Cardiology in the Young

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Anchoring guide catheter to facilitate recanalising occluded pulmonary vein in small children: a novel technique

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Brief Report

Cite this article: Mohammad Nijres B, Muller S, Karimi M, and Aldoss O (2024) Anchoring guide catheter to facilitate recanalising occluded pulmonary vein in small children: a novel technique. *Cardiology in the Young* **34**: 2010–2013. doi: 10.1017/S1047951124025605

Received: 20 January 2024
Revised: 5 May 2024
Accepted: 23 June 2024
First published online: 2 October 2024

Keywords:
pulmonary vein atresia; recanalization technique; drug-coated balloon

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Abstract

Transcatheter pulmonary vein recanalisation is challenging. Herein, we described a novel technique facilitating the recanalisation of occluded three pulmonary veins in two small children. This technique enhances the catheter's alignment and stability during the recanalisation process. Referred to as the "anchoring guide catheter" technique, it can be applied only when the ipsilateral vein is patent.

Introduction

In recent years, advancements in medical, surgical, and transcatheter interventions have significantly improved the prognosis of multivessel pulmonary vein stenosis.[1–4] The experience with recanalising occluded veins, using total chronic occlusion wires and radiofrequency techniques, is growing with a reasonable success rate.[3,4] This manuscript introduces a novel technique designed to facilitate the recanalisation of occluded pulmonary veins.

Case presentation

Case # 1

A 4-year-old male, born prematurely at 26 3/7 weeks, developed multivessel pulmonary vein stenosis that necessitated stent placement at 4 months of age. Stents were placed in the right upper, right middle, left upper, and left lower pulmonary veins. A left upper pulmonary artery wedge angiogram indicated complete occlusion of the stented left upper pulmonary vein, with decompressing collateral draining into the left innominate vein (Figure 1A).

Through a 6-Fr sheath in the femoral vein, a combination of a 4-Fr 100 cm Judkins Right-3 (Cook) catheter inside a 5-Fr 55 cm Judkins Right-4 guide catheter (Medtronic) was advanced to the left atrium via the pre-existing atrial septal defect. This combination facilitated the alignment of the Judkins Right-3 catheter with the occluded left upper pulmonary vein. However, recanalisation attempts using a 0.014" Pilot (Abbott) and a 0.014' Confianza Pro (Asahi) wire proved unsuccessful. Whenever the wire advanced against the atretic vein, it consistently pushed the Judkins Right-3 catheter back, necessitating catheter repositioning to realign it with the atretic vein. A 0.014" Grand Slam wire (Asahi) was successfully placed in the left lower pulmonary vein. Subsequently, a 6-Fr 55 cm H-Stick guide catheter (Cordis) was advanced over the wire inside the left atrium, close to the ostium of the left lower pulmonary vein. Next, a 4-Fr 100 cm Judkins Right-3 catheter was advanced alongside the Grand Slam wire inside the guide catheter and directed towards the occluded left upper pulmonary vein. After proper alignment (Figure 1B and C), the same 0.014' Confianza Pro wire was successfully utilised to recanalise the occluded vein. The Confianza Pro wire was then exchanged for a microcatheter, through which an angiogram confirmed the catheter's placement inside the lingula vein, which connects to the left upper pulmonary vein. Subsequently, the microcatheter was exchanged for a 0.014" Grand Slam wire over which serial balloon angioplasty was performed on the left upper pulmonary vein, using up to 5 mm balloon.

Given the absence of residual stenosis (Figure 1D) and any gradient across the recanalised vein, we concluded that placing a new stent would not provide significant benefit. Instead, we opted to treat the recanalised vein with a Paclitaxel-coated balloon. A 0.035" Rosen wire was positioned in the left upper pulmonary vein, and the short sheath was exchanged for a 6-Fr 35 cm Brite Tip sheath (Medtronic). Subsequently, a 6x40 mm IN.PACT Admiral (Paclitaxel-coated) balloon was advanced into the vein, and the proximal part of the balloon was kept within

