Research

Safety, Feasibility and Variable Procedurals between Transradial and Transfemoral Access in Coronary Angiography

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Abstract: The aim of study is to evaluate the safety, feasibility, and procedural variables of transradial approach comparing with the transfemoral approach in a standard population of patients undergoing coronary catheterization procedure which is considered as one of the major drawn criticisms of the transradial approach is that it takes longer overall procedure and fluoroscopy time, thereby causing more radiation exposure for both patients and doctors. Method: Data has been collected between January 2016 and December 2018, a total of 1,997 patients in Chins-Japan Union Hospital of Jilin University, P.R.China, who had went for coronary catheterization and were randomly assigned to both transradial or transfemoral approaches. Result: Successful catheterization was achieved in a total number of 1044 of 1075 patients (96.1\%) in the transradial group and total number of 917 of 920 patients (99.7\%) in the transfemoral group (\(p = 0.001\)). Comparing both the transradial and transfemoral approaches, fluoroscopy time is (2.46 ± 1.22 versus 2.83 ± 1.31 min; \(p = 0.32\)), procedure time is (8.89 ± 2.72 versus 9.33 ± 2.82 min; \(p = 0.56\)), contrast volume is (67.52 ± 22.54 versus 71.63 ± 25.41 mL; \(p = 0.32\)), radiation dose as dose area product is (24.2 ± 4.21 versus 22.3 ± 3.46 Gycm\(^2\); \(p = 0.43\)), and postprocedural rise of serum creatinine (6 ± 4.5\% versus 8 ± 2.6\%; \(p = 0.41\)) are not that significantly different compares with both transradial and transfemoral groups. While vascular access site complications were significantly lower in transradial group compared with transfemoral group (3.9\% versus 7.6\%; \(p = 0.04\)). Conclusion: The present study shows that transradial access for coronary angiography is safer among the patients when compared to transfemoral access with lower rate of local vascular complications. The transradial approach procedure for coronary angiography is one of best option and an alternative option for trans femoral route and it’s also an excellent opportunity for operators to train for transradial coronary
interventions.

Keywords: TRA-Trans radial artery, TFA-Trans femoral Artery, CABG- Coronary artery bypass graft, RAO-Radial artery obstruction, TRC-Trans radial catheterization, ACS-Acute coronary syndrome, RA-Right artery, LA-Left artery, PCI-Percutaneous Coronary Intervention.

1. Introduction

Following the first address on radial coronary angiography by Campeau in 1989 and radial percutaneous coronary intervention (PCI) by Kiemeneij et al. in 1992, shows that there is an increase in use of trans radial access (TRA) procedure because of lower access site bleeding, early ambulation, patients recovery, patient preference and satisfaction, reduced morbidity, and lower procedural cost when compared with trans femoral approach around the every corner of world\textsuperscript{1,2,3}.

The hand which receives a dual arterial supply from both the radial and ulnar arteries, which come together and form a deep and superficial palmar arches. The radial artery dissimilar like femoral or brachial artery which is accordingly not an end artery, and in the presence of an adequate ulnar collateral supply, its blockage does not compromise with the vascular supply to the hand. Furthermore, the superficial development of the distal radial artery provides for easy compression of the artery, so that patients can mobilize as soon as the arterial sheath is removed on achievement of the trans radial procedure. In recent technological advances which have enabled the miniaturization of diagnostic catheters as well as the equipment for percutaneous transluminal coronary angioplasty. Matured to this miniaturization, the percutaneous arm approach procedure via the radial artery has become more popular procedure throughout the world and it is considered as an alternative to the femoral artery technique\textsuperscript{2-12}. Advantages of this approach are include an lower incidence of access site complications, earlier patient ambulation, improved patient satisfaction, and lower costs\textsuperscript{5-7,10,14-16}. Trans radial procedures can be performed by cannulation of either the right radial artery or the left radial artery. At present, the choice to choose either the right radial or the left radial approach largely depends on the operator’s preference. Most of the studies states or shows that the trans radial approach have been performed through right radial artery apparently because of the naturalness in performing the study from the patient’s right side as commonly used in the femoral approach\textsuperscript{5}. One of the major commentary of the radial approach is that it consumes longer overall
procedure and fluoroscopy time, which states not only more staff (interventionists, radiographers, nurses, and anesthetists if needed clinically) will be exposed to radiation during the procedures, but they will also stand very close to the patient where rates of radiation scattered by the patient are higher while performing. The American Heart Association/American College of Cardiology clearly state that “the responsibility of all physicians who are performing the catheterization is to reduce the radiation injury hazards to their patients, to their professional staff and to themselves”. So, the aim of this study is to evaluate the safety of the radial artery versus femoral artery approach in our institution’s routine coronary angiography practice.

