Comparative Assessment of DOrsal Radial Artery Access with Classical Radial Artery Access for Percutaneous Coronary Angiography-A Randomized Control Trial (DORA Trial)

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Abstract

In percutaneous cardiac catheterization both for diagnostic and intervention purposes, vascular access site is a controversial field from the start of this technique. Percutaneous radial artery approach for coronary angiography was invented by Lucien Campeau at Montreal Heart Institute (Canada) in 1986 with publication of the first 100 cases in 1989. And thereafter, this technique advocated for percutaneous coronary intervention (PCI) by Kiemeneij. In spite of frequent use of dorsal radial artery access for percutaneous interventions, there was no head to head trial comparing dorsal radial access with classical radial artery access. This is first open label randomized control trial with parallel assignment with single masking comparing patients undergoing coronary angiography via dorsal radial and classical radial access. Study done at three tertiary cardiac care centers between January 2019 to January 2020. Total of 985 patients were recruited for the study, out of which fifteen patients were found to be unsuitable and five patients denied for procedure. So, the total of 970 patients were finally recruited for the study. Patients were randomly selected for dorsal radial artery access Group A (485 patients) and classical radial artery access Group B (485 patients) assess without any bias for age and sex.

First time on comparative assessment of dorsal versus classical radial artery vascular access it is found equal in terms of procedural success rate and complication in the form of incidences of radial artery hematoma. While dorsal access was superior in terms of less incidences of radial artery occlusion, radial artery spasm. Post procedure persistence of pain and hand clumsiness is also less in dorsal radial artery access. In comparison to this, number of puncture attempts and time to achieve post procedure haemostasis is less in classical radial access. So, both techniques have pros and coins and it is the discretion of interventionist to adopt which technique.

Keywords: Percutaneous Angiography; Radial Angiography; Dorsal Radial Artery; Snuff Box; Radial Artery Occlusion; Radial Artery Spasm

Abbreviation

TRA: Transradial Angiography; PCI: Percutaneous Intervention; RAO: Radial Artery Occlusion

Introduction

In percutaneous cardiac catheterization both for diagnostic and intervention purposes, the site of vascular access is always a controversial field from the start of this technique. Initially great scientist like Mason Sones and many more thereafter used brachial artery access for cardiac catheterization [17]. Later on seeing increased cases of upper limb ischemia post procedure, cardiologist started using...
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Femoral artery as preferred site for vascular access for 2-3 decades. Due to increased incidences of vascular complications in the form of hematoma requiring blood transfusion, retroperitoneal bleed and formation of arterio-venous fistula, Radner first used radial artery access via the cut down technique in 1947 [19]. Percutaneous radial artery approach for coronary angiography was invented by Lucien Campeau at Montreal Heart Institute (Canada) in 1986 with publication of the first 100 cases in 1989. And thereafter, this technique advocated for percutaneous coronary intervention (PCI) by Kiemeneij [12]. A trans-radial approach for coronary angiography has been increasing in comparison to the trans-femoral approach. Several randomized controlled trials and meta-analyses have demonstrated reduced mortality, decreased major bleeding, access site complications, reduced length of the hospital stay, and comparable stroke rate and most important early ambulation by using a trans-radial approach [1]. The findings have been reproduced in non-emergency diagnostic and percutaneous interventional procedures and as well as in urgent settings of ST-segment elevation myocardial infarction. Radial access procedures also enhance patient comfort and reduce post-procedure bed rest. This has become the standard approach for coronary angiography and percutaneous coronary stent implantation (PCI) (Class I in recent European Guidelines), currently used in the overwhelming majority of procedures. The standard access site of the classical radial artery is located at the distal third of the anterior side of the forearm, where it is situated between the skin and the radius bone which enables easy access and compression. The right radial approach is usually preferred, because the left radial approach is less comfortable for the operator (especially if he has a small stature and/or suffers from back problems) and the patient (especially the obese patient).