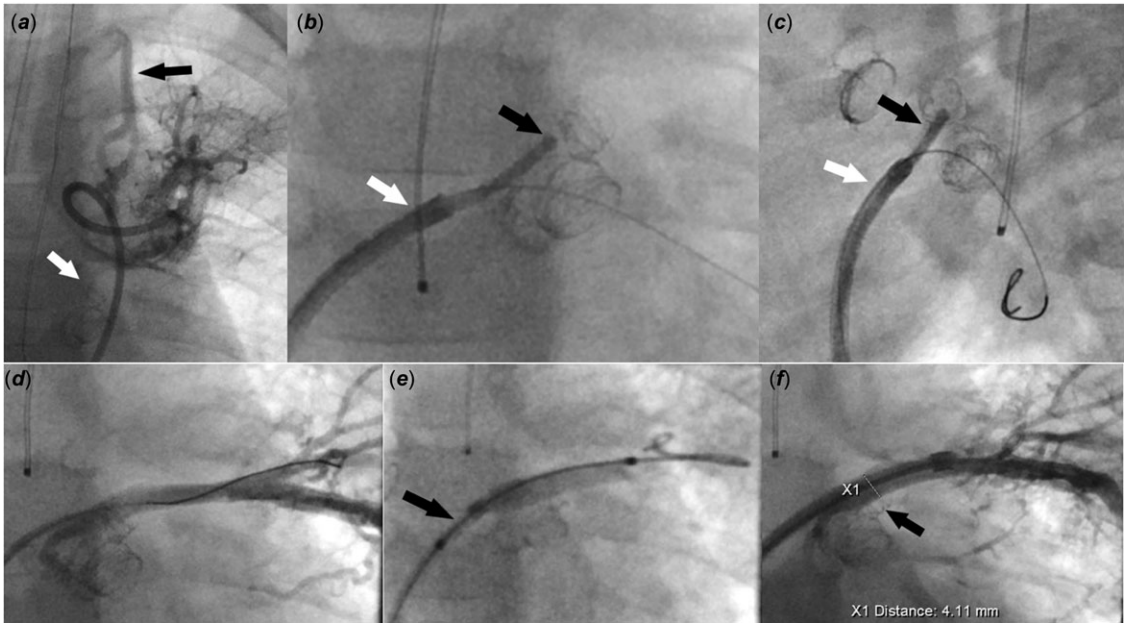

Figure 1. ***A***, cine image shows complete occlusion of the left upper pulmonary vein with no flow across the stent (white arrow) decompression collateral (black arrow) draining to the left innominate vein. ***B***, frontal projection and ***C***, lateral projection images show the wire in the left lower pulmonary vein. The H-stick guide catheter (white arrow) over the wire (anchoring guide catheter) and the 4-Fr Judkins Right-3 catheter (black arrow) inside the guide catheter and buddy to the wire. Notice the catheter is oriented towards the occluded vein before starting to recanalise using a chronic total occlusion wire. ***D***, cine image no residual stenosis in the left upper pulmonary vein after balloon angioplasty with up to 5 mm balloon. ***E***, saved fluoroscopy image shows the proximal part of the drug-coated balloon kept inside the sheath (black arrow) due to its long unneeded length. ***F***, cine image after using a 6 mm drug-coated balloon shows no localised stenosis and no evidence of vascular injury. Notice the presence of in-stent intimal growth inside the inferior aspect of the stent (black arrow).

the sheath (Figure 1E). The balloon was then inflated to six atmospheric pressure for 3 minutes. The angiogram revealed no localised stenosis or injury in the recanalised vein (Figure 1F).

He underwent a follow-up catheterisation 5 months after the recanalisation, revealing moderate narrowing in the left upper pulmonary vein. An additional stent was placed inside the existing stent, resulting in the resolution of the stenosis. We will continue with close clinical follow-up and imaging studies (echocardiogram, cardiac CT scan, and lung perfusion scan) to determine the timing of the next cardiac catheterisation.

Case # 2

A 4-month-old female, with a history of repaired supracardiac total anomalous pulmonary vein return, underwent a second repair due to a recurrence of stenosis in both the left and right pulmonary veins. Subsequently, she was referred to the cardiac catheterisation lab for the recurrence of pulmonary vein stenosis. Angiogram evaluation revealed narrowing in the right common pulmonary vein and the left lower pulmonary vein, and a long segment of occlusion in the right upper and the left upper pulmonary veins (Figure 2A and E).