Furthermore, the superficial procedure of the distal radial artery provides for an easy compression of the artery, so that patients can be shifted to the ward as soon as the arterial sheath is removed on completion of the catheterization procedure. The recent technological advances which have enabled the miniaturization of using diagnostic catheters as well as the equipment used for percutaneous transluminal coronary angioplasty. Matured to this miniaturization, the percutaneous arm approach through the radial artery is becoming more popular and is performed throughout the world as an alternative to the femoral artery procedure technique. Advantages of this trans radial artery approach which include a lower incidence in access site complications, earlier patient ambulation, improved patient satisfaction, and lower costs. Transradial procedures technique can be performed by cannulation of either the right radial artery or the left radial artery. At present, the choice for the right radial or the left radial surgery approach is largely depending on the preference of operator’s. Most of the studies of the trans radial surgery approach performed have been performed through right radial artery naturally because of the familiarity in performing the study from the patient’s right side as commonly used in the femoral approach. One of the major comments of the radial approach is that it will take longer overall procedure and fluoroscopy time, which means not only more staff (interventionists, radiographers, nurses, and anesthetists if needed clinically) which will be exposed during the procedures, but they will also stand very close to the patient where rates of radiation scattered by the patients are higher. Many of the Heart Association/worldwide Colleges/hospitals of Cardiology clearly mentioned that
it is the responsibility of all physicians is to reduce the radiation injury hazard to their patients, to their professional staff and to themselves who are all involved in cath lab. So, the aim of our study is to evaluate and reveal the safety, feasibility and variable procedures of the radial versus femoral artery approach in our institution’s routine coronary angiography practice.

Lower mortality has shown in RIVAL trial that trans radial coronary angioplasty (TRA) procedure in acute coronary syndrome patients has given additional boost to it. Most of the studies of the trans radial procedure approach has always been performed through right radial route because of naturality in performing the study from the patient’s right side and is commonly used in femoral approach even though it can be done from left radial route as well. But it is not totally immune from criticism and complications. One of major criticism drawn from many operators is that of trans radial approach procedure is that it takes very long overall procedure and fluoroscopy time, which states more radiation exposure to catheter lab personnel as they will also stand close to patient where rates of radiation scattered will also be higher. So, the aim of this study was to evaluate the safety of trans radial approach versus trans femoral approach in routine coronary angiography procedure practice in terms of crossover rate from one to the other, contrast amount, overall procedure time, fluoroscopy time, and complications involved in the procedure.

A growing body of evidence supports adoption of trans radial artery procedure to improve coronary angiography related outcomes, to improve healthcare quality, and to reduce cost involved.

2. Material and Method

2.1 Design.

My study was prospective, randomized, single center study conducted in the Department of Interventional Radiology, China-Japan Union Hospital of Jilin University, P.R.China where all cases of diagnostic coronary angiography (CAG) of 1997 consecutive patients for various reasons over a 36 months’ period (from January 2016 till the end of December 2018) were reviewed for this analysis. The study protocol was approved by the local ethics committee and followed the Declaration of Helsinki after obtaining informed consent from each patient who are involved in this
procedure.

The choice between radial artery or femoral artery access was left to the responsibility of the operator who are involved in doing procedure. The right radial approach is the default strategy followed at the catheterization laboratory in our institution. In accordance with institutional policy we followed the procedure of femoral approach which favored for patients with negative findings on the Allen test, and for patients with coronary artery bypass grafts (CABG) was performed. Radial arterial procedure access was carried out in a standard technique by using commercial micro puncture kits. After inserting the sheath, 5000 U of unfractionated heparin was injected directly into the radial artery through the sheath; and nitroglycerine (200 mcg) into intra-arterial was used as the primary antispasmodic. Catherization was performed by using 6 Fr diagnostic catheters. After completion of procedure, the sheath was removed immediately and a compression was applied by hemostatic band was installed for 3 hours, after the procedure patients were allowed to walk around immediately after the end of the procedure.