With ages overtime classical radial artery access too found be associated with many procedures related complications [1]. Classical trans radial access complications can be categorized as intra- or post-procedural and further categorized as related to bleeding or non-bleeding issues. Major intra- and post-procedural complications such as radial artery perforation and compartment syndrome are rare following trans-radial access (TRA). But their occurrence, however, can be associated with morbid consequences, including requirement for surgical intervention if not identified and treated promptly. Non-bleeding complications such as radial artery spasm and radial artery occlusion are typically less morbid but occur much more frequently. Strategies to prevent TRA complications are essential and include the use of contemporary access techniques that limit arterial injury. A novel technique of accessing the dorsal trans radial artery in the anatomical snuffbox/dorsal aspect of the palm was described by Kiemeneij [2,3]. Dorsal trans radial access offers an advantage compared to the classical trans radial access in that the puncture site is distal to the superficial palmar arch bifurcation and preserves the antegrade flow to minimize the risk of hand ischemia [4-6]. The smaller vessel size beyond the bifurcation has been proposed to offer faster hemostasis [7-9]. However, there is a paucity of data examining the routine use of dorsal trans-radial access (TRA). In spite of frequent use of dorsal radial artery access for percutaneous interventions, there was no head to head trial comparing dorsal radial access with classical radial artery access. This is first open label randomized control trial with parallel assignment with single masking comparing patients undergoing coronary angiography via dorsal radial and classical radial assess.

Aims and Objectives of the Study

Comparative assessment between dorsal radial and classical radial artery for percutaneous coronary angiography. The main objectives of the study are to compare both dorsal radial and classical radial artery as a vascular access for percutaneous coronary interventions (diagnostic angiography) in terms of success rate, puncture in the single attempt, radial artery occlusion, radial artery spasm, hematoma/swelling at puncture site, post procedure hemostasis time, post procedure persistence of pain and hand clumsiness.

Materials and Methods

Study done at three tertiary cardiac care centers between January 2019 to January 2020. The total of 985 patients was recruited for the study, out of which 15 patients were found to be unsuitable for the bilateral radial access due to weak pulses and five patients denied for procedure at last moment due to psychological fear. So, the total of 970 patients was finally recruited for the study. Patients were randomly

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selected for dorsal radial artery access Group A (485 patients) and classical radial artery access Group B (485 patients) assess without any bias for age and sex.

**Eligibility criteria**

**Inclusion criteria:** Patients of chronic stable angina who require coronary angiography.

**Exclusion criteria**

- a. Patient having forearm AV fistula for haemo-dialysis
- b. Post CABG patients who used the radial artery as graft
- c. Patients who had type III and type IV radial artery
- d. Patients not willing for procedure.

**Technique**

**For Dorsal radial artery puncture technique:** Technique has been described in detail by Kiemeneij and Davies and Gilchrist [9-12]. The artery is typically palpable at the intersection of the thumb and first finger over the boney structures of the snuffbox (Figure 1 and 2). The patient is positioned with the arm in a neutral position. We usually put a normal saline plastic bottle wrapped with sterile cloth under ventral aspect of the wrist and ask the patient to hold a medium size ball of rolled gauge pieces. This serves to keep the dorsal area opened for access by separating the thumb and first finger. It also gives the patient something to hold during the procedure, which ultimately increases the patient comfort. The hand is thus placed with the snuffbox region facing upwards (anatomical position so less discomfort) rather than the palmar aspect of the wrist (which is the classical approach during radial access). Once the wrist is prepped, access is obtained. The vessel is very superficial. We used to palpate the artery with the tip of the index finger and used to puncture at site of maximum pulsation. We graded the dorsal radial artery into four types based on findings of palpation:

- Type I: Palpable artery without any effort with forceful thrust on tip of the palmer aspect of the index finger which is not suppressible on minimal force.
- Type II: Palpable artery without any effort with forceful thrust on tip of the palmer aspect of the index finger which is suppressible on minimal force.
- Type III: Palpable artery with effort with weak thrust on Palmer aspect of the index finger.
- Type IV: Not palpable.