Through a 6-Fr femoral venous sheath, a 0.014" Grand Slam wire was positioned in the right lower pulmonary vein. Subsequently, a 6-Fr 55 cm H-Stick guide catheter was advanced into the common right pulmonary vein. Inside the guide catheter, a 4-Fr 100 cm Judkins Right-2 catheter (Cook) was introduced alongside the Grand Slam wire. The Judkins Right-2 catheter was oriented towards the anticipated location of the atretic right upper pulmonary vein, determined based on angiograms obtained before the second surgical repair (Figure 2B and C). Subsequently, a 0.014' Pilot wire was introduced inside the Judkins Right-2 catheter and utilised to recanalise the occluded right upper pulmonary vein. The Pilot wire was then exchanged for a 0.014' Grand Slam wire, over which serial balloon angioplasty was performed using balloons up to 3.5 mm, ensuring no residual waist at full balloon inflation. The common right pulmonary vein was stented with a 5 × 8 mm Megatron drug-eluting stent (Boston Scientific). A 3.5 mm balloon was used to balloon the side cell of the stent, extending to the takeoff of the right upper pulmonary vein. The angiogram demonstrated no residual stenosis (Figure 2D).

A similar technique and equipment were employed to recanalise the left upper pulmonary vein. The entire length of the occluded vein was ballooned up to a 3 mm balloon with no waist observed at full inflation. The angiogram confirmed the patency of the left upper pulmonary vein with no localised stenosis (Figure 2 E, F, and G). The left lower pulmonary vein was stented using a 5 × 8 mm Megatron stent.

At the 5-week follow-up, the echocardiogram did not detect flow in the upper pulmonary veins. Cardiac catheterisation revealed re-occlusion of the upper pulmonary veins with unsuccessful recanalisation. She has been scheduled for elective cardiac catheterisation in two months to assess her lower pulmonary veins and to attempt recanalisation of the upper veins.

Discussion

Compared to recanalising occluded peripheral vessels, recanalising occluded pulmonary veins presents a greater challenge.[3,4] In a peripheral vessel, placing the catheter inside the vessel adjacent to the occluded segment provides defaulted optimal alignment of the catheter with the axis of the occluded vessel and offers catheter stability. In contrast, aligning the catheter with the atretic pulmonary vein is challenging due to the spacious left atrium that provides neither support nor alignment to the catheter.[3] The

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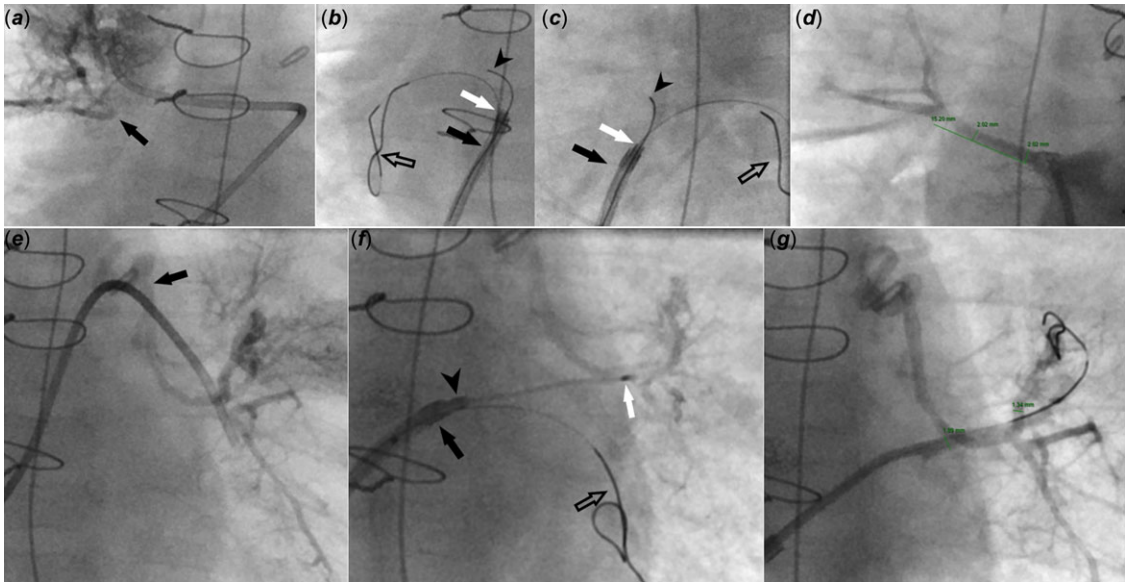

