Chapter 15: Step-by-step guide: Trans-carotid, trans-caval, and direct aortic

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Other Alternative Access Options

While most centers perform 90% of TAVRs via a transfemoral approach, there remains a significant subset of the population who are unable to undergo femoral access, due to obstructive disease or inadequate vessel size with risk of injury to native vessels. Several alternate access sites have been described (subclavian and transapical) but each of these also has limitations. To provide the greatest range of access, specialized TAVR centers may want to consider other complex, less frequently used options. This chapter will describe three alternative access options.

Transcarotid

The first case reported using transcarotid access was in a patient with a tortuous abdominal aorta and bilateral subclavian artery ostial calcifications. Direct access to the carotid artery provided optimal valve positioning and deployment. The procedure was complicated by a carotid artery dissection that resulted in temporary hemiparesis and a prolonged hospital course. The patient was ultimately discharged without neurologic deficits (1).

Since that time, techniques have improved. Recent prospective data from France have shown comparable results with minimal neurologic complications (2).

The procedure involves a cut down typically to the left carotid artery as this provides a more direct angle of approach to the aortic valve. Much like the exposure for a carotid endarterectomy, proximal and distal control is obtained and the artery is accessed with a 5fr sheath. The valve is then crossed and the carotid artery dilated to accommodate an 18F sheath for device delivery and deployment. The valve is then deployed as usual and the carotid artery is closed primarily (Figure 1).

Indications and Contraindications

Indications for a transcarotid approach include patients who cannot have transfemoral access and who also have an absolute (calcified ascending aorta) or relative (desire to avoid the morbidity of dividing any major muscles or bone such as with a mini-sternotomy or thoracotomy) contraindication to a direct aortic approach.

Contraindications to the procedure include a greater than 50% stenosis in the common or internal carotid, congenital variants, prior instrumentation, and contralateral carotid occlusion or vertebral stenosis. In the largest study, screening MRAs were performed to establish if an intact circle of Willis was present. Arteries greater than 7mm were considered accessible.

The transcarotid approach can be done under local anesthesia (3) but nearly all patients in the French study were done with general anesthesia.

Outcomes

The French group reported a mortality rate of 6.3% at 30 days and 16.7% at 1 year in these high-risk patients. Of the 96 patients, three TIAs occurred during the hospitalization and six within 30 days of the procedure. These patients all had neurological imaging post-operatively. No new ischemic defects were identified and there were no permanent strokes.

Transcaval

Transcaval access was first described in 2014 (4). Initially tested in pigs, the transcaval technique involves accessing the femoral vein in the groin and cannulating the abdominal aorta through the IVC, thus bypassing the iliac arteries (Figure 2). This is accomplished by positioning an aortic snare in the abdominal aorta and advancing an electrified guidewire through the femoral vein to pierce the IVC. With the connection established, transcaval sheaths are introduced into the abdominal aorta and the TAVR is performed in the standard fashion. Patients tolerate the aorto-caval fistula during the procedure which is closed at the conclusion of the case. A nitinol cardiac occluder is used most often. Should the occlusion fail, a pre-selected standby covered stent can be used as a bailout. This was initially tried in patients who had no other option for access but was expanded to a prospective trial (5).

Indications and Contraindications

Indications for transcaval access include high risk patients with inadequate iliofemoral access deemed not suitable for other alternative access approaches. These included patients with severe lung disease, morbid obesity, a porcelain aorta, and previous chest irradiation. Other indications cited include a history of previous aortic root procedures (stentless bioprosthetic valve) and aborted transapical access secondary to friable myocardium (5).

Contraindications include bowel positioned between the aorta and IVC, a calcified aorta with no calcium free crossing area, pedunculated aortic atheroma, an aortic dissection and a "leftward aorta." (6). Interestingly, aortic aneurysms were not described as contraindications and were actually deemed desirable zones for access.

Outcomes

A recent prospective study of 100 patients showed successful device usage in 99 of the 100 patients. All patients survived the procedure and none required emergency surgery to address any bleeding issues. Mortality at 30 days was 8% (8 patients). Five patients had ischemic strokes. Bleeding and vascular complications, as defined by VARC-2 major of life threatening bleeding, occurred in 12 patients (5).