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**Figure 1: Anatomy of blood vessels on dorsal aspect of palm.**

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For our study we selected patients having type I and type II arteries. After subcutaneous injection of 1 - 5 cc xylocaine, the artery is punctured, preferably with a 21 gauge (G) open needle, under an angle of 30 - 45° and from lateral to medial. The needle is directed to the point of the strongest pulse. We prefer to access the artery at the dorsum of the hand, distal to the tendon of the extensor pollicis longus muscle, where it is more superficial, rather than at the snuffbox (Figure 1 and 3). At the dorsum of the hand, the radial artery is very superficial, less xylocaine is required and the artery will be easily compressed against the base of the 1st or 2nd metacarpal bone. A through-and-through puncture is not recommended, especially if the artery is punctured at the snuffbox, since the needle will touch the periosteum of the scaphoid or trapezium bones, which can be painful. After the successful puncture, a flexible, soft, J-shaped 0.21″ metallic wire is inserted. The skin is thicker and harder than at the forearm, therefore, to prevent damage to the tip of the introducer and sheath, which might damage the artery, a small skin incision is usually necessary before introducing the introducer-dilator kit. Routine forearm angiography is not needed, although angiography may be helpful if resistance is encountered. Alternatively, a 0.014 coronary guide wire may be very useful (Figure 4-6). After sheath placement, the arm can be located in a neutral position comfortable for the patient and operator. Moving the arm toward the operator no longer requires rotation of the wrist as the elbow is flexed to optimize position, and the patient remains orthopedically comfortable as the joints are not stressed. Vasodilator cocktails can be given per local norm and patient likewise anticoagulated to prevent radial artery occlusion. The procedure itself should be similar to a standard radial procedure. Hemostasis is different after distal radial access. The common hemostasis bands used for the typical radial hemostasis depend on the relative immobility of the distal wrist. The dorsal part of the hand is more mobile, and rigid hemostasis devices may be loosened by the patient's wrist movements. One solution that has worked is to use the gauze initially given to the patient at the beginning of the case and roll it up tight to form a plug to place at the arterial entry site. This is then wrapped with a tight elastic bandage to tamponade the artery. (Initially discovered by our lab technician). The patient is positioned with the arm in a neutral position. The recovery area staff then observes for hemostasis.

Figure 2: Palmer arch.
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**Figure 3:** Puncture of distal radial artery at dorsal aspect of palm.

**Figure 4:** Radiographic (cine film) of punctured site.
Figure 5: Cine film of radial artery course.

Figure 6: Cine film of radial artery course in forearm.
For classical radial artery puncture

The right or left hand is set in the anatomical position, with the ventral surface of arm face upwards. Afterward, the access site is disinfected, lidocaine injected subcutaneously for local anesthesia. Then forearm radial artery is palpated to find the point of the strongest pulse. Then at a 45-degree angle, the artery is punctured with a 21-gauge needle and a 0.018 soft, flexible, metallic wire is then inserted in the needle. Cocktail solution containing 200 micrograms of nitroglycerin and 5,000 units of heparin given via the arterial sheath. A weight-adjusted dose of heparin is further added if PCI is needed. Then, a 0.035 wire is introduced in the sheath with other required instruments such as the intracoronary device and the catheters. After pulling out the sheath, a compression device, TR band, is used for hemostasis.

Statistical analysis

Statistical quantitative data were analyzed using the Unpaired "t" test/Mann-Whitney U test for comparisons of data between the different patient groups. For qualitative variables Chi-Square Test/Fischer's Exact Test was applied. P < 0.05 was considered significant. Graph pad Instat 3 and medcalc software system were used for statistical analysis.

Result

There was no significant difference in age and gender between Group A and Group B. Mean age of the study population in Group A and Group B were 55 ± 6 years and 55 ± 7 years (p value 0.06). Total number of male subjects in group A were 290 (60%) and in group B were 285 (59%) (p value of 0.87) while the number of female subjects in group A were 195 (40%) and in group B were 200 (41%) (p value of 0.86).

