

Creating an Arteriovenous Wire Loop for Structural Interventions

Technique and indications for providing a stable and solid path for delivery sheath and device advancement.

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The use of percutaneous interventions for adult congenital and structural heart disease has grown exponentially in recent years. The development of new devices and techniques has greatly improved the chance to treat structural heart diseases with interventional procedures that are often technically demanding.

Due to the high variability of structural heart diseases, designing an individualized approach to each case is essential to achieve success with this type of procedure. In some interventions, the creation of an arteriovenous wire loop (AV loop) may be useful to facilitate the advancement and deployment of a closure device and enabling advancement of the device from the venous access, with a significant increase of backup support that provides a stable and rigid rail for the delivery sheath and the device and two-sided control of the wire. In this article, we describe the technique and indications for creating an AV loop for different structural interventions.

TECHNIQUE

There are different variations for the creation of an endovascular wire loop, according to the advancement site of the wire (from arterial or venous access), the site where the wire is captured (aorta, left atrium, right atrium, pulmonary artery), and the site of wire externalization (venous or arterial access) (Figure 1).

AV Loop: Retrograde Approach

In this type of AV loop, a retrograde approach is used to advance the wire from the arterial access to the aorta, crossing the defect with wire externalization through the venous access. This loop can be used in percutaneous ventricular septal defect (VSD) closure, aortic or mitral paravalvular leak (PVL) reduction, and special cases of percutaneous treatment of patent ductus arteriosus (PDA).

Venoarterial Loop: Anterograde Approach

In the venoarterial loop (VA loop), an anterograde approach is used to advance the wire from a venous access into the left atrium (LA) through a transseptal puncture, crossing the defect anterograde with advancement of the wire into the aorta, where it is captured, and final externalization is through the arterial access. This technique can be useful for closure of PDA and mitral PVLs when the leak is crossed anterograde with the wire.

INDICATIONS

Mitral PVLs

Mitral PVLs can be closed using the anterograde or the retrograde approach. In the anterograde approach, after transseptal puncture, the defect is crossed with a wire from the LA advancing into the left ventricle (LV) through the leak. The most adequate wire to cross the defect is a 0.035-inch wire with a straight tip with support of an angled short-tip catheter to direct the wire

