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Case Report

Endovascular Management of External Iliac "Snowplowing" Using "Reverse Snowplow" Technique During Transcatheter Aortic Valve Replacement

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Abstract: This case describes an 84-year-old female with chronic diastolic heart failure, coronary artery disease status post coronary artery bypass and percutaneous coronary intervention, hypertension, diabetes mellitus and chronic kidney disease stage III, who presented with progressive dyspnea found to have severe aortic stenosis demonstrated by echocardiogram (aortic valve area, .06 ^{cm2}; mean gradient, 42 mm Hg). She was evaluated by the Heart Team and deemed to be a candidate for a transfemoral transcatheter aortic valve replacement (TAVR) after computed tomography angiography (CTA) evaluation. During insertion of the valve sheath through the external iliac, intimal "snowplowing" occurred resulting in complete occlusion of the iliac artery. The intima was successfully milked back into anatomical position using a "reverse snowplow" technique. Extravasation was managed with covered stents. The patient recovered over several days and was discharged home on post-procedure day 7. When appropriate, Endovascular management of vascular complications avoids the morbidity associated with open repair. Pre-operative evaluation is imperative in identifying anatomical features that pose a risk to vascular complications. This patient had an increased risk with an elevated iliofemoral tortuosity score, however, had minimal calcification and no acute angulation in the iliofemoral arterial system. This case highlights the complexity of vascular complication management and difficulty faced in identifying patients who are at risk for these types of complications.

Keywords: Aortic Stenosis, Structural Heart Disease, Cardiovascular Health

1. Introduction

An 84-year-old female with past medical history including chronic diastolic heart failure, coronary artery disease status post coronary artery bypass and percutaneous coronary intervention, hypertension, diabetes mellitus and chronic kidney disease stage III. She presented to the clinic with progressive dyspnea on exertion. Echocardiogram demonstrated severe aortic valve stenosis (aortic valve area, 0.6 cm^2; mean gradient, 42 mm Hg). Heart Team evaluation deemed her a suitable candidate for TAVR. Pre-operative CTA chest, abdomen, and pelvis demonstrated favorable anatomy for transfemoral approach for TAVR.

The patient's anatomy was pre-operatively evaluated using three-dimensional CTA analysis. Vessel stenosis, skin to femoral artery distance, and tortuosity of the common femoral access site were reevaluated retrospectively to identify risk factors for this complication. Iliofemoral tortuosity scores (IFT) were calculated using the iliofemoral assessment protocol [1]. Scores were generated by true of the vessel divided by the ideal length of the vessel [1]. The true length of the vessel was measured by tracing the three-dimensional path from the aortic bifurcation to the femoral bifurcation (25.4 cm). The ideal length was by placing a single linear measurement from the aortic bifurcation to the femoral bifurcation (19.48 cm). Aortoiliac and infrainguinal peripheral arterial disease was assessed using the TASC scoring system [2]. Skin to femoral artery distance was measured perpendicularly from common artery to skin (3.33 cm). See Table 1.

Table 1. *Right Iliofemoral Vessel Analysis.*

R. common femoral artery diameter	R. common femoral artery length	R. external iliac artery diameter	R. common iliac artery diameter	R. common femoral artery tortuosity score	R. skin to femoral artery distance	TASC classification
7.2 mm	6.94 cm	6.6-7.1 mm	8-8.3 mm	31	3.33 cm	0

Right femoral and aortoiliac measurements. External iliac measurements from distal to proximal. Common iliac artery diameter from distal to proximal.

2. Management

Conscious sedation and local anesthesia were used. Left and right femoral artery and left femoral venous access were used. Access of the common right common femoral artery was obtained and two Perclose ProGlide™ (Abbott Vascular, IL) devices were used to "preclose" the right femoral artery. A 14 French Cook sheath was then placed in the abdominal aorta via the right femoral artery over a Lunderquist® wire (Cook Medical LLC, IN). Following right femoral artery access, a pigtail catheter was placed into the left ventricle using a straight wire. The wire was replaced with an Amplatz extra stiff wire and advanced into the ventricular apex without difficulty.

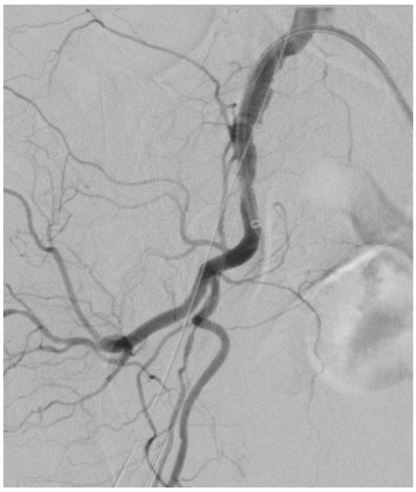

Figure 1. *Angiograph from the right common iliac depicting complete occlusion of the right external iliac.*

A prepped 26 mm CoreValve® (CRS, Medtronic Irvine, CA) delivery system was then inserted over the Amplatz wire but was unable to advance beyond the proximal external iliac artery. The CoreValve delivery system was withdrawn, and the capsule was noted to be overdriven and flared over the tip. The Amplatz wire was replaced with a Lunderquist wire, and the sheath was again, unsuccessfully advanced past the point of stenosis. Endovascular imaging noted retrograde "snowplowing" and complete occlusion of the external iliac artery (Figure 1). An attempt at dilating the proximal external iliac at the point of occlusion was unsuccessful using an 8mm x 4mm EverCross OTW PTA Dilatation Catheter (Medtronic, MN). To reverse intimal snowplowing, an EverCross balloon was placed proximally to the common iliac artery and retracted distally, reversing the snowplowed intima relieving the occlusion. This segment was then then stented with an 8.0 x 8 EverCross stent (Figure 2).

