 30.4 mm and aortic root of 40.5 mm.

Figure 2. Preprocedural computed tomography to determine caval-aortic entry site. Sagittal and coronal views (A and B) of the abdominal aorta and inferior vena cava are analyzed to find the segment where these 2 structures are in close proximity, selecting a site with enough distance from the renal arteries and veins as well as the iliac bifurcation to avoid their damage during access and closure. The sagittal view (A) is helpful to determine the entry level in relationship with the lumbar spine to use the bones as landmarks during fluoroscopy. The cross-sectional view (C) helps to determine the working fluoroscopic view to be used during caval-aorta entry and the orthogonal angle used to point toward the snare in the aorta. LAO indicates left anterior oblique.
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Figure 3. A pigtail catheter was introduced through the left femoral artery for root aortography. A, Aortography showing severe aortic valve insufficiency. B, Simultaneous venography and aortography before the procedure. The caval-aortic crossing system consisting of a stiff 0.014" guidewire (Asahi Confianza Pro 12; Abbott Vascular, Santa Clara, CA) inside a 0.035" wire converter (Piggyback Vascular Solutions, Minneapolis, MN) loaded in a quickcross catheter inside a 5F cobra catheter was introduced into the inferior vena cava (IVC) through the sheath in the right femoral vein. The distal end of the stiff guidewire was connected to the cautery set in cut mode at 50 to 70 W. C, Through the right femoral arterial access, a 20-mm Vascular EV3 GooseNeck snare (Covidien, Plymouth, MN) was positioned in the distal aorta. Confirmation of the orientation of snare in the aorta and guidewire in the IVC was performed at 15° right anterior oblique and 70° left anterior oblique at the infrarenal level with the least amount of calcification. Once the entire system was in position and the guidewire pointing to the snare in the aorta, the cautery was turned on and the wire advanced through the IVC into the distal aorta through the lumen of the snare (Movie I in the Data Supplement). The wire was then captured (D) in the snare and advanced to the ascending aortic curvature (E). The piggyback wire was then advanced loaded on a 0.035" quickcross catheter. Once in the aortic arch, the piggyback and the stiff guidewire were removed and the 0.035" quickcross catheter was left in the aortic arch to exchange for a 0.035-inch Amplatz super stiff guidewire. F, An 18F, 40-cm Cook introducer sheath was then introduced from the venous access connecting femoral vein to aorta (Movie II in the Data Supplement).

Figure 4. A, The CoreValve was subsequently mounted on the 18F catheter system and then advanced to the left ventricular outflow tract to be deployed using the standard technique. B, We encountered difficulties in positioning and hence (C) the valve had to be recaptured, retrieved, and redeployed. D, After percutaneous aortic valve implantation, the patient continued to have >3 AIs because of malposition (too low). E, The decision was made to implant a second 31-mm CoreValve higher up inside the previously placed valve resulting in complete resolution of AI (Movie III in the Data Supplement).

Figure 5. A, Closure of the aorto-caval fistula was performed with a 6-mm Amplatzer Muscular VSD Occluder (St Jude Medical, Inc, St Paul, MN). B, Buddy wire across the caval-aortic fistula as a precautionary measure for embolization. C, Final simultaneous venography and aortography with no residual leak from the fistula (Movie IV in the Data Supplement). No follow-up imaging of the retroperitoneal space was performed thereafter.
Transcaval Transcatheter Aortic Valve Implantation for Severe Aortic Insufficiency

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