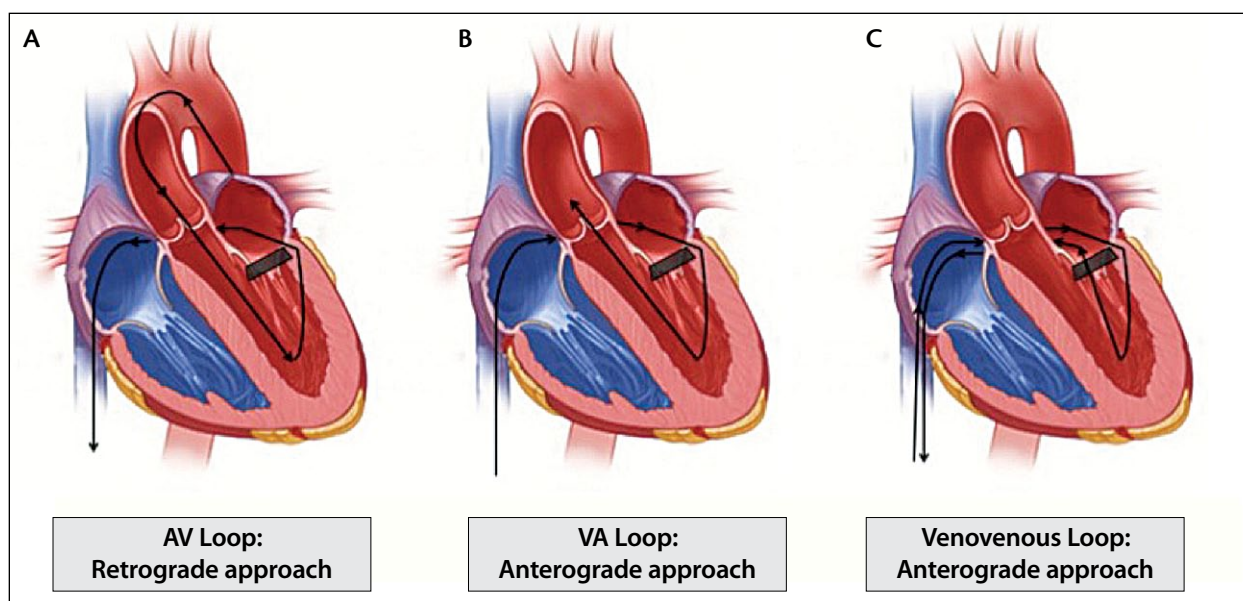


Figure 1. Schematic representation of the different wire loops employed in percutaneous closure of PVLs. AV loop used in retrograde approach (A). The wire is advanced from the arterial access retrograde into the LV crossing the PVL with a snare at the LA and externalization of the wire through the venous access. VA loop with anterograde advancement of the wire into the LA through a transseptal puncture crossing the leak anterograde (B). Wire capture at the ascending aorta with final externalization of the wire through the arterial access. Venovenous loop used to avoid crossing some mechanical aortic prosthesis (technical details summarized in the text) (C).

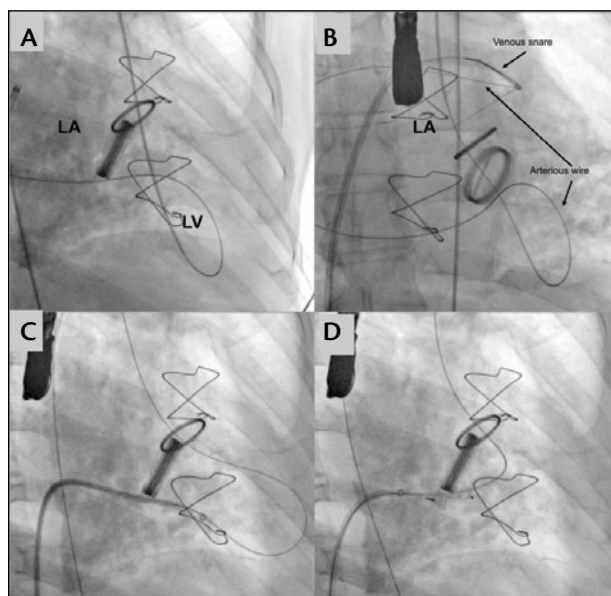


Figure 2. Percutaneous closure of a posterolateral mitral PVL. The leak is crossed retrograde through the mechanical bileaflet aortic prosthesis crossing the PVL from the LV side to the LA (A). A GooseNeck snare is advanced from the venous access through the transseptal puncture to the LA, capturing the arteriosus wire (B). Once the AV loop is established, the sheath is advanced from the venous access to the LV (C). Finally, the device is deployed, maintaining the loop wire until the end of the procedure (D).

into the leak site. The wire is further advanced into the ascending aorta, and a VA loop is established using a 25-mm GooseNeck snare (Covidien, Mansfield, MA) in the ascending aorta introduced from the femoral artery. The most adequate location to capture the wire is the ascending aorta at the entrance of the aortic arch. The delivery sheath is then advanced over the AV loop from the venous side to the LV through the leak, holding both ends of the wire tight with the help of two mosquito clamps. Once the sheath is in place, the closure device is transported and deployed in standard fashion (Figure 2).¹

In the retrograde approach, the leak is crossed with a wire from the LV to the LA, and an AV loop is established, capturing the wire in the LA with a snare previously introduced through the sheath and advanced to the LA after transseptal puncture. Here, too, the most adequate wire to cross the leak is a 0.035-inch hydrophilic wire with a straight tip through a 5-F right Judkins or multipurpose catheter (preferably hydrophilic). The wire is better captured with a 35-mm GooseNeck snare in the LA or with a smaller 15-mm snare in the pulmonary vein. The delivery sheath is advanced over the AV loop from the venous access to the LA and to the LV through the leak, and the closure device is deployed. It is important to achieve a good alignment of the delivery sheath with the defect so that the distal disc stands against the leak in an orthogonal axis to avoid incom-

