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STATE-OF-THE-ART REVIEW

Anatomic Suitability for Transcaval Access Based on Computed Tomography

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ABSTRACT

Transcaval access has been used successfully for over 200 transcatheter aortic valve replacements, large-bore percutaneous left ventricular assist devices, and thoracic endovascular aortic aneurysm repairs. This review teaches how to plan transcaval access and closure based on computed tomography. The main planning goals are to: 1) identify calcium-free crossing targets in the abdominal aorta along with optimal fluoroscopic projection angles and level with respect to lumbar vertebrae; 2) identify obstacles such as interposed bowel or pedunculated aortic atheroma; 3) plan covered stent bailout; and 4) identify jeopardized vascular branches such as renal arteries that might be obstructed by bailout covered stents if employed. The aorta and inferior vena cava are segmented (sculpted) using an image reconstruction workstation and crossing targets are highlighted. Important measurements such as aortic lumen diameter and target distance from renal arteries, aortoiliac bifurcation, and right femoral vein puncture site are reported to assist the operator. The proposed classification for transcaval feasibility has been revised, making some previously unfavorable candidates now feasible or favorable based on procedural success to date. Transcaval access allows percutaneous introduction of large devices into the aorta despite small or diseased iliofemoral arteries. By following these simplified procedures, both operators and imaging specialists can easily prepare comprehensive treatment plans. (J Am Coll Cardiol Intv 2017;10:1–10) © 2017 by the American College of Cardiology Foundation. Published by Elsevier. All rights reserved.

More than 200 transcaval transcatheter aortic valve replacement (TAVR) procedures have been performed to date, still with no directly attributable death or open surgical bailout. Transcaval access has been applied to other applications, including large-bore percutaneous left ventricular assist devices for cardiogenic shock as well as thoracic endovascular aortic aneurysm repairs (1). Enrollment in the 100-subject National Heart, Lung, and Blood Institute-sponsored transcaval TAVR investigational device exemption protocol is now complete and results will be reported soon after follow-up is completed (NCT02280824).

There is sufficient experience with the procedure that it can be accomplished with a modicum of planning and of training. Even though commercially available cardiac occluder devices are permeable and therefore not immediately hemostatic, preliminary experience with these devices suggest the procedure may be reasonably safe and effective for patients who are not eligible for conventional transfemoral access (2).

In 2014 we published a brief pictorial guide on how to plan transcaval access and closure based on computed tomography (CT), including identification of unfavorable candidates ineligible for the

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ABBREVIATIONS AND ACRONYMS

IVC = inferior vena cava

TAVR = transcatheter aortic valve implantation

investigational device exemption protocol (3). Many such unfavorable patients nevertheless underwent successful transcaval access and closure by experienced operators, outside of the protocol. As a result, our classification of suitability for transcaval access has evolved.

The purpose of this tutorial review is to provide updated guidance on how to plan the procedure (Central Illustration). We recommend both operators and imaging specialists master these considerations.

THE GOALS OF COMPUTED TOMOGRAPHY PLANNING

Computed Tomography planning for transcaval access and closure amounts to anatomic patient selection, and covers several key objectives.

OBJECTIVE 1: FIND A CALCIUM-FREE CROSSING TARGET. Calcium is impenetrable for transcaval crossing systems and sheaths. The main goal is to find a calcium-free window (Figure 1) that will allow a sheath and heart valve to traverse but not further injure the aorta. We recommend the target not be surrounded circumferentially by a calcific rim (Figure 1A, lower arrow) and that the calcium-free window be larger than the sheath outer diameter in at least 1 dimension (≥7 mm for CoreValve Evolut R [Medtronic, Minneapolis, Minnesota] with a separate 18-F introducer sheath; ≥7.6 to 8.6 mm for Sapien 3 [Edwards Lifesciences, Irvine, California] and expandable sheaths). This is because it may be more difficult to advance a sheath through narrow and circumferentially calcified windows in the aortic wall (Figure 1A, lower arrow).

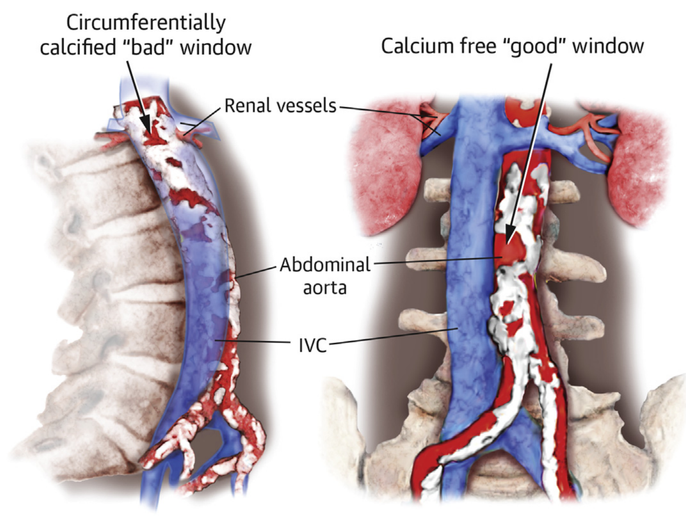
OBJECTIVE 2: AVOID IMPORTANT OBSTACLES. Assure the introducer sheath will not traverse bowel interposed between inferior vena cava (IVC) and aorta (Figure 2A). This seems more common among elderly. Bowel position may change dynamically, and operators can consciously choose to exit the IVC posteriorly away from bowel, and intravascular volume expansion can change the position of IVC, but we recommend excluding crossing targets if there is the possibility of bowel injury.

Pedunculated aortic atheroma (Figure 2B) might lead to atheroembolization during crossing, closing, or manipulating accessory devices such as snares or pigtail catheters. Similarly, aortic dissection (Figure 2C) at the crossing target may be disrupted or extended by advancing the introducer sheath, and dissection above or below the target may be disrupted by the closure device and accessories. Worse, chronic dissections may interfere with closure device apposition to the aortic wall.

By contrast, aortic ectasia and aneurysm are not contraindications to transcaval access, and indeed focal outpouchings serve as desirable zones to seat closure devices.

Another challenge is the leftward aorta, which refers to aortas that from the perspective of the transcaval crossing catheter move leftward away from the IVC as the catheter is advanced. The result is tangential crossing of the aortic wall, which is

CENTRAL ILLUSTRATION **Locating Calcium-Free Crossing Targets**



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