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Review Articles

Transradial Approach for Heart Catheterization

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Over the last decade, the transradial approach has become the preferred method for heart catheterization during diagnostic and therapeutic procedures. Compared to the more traditional transfemoral approach, it has significant advantages, including easier hemostasis, lower vascular complications (such as bleeding, thrombosis, fistulas and pseudoaneurysm), reduced hospital stay and improved healthcare costs. Nevertheless, it still poses significant challenges, such as smaller diameter and limitations on catheter size, longer procedure times, longer learning curve and variability of the artery. Several studies, however, point out that transradial approach failures and procedure times depend on the experience of the operator and are no different than those for the transfemoral approach once operators become proficient enough.

Key words: radial artery, transradial approach, heart catheterization

Introduction

The transradial approach (TRA) for heart catheterization was successfully utilised for the first time in 1989 by Dr. Lucien Campeau, who performed a percutaneous diagnostic coronary angiography using the TRA [7]. Later on, in 1993, Dr. Ferdinand Kiemeneij reported a successful percutaneous coronary intervention (PCI) using the TRA [17]. Initially, the method was established as an alternative to the more frequent transfemoral approach (TFA) and as recently as 2008 was performed in only 1.3% of the coronary interventions in the United States [21]. Over the last decade, however, the TRA has become the preferred method for heart catheterization, especially in Europe and Asia [3, 11]. The right radial artery has been used in almost 90% of the cases [3]. Preference for the TRA stems from the fewer complications, which are due to the radial artery's unique anatomy [9]. Furthermore, according to literature data, TRA significantly decreases vascular complications and the duration of hospital stay and optimises healthcare costs more than TFA [2, 3, 9, 16]. Despite all these advantages, TRA can also

present difficulties during heart catheterization, most often caused by a variant radial artery [9]. Other disadvantages include the relatively high incidence of catheterization failure and limitations of catheter size [5, 16].

The aim of the present manuscript was to briefly review the normal anatomy and variants of the radial artery and their significance for TRA, as well as to outline the advantages and disadvantages of the procedure.

Normal anatomy and variants of the radial artery

The radial artery is the smaller of the two terminal branches of the brachial artery. It arises from the brachial artery in the cubital fossa and traverses through the lateral aspect of the forearm. Further distally, it enters the palm and anastomoses with the deep branch of the ulnar artery. The proximal portion of the artery courses underneath the brachioradialis muscle; its middle part lies adjacent to the superficial branch of the radial nerve. The distal third of the radial artery is positioned superficially, between the tendons of the brachioradialis and flexor carpi radialis muscle [18].

Fig. 1. Angiographic photo of radial loop-proximal portion (arrowhead)

Burzotta et al. authored a classification of the anatomical variants of the radial artery: 1) high origin of the radial artery; 2) radioulnar loops with superficial brachioradial artery; 3) radial artery loop **(Fig. 1);** 4) double radial artery and 5) high origin with double radial artery [6]. Jelev and Surchev divided radial artery variations into two types – "high-arm" and "low arm" [15]. The former included variations in the origin and/or course of the radial artery, which do not alter the "usual" access site in the wrist. These variations do not impede the insertion of the transradial catheter [15]. The "low-arm" variations included hypoplasia of the radial artery and/or atypical wrist access. These variants may render the TRA impossible (in cases of aplasia of the artery) or extremely difficult (in cases of hypoplastic arterial segments). The same authors reported that cardiac catheterization may be impeded by the following aberrant variants of the radial artery: tortuosities of the artery, a radial artery loop, a radio-ulnar loop or a course behind the biceps brachii tendon [15]. Anatomical variations, although not pathological in nature, can cause diagnostic and therapeutic difficulties, which is why they should always be have in mind by both surgeons and internists [10-12, 24].

Advantages and limitations of the TRA

One of the main advantages of the TRA is the anatomical position of the radial artery. In the distal third of the forearm, it is positioned superficially, which allows for easy hemostasis through mechanical compression with a pressure device or a bandage, thus evading complications such as haematoma, thrombosis, pseudoaneurysm, arterio-

venous fistulas and compartment syndrome [1, 4, 9, 19]. Furthermore, the double blood irrigation of the hand constitutes a mechanism for prevention of hand ischemia in cases of radial artery thrombosis, even though it is rare in patients after TRA catheterization [4, 9]. One meta-analysis of randomised trials reported the following advantages of the TRA: absence of major nerves or veins near the artery; no need for postprocedural bed rest, which allows for immediate ambulation, better comfort for the patient and early discharge, which in turn improves the quality of life and reduces hospital stay and hospitalisation costs [1]. These data have been supported by later studies [2, 3, 9, 16]. In comparison to the TFA, the TRA reduces the risk of vascular and bleeding complications by 78% and the need for transfusion by 80% [14]. The two criteria where TFA was rated as superior to TRA were technical results (accounting for success of the procedure) and procedure times [14]. Nevertheless, several studies point out that in truth, TRA failures and procedure times depend on the experience of the operator and are no different than those for TFA once operators become proficient enough [1, 13, 14].

The meta-analysis of Agostoni et al. indicated several reasons for a procedural failure [1]. An inability to successfully puncture the radial artery can be a result of insufficient operator skill, vessel tortuosity or persistent arterial spasm. Difficulties in rotating and manipulating the catheter may lead to failure to cannulate the coronary ostia. Moreover, an interventional procedure - either TRA or TFA - could also fail because of inadequate catheter support or an inability to track the device in the correct place [1]. Gaining access to the radial artery may present more technical challenges and is generally more time-consuming than gaining femoral access [1, 23]. TRA has historically been associated with greater radiation exposure to the operator. However, it can be mitigated through proper placement of the patient's arm at their side rather than abducted 90° - as well as with better experience and proficiency [14]. Another disadvantage may be the limitation on catheter size - i.e. inability to perform coronary procedures requiring an 8F catheter or larger [1, 23].

Fig. 2. Angiographic photo of radial loop-middle portion (arrowhead)

The reported failure rates of TRA vary between 1-5% [8]. Most often, they are the result of inability for radial puncture, arterial spasm or anatomical variants **(Fig. 2)**. The reported variations of the arteries of the upper limb vary between 4-18.5% [4, 20, 22]. Usually, these variations are not considered a reason for procedure inability. It is more likely, however, that a radial artery with a smaller diameter, a remnant radial artery or a slender radial artery may present difficulties during TRA heart catheterization [9]. The radial artery's diameter varies between 2.69±0.40 mm in males and 2.43±0.38 mm in females [5]. An attempt to pass through an artery with a smaller diameter may be uncomfortable or even painful for the patient and may lead to a spasm and risk of artery perforation [9]. An avulsion of the radial artery has also been described [25].

Conclusion

The TRA for heart catheterization is an excellent alternative to the classical TFA, which minimises local vascular complications, improves patient comfort and quality of life, significantly shortens the hospital stay and optimises healthcare costs. Despite these advantages, the TRA requires a longer learning curve and is still associated with some specific challenges, such as variability of the radial artery, higher failure rate and longer procedure times.

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