Journal of
Cardiology & Cardiovascular Therapy
ISSN: 2474-7580

Juniper Publishers
key to the Researchers

Editorial
Volume 2 Issue 2 – November 2016
DOI: 10.19080/JOCCT.2016.02.555583

J Cardiol & Cardiovasc Ther

Transradial Access

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Submission: November 26, 2016; **Published:** December 01, 2016

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Abstract

The radial artery is now the preferred access route for most cardiologists performing coronary angiography and percutaneous coronary intervention in Europe. However, its use across the rest of the world remains variable. Transradial access provides a number of advantages over the femoral route, including reduced risk of bleeding, but is often technically more challenging, particularly early in the learning curve.

Abbreviations: ACS: Acute Coronary Syndrome; STEMI: ST-Elevation Myocardial Infarction; GTN: Glycerltrinitrate; RAO: Radial Artery Occlusion; PROPHET: Prevention of Radial artery Occlusion-Patent Hemostasis Evaluation Trial; RIFLE-STEACS: Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary Syndrome

Background

The first published use of transradial coronary angiography was by Campeau in 1989 using 5 French 23cm sheaths [1]. Since then, the use of transradial access has steadily been increasing. In the United States, there has been a nearly 10-fold rise in transradial access between 2007 and 2011 [2]. In the UK in 2013, 71.2% of PCI cases were performed via the transradial route compared to just 10.2% in 2004 [3].

Benefits of transradial access

The main driving factor for the change from femoral to radial access is the reduction in bleeding and other vascular complications associated with transradial access [4]. Femoral artery access carries risk of access site bleeding including haematoma and pseudoaneurysm that can be painful and require surgical intervention. Additionally, retroperitoneal haemorrhage can be a potentially life threatening complication of femoral arterial access. It is reported that up to 80% of major bleeding events following PCI are access site related [5] The RIVAL study showed no significant difference in a composite of death, myocardial infarction, stroke, and non-coronary artery bypass grafting-related major bleeding at 30 days in patients randomised to transradial or transfemoral access for acute coronary syndrome (ACS) [6].

However, there were higher rates of haematoma (HR 0•40, 95% CI 0•28-0•57; p<0•0001) and pseudoaneurysm requiring closure (HR 0•30, 95% CI 0•13-0•71; p=0•006) in the femoral group [6]. Particular benefit has been demonstrated in the setting of PCI for ST-elevation myocardial infarction (STEMI). The RIFLE-STEACS study randomised 1001 STEMI patients to PCI via radial or femoral access. The primary outcome, a composite of cardiac death, stroke, MI, target lesion revascularization and bleeding at 30 days, as significantly lower in the radial group (13.6% vs. 21.0%, p = 0.003) [7]. The STEMI-RADIAL trial showed 80% lower bleeding and access site complications associated with radial access (1.4% vs. 7.2%, p = 0.0001) [8]. Transradial access is also associated with improved patient satisfaction and reduced time to ambulation post-procedure. In the RIVAL study, 90% of patients in the transradial group reported preference to the same approach should a further procedure be needed compared to 49% in the transfemoral group [6].

Furthermore, it may not be possible to use the femoral route in patients with severe peripheral vascular disease. The majority of patients have radial arteries of sufficient calibre to accommodate a 6 French sheath and 6 French catheters. With the advancement in stent and balloon technology, this is usually sufficient to complete most PCI procedures including treatment of bifurcation lesions. The exceptions to this include rotational atherectomy cases requiring larger burr sizes, complex bifurcation cases such as left main stem or those requiring two stents simultaneously, and complex chronic total occlusion PCI. Additionally, some larger patients may be able to tolerate 7 French equipment whereas smaller patients may only be able to tolerate 5 French equipment.

Challenges of transradial access

Challenges of transradial access include anatomical anatomical variations, catheter selection, radial artery spasm, radial artery occlusion and increased radiation and contrast doses during the learning curve. There is an association between radial access and increased fluoroscopy time in the transition phase from femoral to radial approaches [9]. However, average fluoroscopy time and radiation dose-area product fall close to femoral access levels with increased operator experience [9]. Catheter manipulation and engagement of the coronary arteries from the transradial approach is technically different to that from the femoral approach. For example, manipulation of the left coronary catheter often requires the guide wire placed proximal to the catheter tip in order to torque it into the correct position. Additionally, all catheter exchanges should be done over a guide wire.