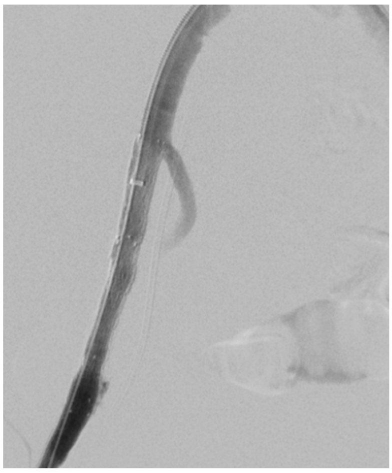

Figure 2. *Angiograph of the right external iliac after successful "milking" of the intima back into place and reversal of occlusion.*

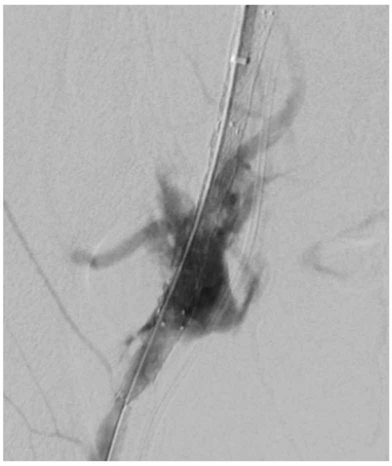

Figure 3. *Repeat angiography of the right external iliac showing extravasation after placement of EverCross stent.*

Shortly after stent placement, the patient became hemodynamically unstable. Angiography demonstrated extravasation of the external iliac artery at the site of prior distal occlusion (Figure 3). The right external iliac was covered with two 8.0 x 50 Viabahn stents (W. L. Gore & Associates, Inc, AZ) via the left external iliac artery access with good hemostasis and flow (Figure 4).

Figure 4. *Final angiograph at the sight of dissection in the right external iliac after placement of two covered Viabahn stents.*

The Perclose devices were used for hemostasis at the right femoral site. The left femoral artery sheath was removed and closed with a Starclose device (Abbott Vascular, IL). The TAVR procedure was aborted and the patient was transferred to the critical care unit. The patient was placed on apixaban and discharged on post procedure day 7.

3. Discussion

Stenting of aortoiliac vascular perforations is well documented and covered stent-graft implementation is the standard treatment [3-9]. In our patient, overdriving of the nosecone of the delivery device created an edge capable of lifting and "snowplowing" the intima upon delivery system insertion, resulting in occlusion of the external iliac artery. Repair of this intimal injury with a balloon to "reverse snowplow" the intima and restore flow is a novel method of endovascular repair. Subsequent coverage of the site of extravasation with a Viabahn covered stent was performed as described elsewhere.

IFT was elevated at 31; however, length, calcification and size were benign in our patient. On retrospective analysis our patient did have anatomic risk factors for vascular injury in terms of iliofemoral tortuosity score during TAVR. There were no turns greater than 90 degrees in her iliac arteries. Further investigation of iliofemoral length and tortuosity must be explored to stratify patients at risk for complications [10-14].

Complications with CoreValve deployment relating to circumferential intimal "snowplowing" and occlusion have not been previously described. The overdriven capsule likely created an edge capable of creating intimal injury which was exacerbated with attempts to advance the sheath proximally. Repair of this circumferential intimal dissection by utilizing an EverCross balloon to draw the intima back into place and affix it with a covered stent is a novel technique. This major vascular complication, as defined by the VARC III classification [15], was successfully used to restore flow and obtain hemostasis.

This patient denied follow-up scheduling to complete TAVR and opted for medical management of aortic stenosis.

4. Conclusion

Pre-operative evaluation helps identify anatomical features specific to anticipated access location that would preclude patients from safely undergoing transcatheter aortic valve replacement. However, this evaluation is not perfect. Vascular complications still exist and are often complex. They require an adaptive endovascular skillset and knowledge to successfully manage with the least morbidity and mortality possible. This case highlights a patient with suitable anatomy for a routine transfemoral TAVR with an unexpected complication that was successfully managed with a novel endovascular technique. Further investigation to determine patients at risk for these complications should be evaluated.

Learning objectives:

1) To understand the endovascular management of complex vascular complications during TAVR procedure.
2) To identify patients at risk for vascular complications during TAVR procedure.

Competing Interests

The authors declare no financial or non-financial interests to disclose.

Abbreviations

TAVR (Transcatheter aortic valve replacement), IFT (iliofemoral tortuosity), TASC (Tran-Atlantic Inter-Society Consensus Document on Management of Peripheral Arterial Diseases), CTA (Computed tomography angiography), CABG (coronary artery bypass graft), PCI (percutaneous coronary intervention), VARC (Valve Academic Research Consortium).

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