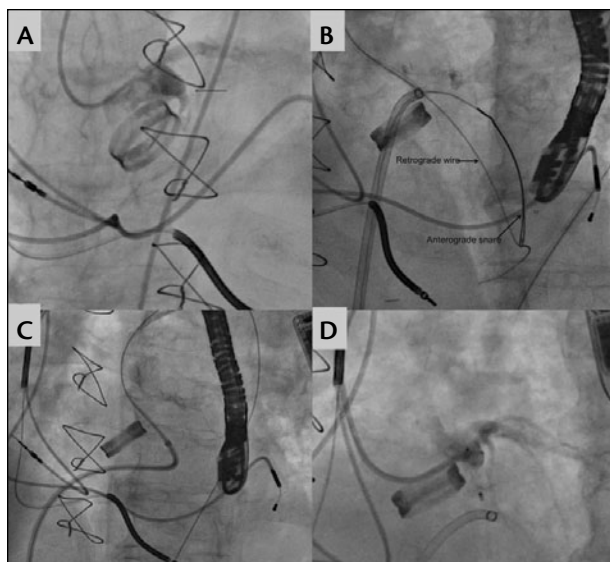


Figure 3. Percutaneous closure of a very angulated aortic PLV. Aortic PLV (A). Wire passed retrograde through the leak captured in the LV with a GooseNeck snare advanced through the transseptal sheath (B). Anterograde advancement of the sheath through the AV loop (C). Aortic PLV closed with an Amplatzer vascular plug III deployed in an anterograde fashion (D).

plete closure of the PVL or interference with the mitral prosthesis.

Aortic PVLs

Aortic PVLs are closed using the retrograde technique, except in cases when aortic and mitral PVLs are planned to be closed during the same procedure. In the retrograde technique, a hydrophilic wire is used to cross the defect. After the defect is crossed with the wire, the delivery sheath is advanced into the LV, and the closure device is finally deployed in a standard fashion. There are some cases of aortic leak (eg, very calcified or with an unusual pathway) in which, after crossing the leak retrograde with the wire and advancing it to the left ventricle, it is impossible to advance the sheath. In such cases, after a transseptal puncture with the help of an end-hole Arrow-Berman catheter (Arrow International, a division of Teleflex, Durham, NC), the wire in the LV is captured with a GooseNeck snare and exits through the femoral vein. The AV wire loop is established, and the sheath is advanced from the venous access to the LA, LV, and aorta through the leak, advancing the device and closing the aortic leak in an anterograde fashion (Figure 3).

In patients with simultaneous aortic and mitral PVLs, the retrograde approach is preferred to cross both, with a hydrophilic wire snared into the LA and exteriorized through the femoral vein, establishing the AV loop. The

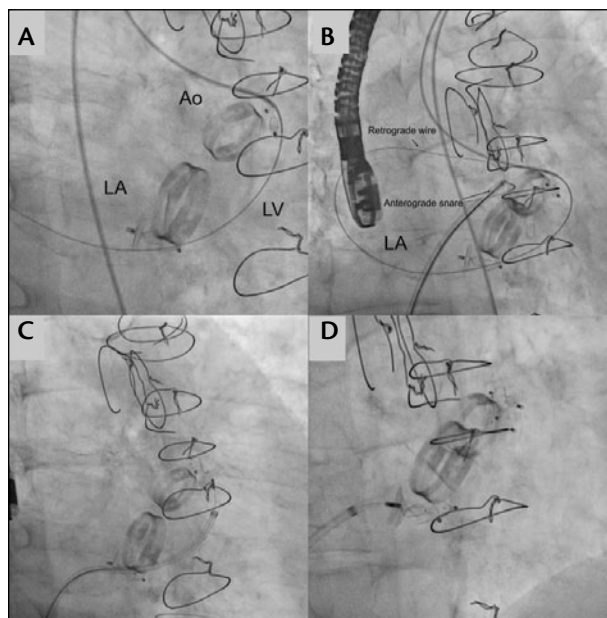


Figure 4. Closure of mitral-aortic leaks. Wire retrogradely crossing both leaks partially closed in a previous procedure (A). Wire captured in the LA with a GooseNeck snare (B). Anterograde deployment of a second device in the aortic PLV (C). Anterograde deployment of a second device in the mitral PLV (D).

delivery sheath is then advanced anterograde over the AV loop from the LA to the LV and to the aorta, and both leaks are sequentially closed by deploying the first device in the aortic PVL and then the second device in the mitral PVL, consecutively, through the same sheath (Figure 4).