The anatomy of the arterial system in the upper can be challenging particularly in elderly and hypertensive patients. The presence of a tortuous subclavian or brachiocephalic artery can make it difficult to pass the wire and catheter into the ascending aorta. This can often be overcome by asking the patient to perform deep inspiration or by using a hydrophilic-coated guide wire. Radial tortuosity or radial loops are relatively common. Even angulations greater that 1800 can usually be overcome by using a soft-tipped hydrophilic guide wire to traverse the loop. This alone often straightens the loop. If not, then a low profile catheter can be passed and with gentle traction and torque the loop usually straightens. The radial artery is a muscular artery rich in alpha-1 adrenoceptors. This makes it prone to vasospasm in response to catecholamines and mechanical stimulation. The reported incidence of radial artery spasm is 4.7% [10]. This rate can be reduced by appropriate patient preparation, the use of hydrophilic arterial sheaths and the administration of vasodilators intra-arterially once access has been obtained. Patient anxiety contributes to the development of radial artery spasm due to elevated catecholamine levels.

Many operators therefore offer intravenous sedation with benzodiazepines such as diazepam or midazolam prior to administration of local anaesthesia. It is also important that sufficient local anaesthesia is administered and that multiple punctures are avoided. Many vasodilating agents have been used to prevent radial artery spasm there is significant inter-operator variation. A combination of glycerltrinitrate GTN) 200mcg and verapamil 5mg has been shown to reduce spasm rate from 22% to 8% in one study [11]. Combinations of verapamil 2.5mg plus molsidomine 1mg, and GTN 200mcg plus verapamil 2.5mg have also been shown to be highly effective at reducing radial artery spasm [12,13]. Once radial artery spasm has occurred, manipulation and passage of catheters can be difficult and painful for the patient.

This can often be overcome by waiting for a few minutes, administering more sedation and more intra-arterial vasodilators. If this fails, then smaller diameter catheters (such as 5 French or 4 French) can be used. In the minority of cases, switching to femoral access may be required. Whilst radial artery occlusion (RAO) is a potential complication of transradial access, it is rarely a clinically significant event as the palmar arch has a dual supply from the radial and ulnar arteries. However, RAO can potentially limit future use of the radial artery for coronary angiography, dialysis fistulas or grafts for coronary artery bypass. It is hypothesised to be caused by arterial thrombosis on a background of vascular injury from sheath insertion. Hand ischaemia following radial access is extremely rare and usually requires surgical intervention. RAO is estimated to occur in 1-10% of cases [14]. However, roughly 50% recanalise within 3 months [15,16]

Traditionally, intra-arterial herapin has been used to reduce the risk of RAO. Early data showed a RAO rate of 4.3% with 5000iu unfractionated heparin compared to 24% with 2000-3000iu unfractionated heparin and 71% with no heparin [17]. However, this was during the early years of transradial angiography and before the development of newer hydrophilic radial sheaths. A subsequent study of 162 patients comparing 50iu/kg unfractionated heparin with 5000iu unfractionated heparin and showed no definite RAO in either group but the weight adjusted group had a shorter compression time (235.5mins vs 204.5mins, $p<0.00001$) [18]. It has also been shown that there is no difference in RAO rates whether heparin is administered intra-arterially or intra-venously [19]. This suggests that prevention is due to a systemic rather than local action of heparin.

More contemporary data suggests that heparin may not be required at all. Patent haemostasis is a technique whereby a radial compression band is applied to the arterial puncture site on sheath removal and inflated with just enough air to prevent bleeding whilst allowing distal flow to the palmar arch. Achievement of patent haemostasis can be demonstrated by the presence of a satisfactory pulse oximeter trace whilst manually compressing the ulnar artery. The PROPHET study demonstrated that patent haemostasis significantly reduces the rate of RAO measured at 24 hours and 30 days [20]. The PHAROAH study demonstrated no difference in RAO rates at 30 days with or without 50iu/kg heparin as long as patent haemostatis is achieved (4.5% vs 5.0%, $p=0.83$) [21].

Summary

Over the last 25 years, transradial access for coronary angiography and PCI has emerged as the preferred route for many Interventional Cardiologists. This is based on the obvious advantages in terms of reduced vascular complications, patient preference and early ambulation. After the initial learning phase, the majority of challenges can be overcome by adequate patient and procedural planning. It should now be regarded as the default access option for the majority of cases.

How to cite this article: Tushar K, Nora R, Ahmed E. Transradial Access. J Cardiol & Cardiovasc Ther. 2016; 2(2): 555583. DOI: 10.19080/JOCCT.2016.02.555583

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