Femoral artery procedures were done by using vascular sheaths, which are placed using Seldinger’s technique. Catherization for femoral artery was performed by using 6 Fr diagnostic catheters. After the end of the procedure, the sheath was removed immediately in the catheter laboratory and manual compression was performed on puncture site for a minimum of 15 minutes or until satisfactory hemostasis had been achieved. This was followed by placement of a compressive bandage for 6 hours. Closure devices were not used.

Study population was laminated accordingly to arterial access used to perform the procedure into two groups; radial group and femoral group. An access crossover was recorded and stratified which was based on the first route of access attempted. Crossover to femoral was defined as the necessary need to shift to the trans femoral approach and was left to the operator’s responsibility. Crossover to the femoral approach was classified into the following three groups based on the followings: puncture failure -lack of radial cannulation, radial and brachial failure- severe spasm, tortuosity, loops, remnant, or other anomalies, and epiaortic failure severe subclavian or aortic tortuosity.38
2.2 Procedure.

Enrolled patients in hospital underwent an comprehensive cardiac evaluation including coronary angiography as a part of their diagnostic procedure and those who underwent subsequent percutaneous coronary intervention among additional under this procedure group were excluded. The choices between trans femoral or trans radial artery access was left to the operator’s decision. And right radial approach procedure being taken as the default strategy. Trans femoral approach procedure was favored for patients with abnormal Allen test and with coronary artery bypass grafts (CABG).

Radial artery was punctured by 21 G needle and 0.021 guide wires (Cordis, USA) were inserted. 5-F sheath and 6-F sheath were used for diagnostic purpose and additional under this intervention depending on need. After sheath replacement, mixture of medicine containing 200\(\mu\)g nitroglycerin, 2.5mg diltiazem, and 2500 IU unfractionated heparin was injected. Angiogram was performed by using 5-F TIG catheter (Terumo, Japan). For those having abnormal take-off where cannulation was not possible with TIG catheter, Judkin’s left or right (JL/JR) catheter was used. Radial sheath was removed just after the completion of procedure and compression was performed for 2 hours with radial compression device (TR band; Terumo) using the “patent hemostasis” protocol proximal to puncture site (Figure 1)\(^{34}\). TR band was inflated with 15 to 19 mL of air. The patency of radial artery was checked at least once for every 20 minutes by palpation and by seeing the color of palm and was removed after 2 hours of sheath removal. Light pressure bandage was applied later on and this will be removed next day.

Procedure duration was calculated as the time between the patient entering and leaving the catheter laboratory. Fluoroscopy time is recorded, as it is correlated to catheter manipulation, whereas the fluorography time is not included in our study, as it is independent from catheter manipulation and is associated with the cine angiography recording. Contrast injection was performed using an automatic power injection device Which allows us for online control of contrast injection rate and volume.\(^{39}\) In our institution, coronary angiography and subsequent coronary intervention procedure was performed whenever necessary in a single session in order to optimize patient health, emergency and comfort. All diagnostic coronary angiography which were followed by percutaneous coronary intervention (PCI) were
excluded in our study, because we are not measuring and recording into our study data base because the contrast amount, fluoroscopy and procedure times of the diagnostic coronary angiography independently different from PCI procedures of the same case.

Trans femoral procedures were performed by using 5 Fr diagnostic catheters (JL/JR). At the end of the procedure, sheath was removed and manual compression was applied until satisfactory hemostasis had been achieved followed by the placement of compressive bandage with dynaplast for 6 hours. Patients were divided into two groups, trans radial and trans femoral, according to arterial access used to perform procedure. Crossover to trans radial access was defined as failed access, extreme tortuosity and peripheral arterial disease (Figure 2).

