

Strategies to overcome challenges of transradial coronary angiography and intervention

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The transradial approach has become the preferred route for performing coronary angiography and interventions. Several studies reported that radial access is associated with significant reduction in vascular complications compared with the femoral access. This technique allows also early ambulation, improves the patient's well-being, and is less expensive. One important limitation of radial access is that coronary engagement from transradial approach is more challenging than transfemoral approach. The increased susceptibility of the radial artery to spasm, the radial-brachial artery tortuosities, and the subclavian-aorta curves make catheter advancement and coronary artery cannulation difficult. Hereby, we suggest several techniques for recognising and overcoming potential challenges during transradial coronary angiography.

Keywords

Cardiac catheterization; radial artery; coronary arteries; cardiac catheters

1. Introduction

The transradial approach has become the preferred route for performing coronary angiography and interventions. Campeau (1989) was the first to describe cardiac catheterization by the radial access in 1989, shortly followed by reports of the first transradial angioplasty (Kiemeneij and Jan Laarman, 1993; Kiemeneij and Laarman, 1994).

Several studies reported that radial access is associated with significant reduction in vascular complications compared with the femoral access (Jolly et al., 2009; Kiemeneij et al., 1997a; Mann et al., 1998). This technique allows also early ambulation (Kiemeneij et al., 1997b), improves the patient's well-being (Mann et al., 1998), and is less expensive (Louvard et al., 2001). Repeated transradial catheterizations have been shown to be safe, efficient and feasible through the same radial artery (Charalambous et al., 2014).

One important limitation of radial access is that coronary engagement from transradial approach is more challenging than

transfemoral approach. While approaching coronary arteries using the radial access, additional catheter manipulations are required (Ratib et al., 2010).

2. Transradial artery access challenges

2.1 Radial access

Successful right radial artery cannulation can be occasionally challenging. The first obstacle to overcome is when the radial artery is initially cannulated but the wire does not pass. In this case, a soft 0.018- to 0.021-inch micropuncture wire can be threaded into the lumen and advanced carefully until the wire traverses the elbow, allowing the sheath insertion (Gupta et al., 2013). Once the sheath is in place, a 'cocktail' of nitroglycerine and verapamil is administered through the sheath sidearm to reduce radial artery spasm (Chen et al., 2005; Saito et al., 1999). Radial artery spasm is associated with significant patient discomfort and presents a potential risk for procedural failure (Ball et al., 2011; Hildick-Smith et al., 2003; Ho et al., 2012).

2.2 Traversing radial/brachial artery tortuosity and loops

Navigating the arm can be sometimes difficult because of tortuosities of radial and brachial artery, before the subclavian artery. Radial/ brachial artery tortuosity is associated with older age and long history of hypertension (Hamon et al., 2010; Lo et al., 2008).

A simple method to overcome these anomalies is passing a hydrophilic-coated wire or a coronary angioplasty wire through tortuous vessels. A 5 Fr diagnostic catheter is then cautiously advanced onto the positioned wire. Once the subclavian artery has been reached, the hydrophilic/ coronary angioplasty wire is then exchanged with a standard J-tip guidewire for better catheter support (Sandhu et al., 2017).