While this type of access generally requires specialized experience, it has multiple benefits including improved ergonomics when operating from the groin, straight sheath trajectory, less brachial plexus injury and no surgical dissection. All patients in the study underwent the procedure under general anesthesia.

Direct Aortic

Direct aortic access for TAVR was first described in 2009 in Germany (7) in a patient with severe calcification in the femoral, iliac and subclavian arteries. Since that time, direct aortic access has remained a viable option for patients who require alternative access.

Direct aortic access involves a partial sternotomy or right anterolateral thoracotomy to access the ascending aorta. The pericardium is incised to expose the proximal ascending aorta. Two diamond-shaped pursestring aortic cannulation sutures are placed in the ascending aorta and direct access is made with a needle. A 6Fr sheath is then introduced over a wire and the aortotomy is serially dilated to accommodate an 18Fr sheath. The valve is deployed in the standard fashion and the sheath is removed. The aortotomy is closed by securing the purse string sutures (Figure 3).

Indications and Contraindications

Indications include patients where transfemoral or subclavian access are not options due to severe vascular disease, and a transapical approach is unfavorable due to severely depressed LV function, left ventricular thrombus, a left ventricular aneurysm, or when the patient has had a previous thoracotomy. Access through a mini thoracotomy provides exposure and less risk of disrupting any previous proximal bypass anastomoses. The mini sternotomy approach keeps the pleura intact and may provide a wider exposure.

Contraindications to transaortic access include a porcelain aorta identified by preoperative CT scan.

Outcomes

In a report from Italy, 25 patients underwent direct aortic access over a 4 year period. Thirty day mortality was 8% (2 patients). There were no strokes or neurologic events (8). One year outcomes from the same group had a mortality rate of 17.9% (16 patients) with one patient having a non-disabling stroke (9).

In a study from Houston, 78 patients underwent direct aortic access. Thirty day mortality was 8% (10).

While direct aortic access generally involves a mini sternotomy or mini thoracotomy, the benefits of this approach include direct manipulation of the angle of delivery for a more controlled deployment.

Conclusion

As the technology for device deployment improves and sheath sizes continue to decrease, more patients will be suitable for trans-femoral access and benefit from the advantages of that approach. While it is difficult to directly compare different access routes, it is important to understand the risks of mortality and other complications with alternate approaches. Most studies of alternate access options have not yet published results beyond 1 year.

It is difficult to know whether the increased mortality from other access options is related to the procedure itself or to the comorbidities that led to the requirement for alternate access. Nevertheless, having the capability to approach the aortic valve from multiple routes offers greater flexibility to any TAVR program and makes the procedure available to a greater number of patients.

Table 1

Access	**30 Day mortality**	**1 year mortality**
Trans carotid	6.3%	16.7%
Trans caval	8%	n/a
Trans aortic	8%	17.9%
Trans femoral	4.7%	16.7%