Figure 2. ***A***, cine image shows a long segment of complete occlusion of the right upper pulmonary vein starting at the joint point of segmental veins (black arrow). ***B***, frontal projection and ***C***, lateral projection images illustrating the "anchoring guide catheter" technique. The guide wire is in the right lower pulmonary vein (empty arrow). The guide catheter is advanced over the grand slam wire (black arrow). The Judkins Right-2 catheter (white arrow) is advanced inside the guide catheter, buddy to the grand slam wire. The catheter is oriented towards the occluded right upper pulmonary vein and a Pilot wire (arrowhead) was used to recanalise the vein. ***D***, cine image shows the small size right upper pulmonary vein joining the right common pulmonary vein through the dilated side cell of the stent. ***E***, cine image shows a long segment of complete occlusion of the left upper pulmonary vein with a decompressing collateral vein (black arrow) to the paravertebral venous system. ***F***, cine images of left upper pulmonary vein angiogram through a microcatheter confirming the microcatheter inside the left upper pulmonary vein. The guide wire is in the left lower pulmonary vein (empty arrow). The anchoring guide catheter (black arrow) is advanced over the guide wire. The Judkins Right-2 catheter (arrowhead) is inside the guide catheter buddy to the guide wire. ***G***, cine image after balloon angioplasty of the occluded vein. Notice the left upper pulmonary vein is small in size with no localised stenosis.

"coaxial catheter" technique or a steerable sheath is usually employed to help oppose the catheter against the atretic pulmonary vein, achieve alignment, and provide some support.[2–4] However, forceful wire advancement often leads to the loss of catheter position, requiring adjustments that can be time-consuming.

In small children, the novel "anchoring guide catheter" technique allows placing the guide catheter close to the ostium of the targeted vein (as the ipsilateral upper and lower vein ostia are anatomically close). With a longer catheter inserted alongside the guide wire, optimal alignment and apposition can be achieved with ease. Additionally, the presence of the guide wire inside the ipsilateral vein allows for stabilising the catheter and helps minimise forces applied on the recanalisation wire, preventing it from pushing the catheter back and losing position or orientation. Using a long 5-Fr sheath instead of the 6-Fr guide catheter offers the advantage of reducing the required sheath size in the femoral vein. However, we refrain from employing this approach as we prioritise avoiding sheath exchanges to mitigate vein trauma and the subsequent risk of femoral vein loss. Moreover, although steerable sheaths could potentially offer adequate support due to their stiffness, we are cautious about their use in small children due to their larger outer diameter. Furthermore, the extended curve on the distal part of the sheath may impede our ability to manoeuvre the sheath effectively within a small left atrium.

It's worth noting that whenever we employed this anchoring technique, we maintained the guide catheter on a slow continuous flush of heparinised saline (0.5 IU/ml) to minimise the risk of bleeding and clot formation. This continuous flushing technique was previously described by our group.[5]

The effectiveness of drug-coated balloons in pulmonary veins is not well-established, and it was used in our case as an off-label intervention, aiming to halt fibrosis and the recurrence of stenosis.[6,7]

Conclusion

The "anchoring guide catheter" technique may enhance the success rate of recanalising pulmonary veins in small children when the ipsilateral veins are patent. Further studies are essential to validate these findings and improve recanalisation techniques.

Competing interests. The authors declare that there is no conflict of interest.

Ethical standards. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent. As our case report does not meet the definition of research, it is not subject to institutional review board oversight as per the University of Iowa Institutional Review Board. As such, informed consent was not obtained from the individual participant included in the case report.

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