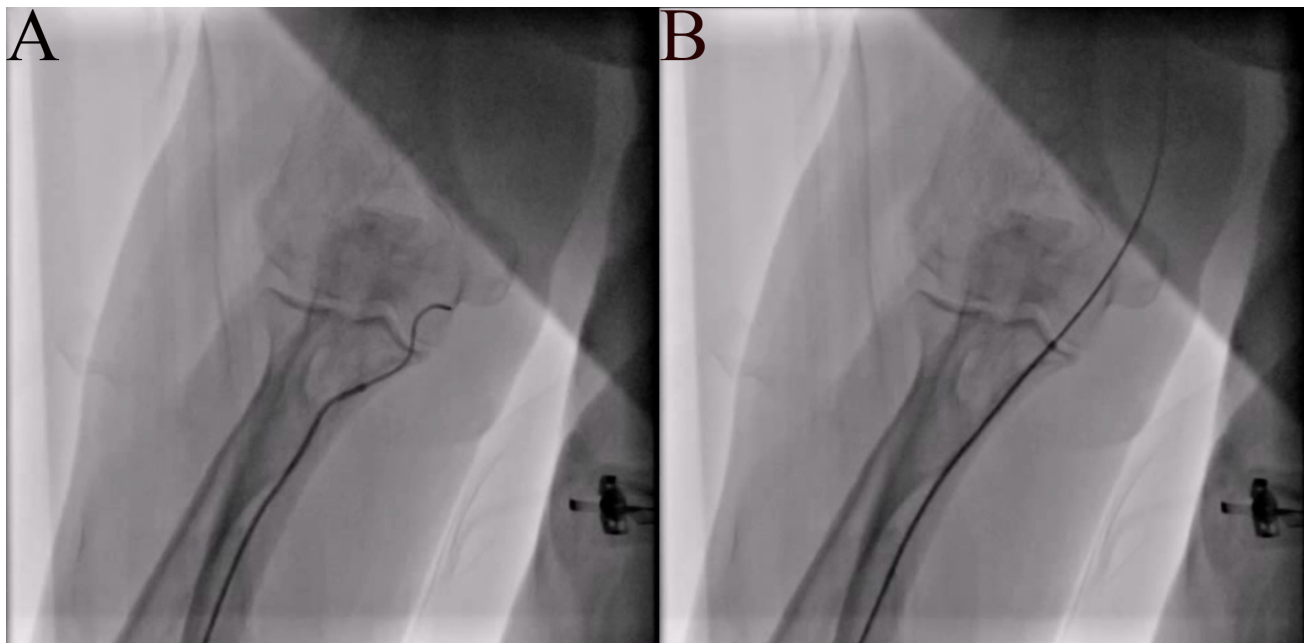


Fig. 1. Coronary angiogram (View: AP and LAT. 0°). A patient with radial artery tortuosity. (A) The J-wire failed to pass the tortuous segment. (B) Once the J-tip wire reaches the loop, the catheter is loaded onto the wire and while holding the wire and the catheter together, pull back and rotational manoeuvres are applied to negotiate tortuosity and facilitate catheter advancement.

Alternatively, once the J-tip wire reaches the loop, the catheter is loaded onto the wire and while holding the wire and the catheter together, pull back and rotational manoeuvres are applied to negotiate tortuosity and facilitate catheter advancement (Fig. 1, Motion Image 1).



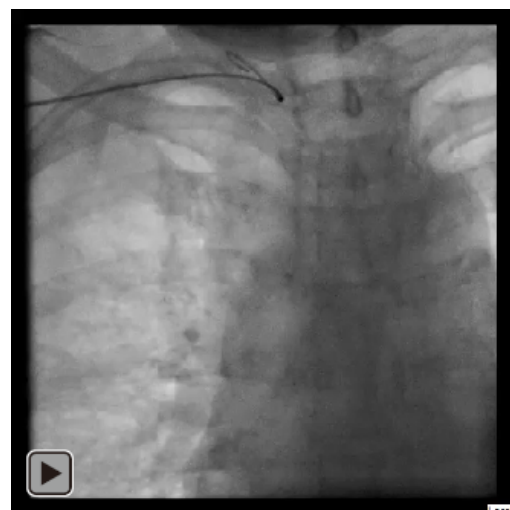
Motion Image 1. The embedded movie may also be viewed at <https://rcm.imrpess.com/EN/10.31083/j.rcm.2020.04.252>.

2.3 Subclavian artery tortuosity

Brachiocephalic trunk and subclavian artery tortuosity can be another challenge for coronary cannulation, making the procedure more complex. These anomalies are more frequent in older patients and women (Cha et al., 2003).

Asking the patient to take a deep inspiration with breath holding may modify the angulation between the right subclavian artery and the ascending aorta, in order to facilitate the placement of the catheter in the ascending aorta (Fig. 2, Motion Image 2). If this is

unsuccessful, a hydrophilic or an angioplasty wire may facilitate the passage through a tortuous neck anatomy.



Motion Image 2. The embedded movie may also be viewed at <https://rcm.imrpess.com/EN/10.31083/j.rcm.2020.04.252>.