There is no specific device especially designed to repair PVLs. The first procedures were performed using the Rashkind double-umbrella device with total or partial success. Subsequently, various devices from the Amplatzer family of devices (St. Jude Medical, Inc, St. Paul, MN) have been used. These devices were initially designed for closure of atrial septal defects, VSD, and PDA. Lately, Amplatzer vascular plugs II and III have been successfully employed, with different sizes, profiles, and structures, and are now considered to be the most adequate devices to close these defects.

VSD Closure

Percutaneous closure of congenital or acquired (post-myocardial infarction septal rupture) muscular VSD is an attractive therapeutic alternative to cardiac surgery.²

Transcatheter VSD closure is usually performed by crossing the wire retrograde, from the left ventricular side to the right ventricle through the VSD, snaring the wire in the pulmonary artery or, less often, in the inferior or superior vena cava, with externalization of the wire in the venous access to establish the AV loop (Figure 5). The AV loop provides

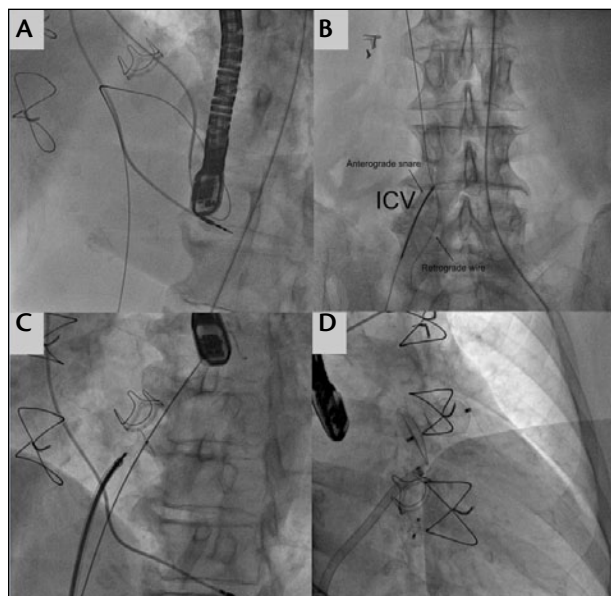


Figure 5. Percutaneous closure of postsurgery VSD and LAA in the same procedure. Wire passed in a retrograde fashion through the aortic prosthesis and VSD (A). Wire snared in the IVC (B). An Amplatzer muscular VSD (St. Jude Medical, Inc.) being deployed anterograde (wired through transseptal in LAA) (C). VSD and LAA devices deployed (D).

a stable and rigid rail for the delivery sheath and device. In muscular VSD located at the apical part of the septum, a transjugular venous access may be considered to achieve a better alignment with the defect, improving the alignment of the device through the defect.

Percutaneous closure of perimembranous VSD (usually congenital or postsurgery after prosthetic replacement of the aortic valve) is also feasible and even more challenging because of the proximity of the aortic and tricuspid valve, as well as the conduction system. The difficulty of these procedures is multiplied by the need for catheterization through a prosthetic aortic valve, although even mechanical valves can be safely crossed in most cases (especially bileaflet).

PDA Closure

Transcatheter closure is the first choice for treating PDA in adults.^{3,4} The anatomic changes of the PDA in adult patients with tortuous, calcified, and sometimes friable ductal walls increase the difficulty of the procedure such that the development of an AV loop may be essential for successful closure of the PDA.

