Transcatheter Aortic Valve Replacement: Comparing Transfemoral, Transcarotid, and Transcaval Access

Gaetano Paone, MD, Marvin Eng, MD, Loay S. Kabbani, MD, Jamil Borgi, MD, Ed Peterson, PhD, Brianna Novitsky, MS, Benjamin Burroughs, PA-C, Dee Dee Wang, MD, William W. O'Neill, MD, and Adam S. Greenbaum, MD

Divisions of Cardiac Surgery, Cardiology, and Vascular Surgery and Department of Biostatistics and Epidemiology, Henry Ford Hospital, Detroit, Michigan

Background. **Despite newer-generation valves using smaller-sized sheaths, 10% to 20% of patients undergoing transcatheter aortic valve replacement (TAVR) require nonfemoral artery access for valve delivery. To avoid a transthoracic procedure, we have used transcarotid (TC) and transcaval (TCav) approaches in these patients. This study compared the results of a contemporary experience with transfemoral (TF), TC, and TCav approaches.**

Methods. **Between January 2015 and March 2017, 491 patients underwent TAVR at our institution, of which 463 were included in this analysis. Valve delivery was TF in 373 patients, TCav in 58, and TC in 32. Patient characteristics and outcomes, including 1-year survival, were compared.**

Results. **Preoperative demographics and postoperative outcomes were similar for the three groups with several exceptions. TCav patients had higher The Society of Thoracic Surgeons risk score than TF patients (8.0 ± 5.2 vs 6.1 ± 4.3, $p = 0.004$). Lung disease, cerebrovascular disease, and peripheral vascular disease were more common in TC and TCav patients. Median length of stay was 2 days for TF, 3 days for TC, and 4 days for TCav (TF vs TCav, $p = 0.001$). Procedural mortality, percentage discharged home, and the 30-day readmission rate were similar for all. Unadjusted Kaplan-Meier survival was also similar at 1 year (TF, 86%; TC, 83%; TCav, 80%).**

Conclusions. **Patients unsuitable for TF TAVR treated with TC or TCav access had 30-day/in-hospital and 1-year survival similar to a contemporary cohort undergoing TF access. Avoiding surgical entry to the chest may offer procedural and intermediate-term outcomes equivalent to TF TAVR.**

(Ann Thorac Surg 2018;■:■–■)

Transcatheter aortic valve replacement (TAVR) has been shown to be a viable and accepted approach for treatment of inoperable and high-risk patients with severe symptomatic aortic stenosis [1–3]. Recent reports have shown excellent results in patients at intermediate risk, and trials for those in low-risk cohorts are presently ongoing [4, 5].

Despite newer-generation valves that use smaller-sized sheaths, approximately 10% to 20% of patients undergoing TAVR continue to require alternative nonfemoral artery approaches for valve delivery. Perhaps due to more comorbid conditions and higher risk profiles in patients with unsuitable iliofemoral artery anatomy, reported results using more invasive transaortic or transapical approaches for access have generally been worse than with transfemoral (TF) valve delivery [6–8].

To avoid a transthoracic procedure, we have used transcarotid (TC) and transcaval (TCav) approaches in patients unsuitable for TF delivery. In this study we reviewed and compared the results of our contemporary experience with TF, TC, and TCav approaches.

Patients and Methods

Between January 2015 and March 2017, 491 patients underwent TAVR at our institution. All patients had severe symptomatic aortic stenosis and were evaluated and approved as appropriate candidates for TAVR by our multidisciplinary structural heart disease team. Valve delivery was TF in 373 patients, TCav in 58, and TC in 32. The analysis excluded 28 additional patients as follows: 10 patients who underwent a transaortic approach, 6 with transapical access, and 12 who received an investigational device through TF access.

Drs Paone, Eng, O'Neill, and Greenbaum disclose a financial relationship with Edwards Lifesciences, LLC.

Accepted for publication April 13, 2018.

Presented at the Poster Session of the Fifty-fourth Annual Meeting of The Society of Thoracic Surgeons, Fort Lauderdale, FL, Jan 27–31, 2018.

Address correspondence to Dr Paone, Division of Cardiac Surgery, Henry Ford Hospital, 2799 W Grand Blvd, B1439, Detroit, MI 48202; email: gpaone1@hfhs.org.

Published by Elsevier Inc.

0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2018.04.029

All data were prospectively entered into The Society of Thoracic Surgeons (STS) Adult Cardiac Surgery database and the Transcatheter Valve Therapy Registry and retrospectively reviewed. Patient characteristics and outcomes were compared. In-hospital and 1-year survival was assessed. Procedural or operative mortality is defined in accordance with the STS definition of any death occurring within 30 days or in-hospital at any duration. The Henry Ford Hospital Institutional Review Board approved this study.