2.4 Ascending aorta access

Once reaching the aorto-brachiocephalic junction, the catheter can be oriented towards the ascending aorta in order to facilitate wire access. Sometimes the wire has the tendency to enter the descending aorta. If this happens repeatedly, the catheter is initially advanced in the descending aorta over the wire and both the catheter and guidewire are withdrawn together as an assembly with the catheter tip kept facing medially towards the ascending aorta by

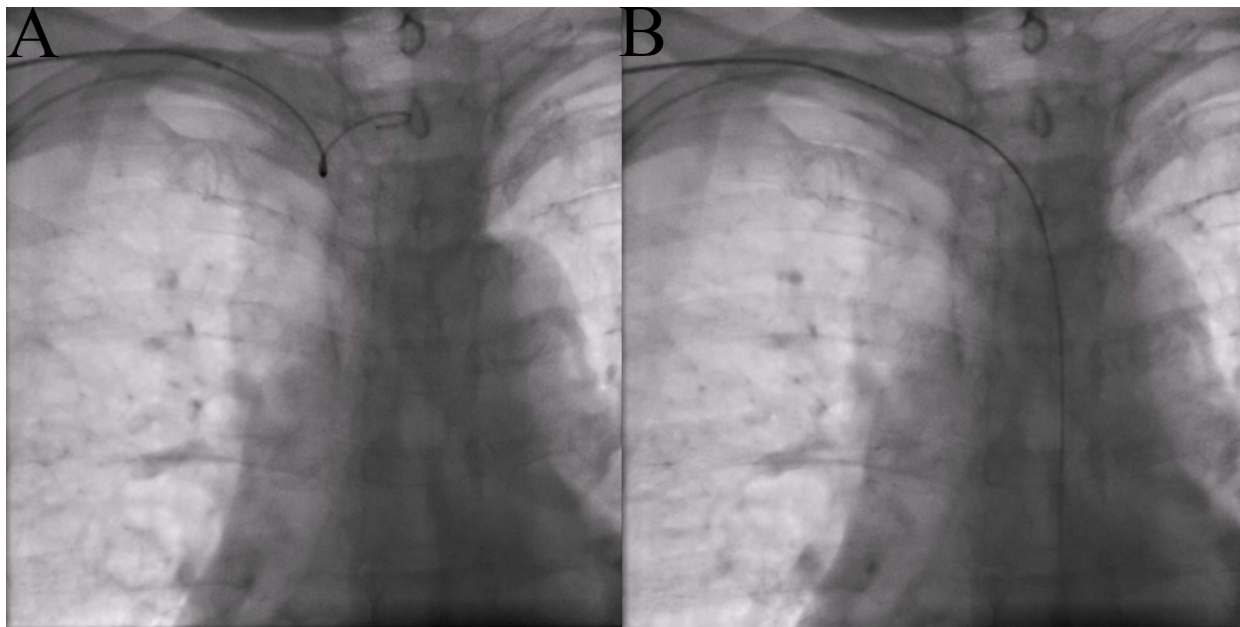


Fig. 2. Coronary angiogram (View: AP and LAT, 0°). A patient with subclavian artery tortuosity. (A) The J-wire is unable to negotiate through the loop. (B) The respiratory maneuver-asking the patient to take a deep breath and hold it, facilitates the wire and catheter placement in the ascending aorta.

gentle counterclockwise rotation. This manoeuvre usually leads to successful catheter placement in the ascending aorta.

2.5 Diagnostic coronary angiography

Judkins catheters (JL3.5 and JR4) are the most commonly used catheters for coronary angiography.

2.5.1 Engaging the LCA

Although LCA engagement through the femoral access is usually an easy process, engagement through the radial access might be sometimes challenging.

2.5.1.1 JL catheter. When utilizing the right radial, a short tip-JL3.5 would be a standard choice.

The J-wire is advanced to the level of aortic valve and curved just above the level of sinotubular ridge. Then, the JL3.5 catheter is advanced over the wire beyond the sinotubular junction. The guidewire is removed slowly and the catheter is gently pulled back until it falls into the left coronary ostium.

If this technique is not successful, the J wire is advanced within the catheter to enhance torqueability and the catheter is gently pushed into the left coronary sinus, until it jumps into the left coronary ostium.

2.5.2 Engagement of the RCA

2.5.2.1 JR catheter. The right coronary artery Judkins engagement technique is similar to femoral approach. When the catheter is advanced over the wire into the ascending aorta, they may fall into either left or right coronary cusp. In the case that it ends in the left coronary cusp, the catheter is gently withdrawn, rotated clockwise just slightly over the valve, and advanced into the right cusp. Once the JR catheter tip is at the level of the right sinus, slow withdrawal with clockwise rotation allows the engagement of the right coronary artery ostium.