Overall procedural success rate was 96% (466) in group A and 98% (475) in group B (p value 0.060). The Puncture in the single attempt was done in 92% (446) in group B while in Group A single attempt puncture was successful only in 78% (378) of the patients (p value, 0.0001). Radial artery occlusion was reported in 2% (10) patients in group A and 13% (63) patients in group B. (p value < 0.0001). Radial artery spasm leading to abandon radial access occurs in 1% (5) patients in group A and 12% (58) patients in group B (p value < 0.0001). In 10% (48) patients radial artery hematoma/swelling at puncture site reported in group A while in group B it was 8% (38) (p value 0.27). Time for proper hemostasis at puncture site was 28 minutes in group A and 24 minutes in group B (p value < 0.0001). Post procedure persistence of pain was reported in 1% (5) patients in group A while in group B it was 14% (68) (p value < 0.0001). Post procedure hand clumsiness was seen in 0.4% (2) patients in group A while in group B it was seen in 9% (44) patients (p value < 0.0001) (Table 1 and figure 7-9).

![Figure 7](image-url)  
*Figure 7: Line diagram showing different parameters of comparison between dorsal (Group A) and classical radial (Group B) access.*
Comparative Assessment of Dorsal Radial Artery Access with Classical Radial Artery Access for Percutaneous Coronary Angiography-A Randomized Control Trial (DORA Trial)

Figure 8: Different parameters in both arms (Group A-Dorsal radial artery, Group B-Classical radial artery).

Figure 9: Dorsal radial artery access parameters.
Discussion

Search for ideal vascular access for percutaneous coronary interventions with minimal vascular complications is always an area of interest for the interventionalist. Other than vascular complications ease of procedure safety, radiation safety for the operator and post procedure satisfaction of the patients are the other factors which are too kept in mind. Till date classical right radial artery vascular access is scientifically proven superior over femoral artery access in terms of vascular complications and mortality due to it [13]. But with time, it was observed that even classical radial artery access was also not complications proof. Many complications including radial artery spasm, hematoma, compartment syndrome of the forearm and loss of fine movements of the hand was reported with this access [14]. In operators radiation exposure, new back problems, difficulty in repeat procedure from same access if needed in future and lack of radial artery graft if needed during CABG were a concern. So, the need for new access site arises. And a novel technique of accessing the dorsal radial artery was described by Kiemeneij in 2017 [12,14]. Till then a lot of papers were published with this technique including case reports, case series and meta-analysis but there was no head to head comparison between the two techniques. Our study is first randomized control trial comparing dorsal radial artery access with classical radial artery access conducted at 3 tertiary level cardiac centers. With this technique the main series are those of the pioneers of the technique, Babunashvili and Dundua [2] and Kaledin., et al [14]. In Babunashvili and Dundua series of 637 patients with distal dorsal radial access, the dorsum of the hand (rather than the snuffbox) was used in 92%, only 11% were PCI procedures and sheath size was 5F in 91% and 6F in 9%. Overall success rate was 98%. Radial artery occlusion rate was 0% acutely and 0.2% at late (more than 3 months) follow-up. In our study of 950 patients, 485 patients were undergone dorsal radial access at the dorsum of the hand too, rather than the snuff box, 100% procedures were coronary angiography and sheath size was 6 F in all patients. Overall success rate in our patients was 96% as compared to 98% in classical radial artery access, which was clinically not significant. So, we can say in terms of success rate, both access, are same with no superiority of one over other. Radial artery occlusion was 2% in dorsal radial artery access which is higher than Babunashvili and Dundua series i.e. 0.2% which may be due to less expertization of our team as compared to pioneers. But radial artery occlusion in dorsal access is clinically less as compared to classical radial artery access (13%) in our study, which is clinically significant. So, in terms of radial artery occlusion dorsal radial artery access is superior to classical radial artery access. Dorsal radial access is also statistically and clinically superior than classical access in terms of radial artery spasm, post procedure persistence of pain and hand clumsiness. While classical radial artery access is statistically and clinically superior than dorsal access in terms of puncture in single attempt and post procedure hemostasis time. While both procedure are statistically equal in terms of success rate, radial artery hematoma/swelling at puncture site without any clinical superiority of one technique over other. Puncturing dorsal radial artery is demanding and required a learning curve of at least 50 puncture even in whom who are expert in classical radial artery puncture. Puncture at snuff box or at other site on the dorsal surface hardly carries a clinical importance.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameters</th>
<th>Dorsal radial artery (n = 485) (Group A)</th>
<th>Classical radial artery (n = 485) (Group B)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Success rate</td>
<td>466 (96%)</td>
<td>475 (98%)</td>
<td>0.06</td>
</tr>
<tr>
<td>2</td>
<td>Puncture in single attempt</td>
<td>378 (78%)</td>
<td>446 (92%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>3</td>
<td>Radial artery occlusion</td>
<td>10 (2%)</td>
<td>63 (13%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>4</td>
<td>Radial artery spasm</td>
<td>5 (1%)</td>
<td>58 (12%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>5</td>
<td>Radial artery hematoma/swelling at puncture site</td>
<td>48 (10%)</td>
<td>38 (8%)</td>
<td>0.27</td>
</tr>
<tr>
<td>6</td>
<td>Post procedure haemostasis time</td>
<td>28 minutes</td>
<td>24 minutes</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>7</td>
<td>Post procedure persistence of pain</td>
<td>5 (1%)</td>
<td>68 (14%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>Post procedure hand clumsiness</td>
<td>2 (0.4%)</td>
<td>44 (9%)</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