And this was classified into the following three groups: puncture failure -lack of radial cannulation, radial and brachial failure -severe spasm, tortuosity, loops, remnant, or other anomalies, and epiaortic failure -severe subclavian or aortic tortuosity (Figure 3).

Procedure duration was stated from the time between first needle skin contact to removal of last catheter of patient. Total fluoroscopy time was recorded, as it is correlated to catheter manipulation. Angiographic and procedural details which includes severity of coronary artery disease and complexity of lesions are noted.
(a) TR band

(b) various internal diameters of radial artery

(c) various internal diameters of radial artery
(d) various internal diameters of radial artery

(e) various internal diameters of radial artery
(f) RAO with collaterals

(a) vasospasm, focal
(b) vasospasm, diffuse

(c) perforation
(d) dissection

Reasons of radial crossover from transfemoral route:
(a) calcified aorta.

(b) Tortuous

2.3 Statistical Evaluation.

Statistical analyses are performed using the SPSS 17.0. Continuous variables were analyzed using Student’s t-test and presented as mean ± SD whereas categorical variables were given as numbers (percentages). The comparison between groups was done by Mann–Whitney U test for continuous variables and by Chi-square or Fisher’s exact test for categorical variables. p < 0.05 was considered statistically significant.

| Characteristics | TransradialCAG(n=1075;% | Transfemoral(n=920;% | p value
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>51 ± 16.4</td>
<td>49 ± 14.9</td>
<td>0.16</td>
</tr>
<tr>
<td>Male</td>
<td>855 (79.6%)</td>
<td>699(71.7)</td>
<td>0.2</td>
</tr>
<tr>
<td>Female</td>
<td>219(20.4%)</td>
<td>220(28.3)</td>
<td>0.23</td>
</tr>
<tr>
<td>Height(cm)</td>
<td>166.5 ± 10.8</td>
<td>154 ± 8.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Weight(kg)</td>
<td>63.6 ± 11.2</td>
<td>59 ± 9.6</td>
<td>0.18</td>
</tr>
<tr>
<td>BMI(KG/m²)</td>
<td>24.9 ± 2.8</td>
<td>23.8 ± 3.6</td>
<td>0.4</td>
</tr>
<tr>
<td>BSA(m²)</td>
<td>1.66 ± 0.22</td>
<td>1.62 ± 0.19</td>
<td>0.24</td>
</tr>
<tr>
<td>Serum</td>
<td>1.2 ± 0.3</td>
<td>1.3 ± 0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Creatinine (mg/dl)

**CAD risk factors**
- Hypertension: 420 (39.1) vs. 312 (34); p = 0.32
- Diabetes mellitus: 357 (33.2) vs. 267 (29); p = 0.29
- Smokers: 322 (30) vs. 322 (35); p = 0.31
- Family history of CAD: 75 (7.1) vs. 36 (4); p = 0.43
- Dyslipidemia: 440 (41) vs. 334 (36.4); p = 0.22

**Clinical diagnosis**
- Acute coronary syndrome: 675 (62.8) vs. 542 (58.9); p = 0.12
- Chronic stable angina: 354 (33) vs. 239 (26.1); p = 0.32
- Cardiomyopathy: 06 (0.6) vs. 37 (4); p = 0.5
- Chest pain for evaluation: 26 (2.5) vs. 45 (4.9); p = 0.53
- Previous CABG: 06 (0.6) vs. 30 (3.3); p = 0.04
- Valvular Heart disease: 3 (0.3) vs. 22 (2.4); p = 0.02