Traditionally, an anterograde approach is used for percutaneous closure of most types of PDA. These procedures, initially used for pediatric patients, involve insertion of a catheter from the femoral vein through the right atrium and right ventricle to the pulmonary artery, and then pass-

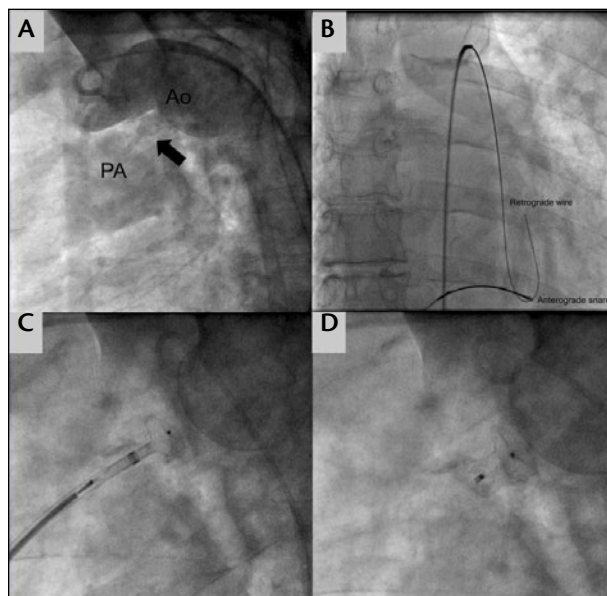


Figure 6. An AV loop to close a calcified PDA. Aortography showing a calcified PDA (A). Snare of the wire after crossing the PDA in a retrograde fashion (B). Anterograde deployment of the Amplatzer PDA occluder (C). Occluder device deployed (D).

ing the wire and catheter into the descending aorta via the PDA. However, in contrast with young patients, 15% of adult patients present with a PDA that has severe calcification or tortuosity; such morphologic abnormalities increase the difficulty of crossing with the wire and delivery sheath. In those cases, a retrograde approach is used, crossing the ductus with the wire inside a left Amplatz catheter, snaring the wire in the pulmonary artery, and exteriorizing it through the venous access. A sheath and device are then advanced in an anterograde fashion (Figure 6).

VARIATIONS OF THE TECHNIQUE: SPECIAL TRICKS AND TIPS

Preserving the Loop

In mitral PVLs, it is convenient to preserve the AV wire loop until the end of the procedure, advancing the device through the sheath maintaining the loop of the wire, so that a second device can posteriorly be delivered in large leaks with residual shunting (Figure 2).

Venovenous Loop

In patients with mitral PVLs and specific types of aortic mechanical prostheses (monodisc valves), which might produce hemodynamic instability while crossing with the catheter, a different approach must be conceived. In these cases, a hydrophilic catheter is advanced anterograde from the LA through the mitral prosthesis, crossing the mitral PVL from the LV in a retrograde manner. The wire is then snared in the

LA, exteriorizing it through the femoral vein to establish a venovenous loop to allow delivery of the device.

Anterograde-Retrograde Attempt

In patients with several mitral PVLs in different locations (eg, anterolateral and posteroseptal), the anterolateral PVL can be crossed in an anterograde fashion using the same wire to cross the posterolateral PVL in a retrograde fashion, snaring it at the LA with a second transseptal sheath to allow the deployment of both devices.

Two Devices at Once

In patients with very large defects, the leak is first crossed in a retrograde fashion and an AV loop is established, positioning the first sheath in the LV directed to the apex. Through this sheath, a high-support wire is introduced in the LV, and two different sheaths are advanced through both wires, allowing the deployment of two devices simultaneously.

CONCLUSION

The high anatomic variability of structural heart diseases makes the individualization of therapeutic management mandatory, so that new interventional techniques should be considered, if necessary. The development of an AV wire loop may be essential in some structural percutaneous procedures, providing a stable and solid path for advancement of the delivery sheath and the device. Once the AV loop is established, the advancement of the delivery sheath and transportation of the device is, for the most part, assured. Lately, we maintain the AV wire loop until the end of the procedure. This strategy has contributed to an increased rate of success and reduced procedural time. The high anatomic variability of structural heart diseases makes the development of new approaches necessary in order to extend the number of patients who could benefit from these techniques. ■

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