Figure 1

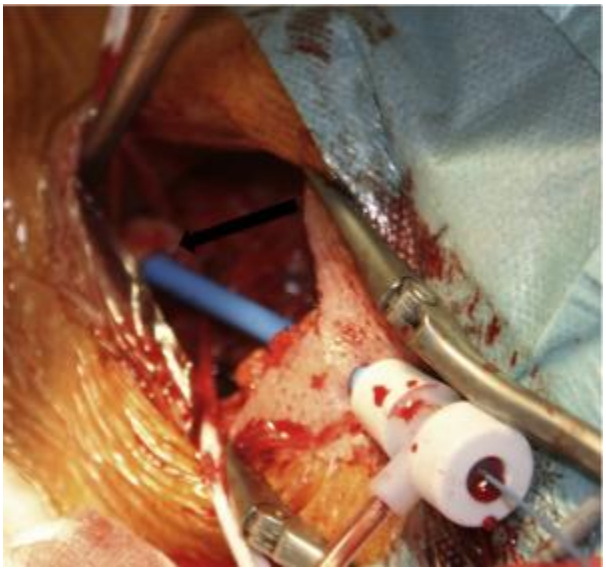


Figure 2

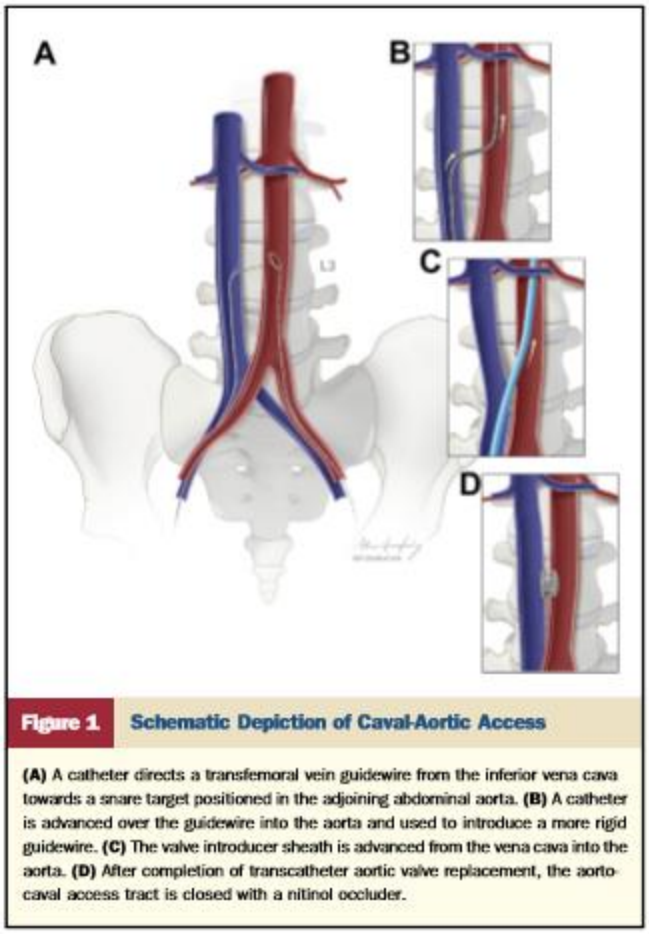
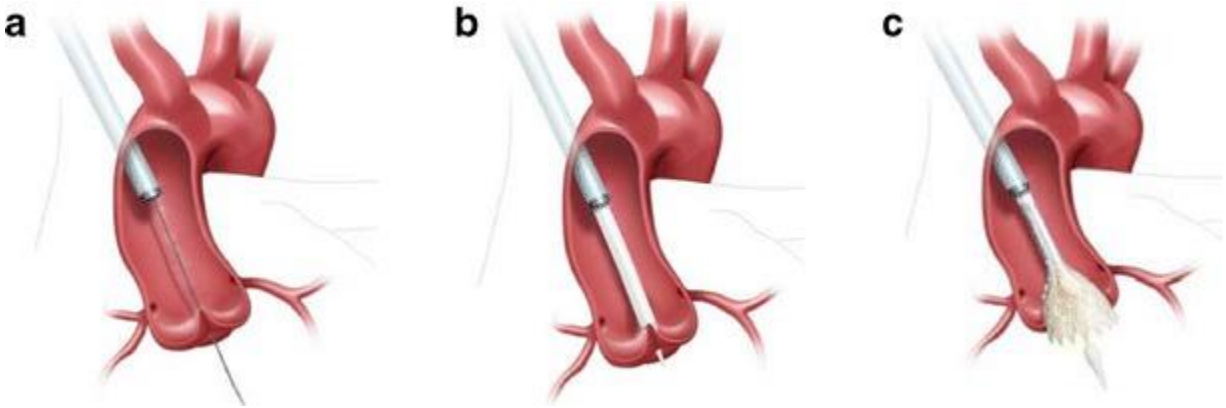


Figure 1 **Schematic Depiction of Caval-Aortic Access**

(A) A catheter directs a transfemoral vein guidewire from the inferior vena cava towards a snare target positioned in the adjoining abdominal aorta. **(B)** A catheter is advanced over the guidewire into the aorta and used to introduce a more rigid guidewire. **(C)** The valve introducer sheath is advanced from the vena cava into the aorta. **(D)** After completion of transcatheter aortic valve replacement, the aorto-caval access tract is closed with a nitinol occluder.

Figure 3



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