Table 1: Results of study.

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In Kaledin, et al. [2] series of 2,884 patients undergoing endovascular interventions, the snuffbox (rather than the dorsum of the hand) was used in 96% of patients, 93.5% of interventions were PCI procedures, with sheath size of 6F in 98% and 7F in 1%. Success rate was 97%. At follow-up, radial artery occlusion rate at the access site with preserved blood flow of forearm radial artery was observed in 2% of cases; at follow-up, radial artery occlusion rate at the access site with preserved blood flow of forearm radial artery was observed in 2% of cases; Other access site complications were similar to those observed with the forearm approach: hematoma (0.2%), pulsatile hematoma (< 0.1%), infection (0.1%), dissection (0.1%), arteriovenous fistula (< 0.1%). This is in contrast with the 4.2% radial artery occlusion rate observed by the same authors using the traditional forearm radial approach. In our study the radial occlusion rate is higher in both technique which may be due to less expertization of our team as compared to those pioneers but it nullifies the effect as same operator perform both access in our study in both arms for comparison purposes.

Out of 118 consecutive patients assigned to Kiemeneij’s operation program, 70 patients were considered suitable for left distal radial access. There were eight procedural failures, requiring crossover to traditional right radial or left radial approach. All other procedures were successful (89%), without major discomfort for the patient and operator. No radial artery occlusions at the site of the forearm were encountered. In our study it was not designed to assess a difference between left and right dorsal radial access [12]. We may include this parameter in our future studies pertaining to this field.

In Kim, et al. [11] series of 150 selected patients who had coronary angiography or PCI with 6 French catheters via left snuffbox approach, success rate was 88%. Main reasons for failure were failed puncture. In our study too it is found after data analysis that classical radial artery access is statistically and clinically superior than dorsal radial access in terms of puncture in the single attempt. Puncturing dorsal radial artery is demanding and required a learning curve of at least 50 puncture even in whom who are expert in classical radial artery puncture.

Conclusion

Dorsal trans-radial access is an another route of vascular access for percutaneous coronary interventions. First time on comparative assessment of dorsal versus classical radial artery vascular access it is found equal in terms of procedural success rate and complication in the form of incidences of radial artery hematoma. While dorsal access was superior in terms of incidences of radial artery occlusion, radial artery spasm. Post procedure persistence of pain and hand clumsiness is also less in dorsal radial artery access. In comparison to this, number of puncture attempts and time to achieve post procedure haemostasis is less in classical radial artery access. So, both techniques have pros and coins and it is the discretion of interventionist to adopt which technique.

Our observations regarding dorsal radial access

Advantage

1. Anatomical position of the forearm and palm, so patient is in more comfortable position.

2. Proximal radial artery access is preserved for future interventions and as graft material for future CABG if required.

3. Post procedure complications in the form of hand clumsiness, persistent pain are less as compared to classical radial artery access.

4. Advantageous in terms of the patient comfort.

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Disadvantages

1. Needed learning curve to puncture. (At least 50 successful puncture needed).
2. In patients of long height (above 6 feet), long length catheters (110 or 120 cm length) are required.
3. Proper hemostasis device needed to be discovered.

Acknowledgments

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Conflict of Interest

No conflict of interest.

Bibliography


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