Procedure Selection

All patients were initially evaluated for TF valve delivery. Those deemed unsuitable were then considered for TC or TCav access. The choice between the two was generally based on further evaluation of the computed tomography (CT) scan and additional clinical findings. A team consensus of the best approach for each individual patient was adjudicated at our weekly multidisciplinary conference (Fig 1).

Anatomic suitability for TCav access was determined by evaluation of the baseline CT scan according to criteria categorized as favorable, feasible, or unfavorable [9, 10]. Favorable criteria included a calcium-free aortic space at an access point between the aorta and inferior vena cava, with no evidence of interposed bowel, renal vein, or lumbar artery. To ensure the capability for covered stent bailout if necessary, the intended crossing target was more than 10 mm below the lowest renal artery and more than 10 mm above the aortic bifurcation.

Patients were considered candidates for TC TAVR if by CT scan they had common carotid arteries of 6.0 mm or more in diameter, without significant calcification or tortuosity. Additional preoperative evaluation consisted of carotid duplex scanning in all. Patients with significant unilateral disease (>50%) were considered candidates if the stenotic side was suitable for valve delivery. Additional attention was paid to the presence and direction of vertebral artery flow. The presence of a 2-vessel arch configuration was not considered a contraindication to the TC approach.

We now favor a carotid approach in those morbidly obese in whom control of the femoral access site may be difficult and lead to significant bleeding. Similarly, we have chosen a carotid approach in several Jehovah's Witness patients. The choice between TCav and TC access when both are considered equally feasible is always made after discussion and consensus at our weekly multidisciplinary conference. These discussions may sometimes include personal preferences and nonclinical considerations that cannot be easily explained.

Although we have only limited recent experience with percutaneous transaxillary access, we would next evaluate this approach should the previous three approaches not be available. Transthoracic transaortic and finally transapical approaches are considered only when all other possible access routes are not available.

Procedural Details

All TF and TCav procedures were performed in a hybrid cardiac catheterization suite. For most patients in both groups, the anesthetic technique consisted of monitored anesthesia care. All TC procedures were performed in a hybrid suite in the operating room using general endotracheal anesthesia.

TF TAVR

Standard TF delivery techniques were used. Balloon-expandable Sapien XT/3 valves (Edwards Lifesciences, Irvine, CA) were deployed under rapid pacing using contrast aortography through a pigtail catheter in the right coronary sinus to confirm the appropriate positioning. Placement of self-expanding valves (CoreValve Evolut R; Medtronic CoreValve LLC, Santa Ana, CA) was guided by intermittent aortic injections from a pigtail catheter in the noncoronary sinus and aided by pacing at a rate of 120 to 140 beats/min during valve deployment. Hemostasis at the access site is achieved with use of the Perclose ProGlide Suture-Mediated Closure System (Abbott Vascular, Santa Clara, CA). Postprocedure there was a short period of recovery in the cardiac catheterization laboratory holding area, after which patients were then sent directly to a general telemetry room.

TCav TAVR

The preprocedure planning and technical aspects of TCav TAVR have been previously described in great detail [9–12]. Briefly, the TAVR CT scan is used to plan the crossing site from the inferior vena cava to the infrarenal abdominal aorta. From the right femoral venous access, an endovascular guiding catheter directs an electrified 0.014-inch guidewire from the inferior vena cava toward a snare in the abdominal aorta, which then captures the wire and advances it into the thoracic aorta. A series of enlarging catheters (0.014-inch, 0.035-inch) are exchanged for a stiff guidewire that enables delivery of a suitable large-bore sheath. From this point, valve delivery is essentially the same as a conventional TF TAVR. The aortocaval access site is closed at the end of the procedure after heparin reversal using a nitinol patent ductus arteriosus occluder (Abbott Vascular). The access site in the right common femoral vein is controlled with the ProGlide Closure System in a manner similar to that during TF cases.

TC TAVR

All valves were delivered using standard TF delivery systems. From either side, the access sheath is routinely positioned with its tip just inside the ascending aortic arch. We prefer the right carotid artery when suitable because this requires passing through only a short distance of relatively smaller common carotid artery diameter before entry into the larger innominate artery. All TC cases were done without shunting, electroencephalographic monitoring, or cerebral oximetry.

Femoral artery and vein access is used for placement of a pigtail for aortography and temporary pacemaker