2.5.3 Coronary intervention

For coronary intervention, extra back-up and Judkins right are standard workhorse guides for left and right coronary intervention, respectively.

2.5.3.1 Extra back-up catheter. The wire is pulled slightly back and then the catheter. A gentle clockwise rotation will direct the tip of catheter to the left side. Usually the catheter jumps from the posterior sinus to the left sinus. Then the wire is pulled out and the catheter tip is pushed onto the left sinus of Valsalva. A slight counter-clockwise rotation may be needed to facilitate the catheter engagement to the left coronary artery ostium. Finally, the catheter is slightly pulled back to achieve a coaxial position.

2.6 Coronary catheters exchange

Catheter exchange can be achieved using a 150 cm J-wire without the need of long exchange wire. A 10 mL syringe filled with normal saline is connected to the distal catheter tip, followed by slowly withdrawal of the catheter and injecting normal saline at the same time, allowing the J-wire to stay in the coronary cusp.

3. Discussion

Transradial access for coronary angiography and interventions is escalating due to lower rates of access-site complications/bleeding and early ambulation. However, this procedure involves several potential technical challenges.

Radial artery spasm is a common complication encountered during the procedure and is induced by the introduction of a sheath or catheter into the radial artery. The radial artery is a muscular vessel and is largely dominated by alpha-1 adrenoceptor function (He and Yang, 1998). Thus, circulating catecholamines and mechanical stimulation result in radial artery spasm. Administration of verapamil with nitroglycerin through the side arm sheath has been advocated for prevention and treatment (Chen et al., 2005;

Saito et al., 1999).

Furthermore, it's not uncommon to find a variant anatomy or tortuous course of the radial and brachial artery (Lo et al., 2008). Although certain anomalies may be difficult to overcome and an alternative access may be needed, several techniques are available to facilitate catheter passage through the loops like the use of a hydrophilic or an angioplasty wire.

Tortuosity of the subclavian artery is another important limitation of the transradial approach in coronary angiography and interventions. Severe tortuosity of the subclavian artery occurs in up to 10% of patients. Clinical predictors include short stature, hypertension, female gender, and advanced age (Cha et al., 2003). The Arteria Lusoria or aberrant right subclavian artery, an anatomic variant in which right subclavian artery originates from the descending aorta, distal to the left subclavian at the ductus arteriosus is present in 0.6-1.4% (Scala et al., 2015). Having the patient take a deep breath and hold it, reduces the amount of tortuosity and enables delivery of the wire/catheter into the ascending aorta.

Additionally, a hydrophilic or angioplasty wire may also enable easier negotiation into the ascending aorta.

Sometimes the guidewire is repeatedly biased towards the descending aorta. In these cases, breathholding in deep inspiration may facilitate the access to the ascending aorta. If this is not successful, the catheter is advanced over the wire in the descending aorta initially. The wire is then brought inside the catheter lumen and both catheter and wire are pulled back and rotated counterclockwise. This allows access to the ascending aorta.

Engaging the coronary ostia can be also be challenging. Judkins remain the most commonly used catheters for diagnostic coronary angiography (Bertrand et al., 2010). Downsizing to a JL3.5 rather than a JL4 is necessary for engaging the left coronary artery. The catheter is advanced over the wire beyond the sinotubular junction. The wire is removed slowly and the catheter is gently retracted until it falls to the left coronary ostium. For right coronary artery engagement, JR4 is the catheter of choice. Similar to the transfemoral technique, slow withdrawal and clockwise rotation will allow engagement of the right coronary artery ostium. Percutaneous coronary intervention of the left system is usually performed with extra back-up catheters. The cannulation of the of the left coronary artery is different from the femoral approach as the engagement is made from below the ostium with a counterclockwise rotation.

4. Conclusions

Although transradial approach is technically more difficult than transfemoral approach, has become the preferred route for performing coronary angiography and interventions. This article illustrates several techniques that may be used to overcome potential challenges.

Authors' contributions

AR and KP conceived of the presented idea. KP wrote the manuscript with the support of AK. SG, YF and EN contributed to the final version of the manuscript. AK supervised the project.

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Conflict of interest

The authors declare no conflicts of interest statement.

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