Continue Table 1: Baseline characteristics of patients (n = 1996).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>TransradialCAG(n=1075;%)</th>
<th>Transfemoral(n=920;%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVEF(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) &gt;45%</td>
<td>817(76)</td>
<td>645(70.2)</td>
<td>0.32</td>
</tr>
<tr>
<td>(b) 35-45%</td>
<td>119(11.2)</td>
<td>153(16.7)</td>
<td>0.21</td>
</tr>
<tr>
<td>(c) &lt;35%</td>
<td>137(12.8)</td>
<td>119(13.1)</td>
<td>0.4</td>
</tr>
<tr>
<td>Medications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>1001(93.2)</td>
<td>707(76.9)</td>
<td>0.5</td>
</tr>
<tr>
<td>Clopidogre</td>
<td>154(50.6)</td>
<td>635(69.1)</td>
<td>0.3</td>
</tr>
<tr>
<td>Prasugrel</td>
<td>131(12.3)</td>
<td>168(18.4)</td>
<td>0.11</td>
</tr>
<tr>
<td>Ticagrelor</td>
<td>57(5.8)</td>
<td>29(3.1)</td>
<td>0.33</td>
</tr>
<tr>
<td>Statin</td>
<td>980(91.2)</td>
<td>721(78.4)</td>
<td>0.7</td>
</tr>
<tr>
<td>Beta-Blockers</td>
<td>784(72.9)</td>
<td>619(67.4)</td>
<td>0.53</td>
</tr>
<tr>
<td>ACEI/ARB</td>
<td>973(90.5)</td>
<td>753(81.9)</td>
<td>0.19</td>
</tr>
<tr>
<td>CCB</td>
<td>229(21.4)</td>
<td>267(29.2)</td>
<td>0.5</td>
</tr>
<tr>
<td>Aldosterone antagonist</td>
<td>131(12.3)</td>
<td>83(9.2)</td>
<td>0.31</td>
</tr>
<tr>
<td>Angiopraphic severity of CAD(obstructive)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) SVD</td>
<td>349(47.2)</td>
<td>419(58.2)</td>
<td>0.18</td>
</tr>
<tr>
<td>(b) DVD</td>
<td>211(28.6)</td>
<td>160(22.2)</td>
<td>0.56</td>
</tr>
<tr>
<td>(c) TVD</td>
<td>180(20.4)</td>
<td>103(14.3)</td>
<td>0.67</td>
</tr>
<tr>
<td>(d) Left</td>
<td>40(3.8)</td>
<td>37(5.3)</td>
<td>0.3</td>
</tr>
</tbody>
</table>
other vessel)  
CAD (intermediate 50-70%)  176(16.4)  102(11.2)  0.29  
Non-obs  96(8.9)  37(4.2)  0.44  
CAD(recanalised)  
Normal coronaries  58(5.4)  54(6)  0.31  

Data presented as mean ± standard deviation or number (percentage). BMI = body mass index; BSA = body surface area; CAD = coronary artery disease; DM = diabetes mellitus; LVEF = left ventricular ejection fraction; ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin-receptor blocker; CCB = calcium-channel blocker; SVD = single-vessel disease; DVD = double-vessel disease; TVD = triple-vessel; CABG = coronary artery bypass graft.

**Table 2: Procedural and postprocedural outcome of patients (n = 1, 996)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Transradial CAG  (n = 1075; %)</th>
<th>Transfemoral CAG  (n = 920; %)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Catheters used</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Single catheter</td>
<td>1033(96.1)</td>
<td>9(1.1)</td>
<td>0.24</td>
</tr>
<tr>
<td>(b) Cather exchanged(AL/AR/JR/JL)</td>
<td>41(4.9)</td>
<td>910(98.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Crossover rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Radial to femoral</td>
<td>30(2.9)</td>
<td>---</td>
<td>0.0001</td>
</tr>
<tr>
<td>(b) Femoral to radial</td>
<td>---</td>
<td>2(0.2)</td>
<td></td>
</tr>
<tr>
<td>UFH</td>
<td>1075(100%)</td>
<td>920(100)</td>
<td>0.22</td>
</tr>
<tr>
<td>Duration of Radial artery compression(Hr.)</td>
<td>2.0 ± 0.1</td>
<td>---</td>
<td>0.11</td>
</tr>
<tr>
<td>Fluoroscopy time(min)</td>
<td>2.45 ± 1.21</td>
<td>2.82 ± 1.30</td>
<td>0.31</td>
</tr>
<tr>
<td>Radiation dose(Gy × cm²)</td>
<td>24.2 ± 4.21</td>
<td>22.3 ± 3.46</td>
<td>0.43</td>
</tr>
<tr>
<td>Procedure duration</td>
<td>8.88 ± 2.71</td>
<td>9.32 ± 2.81</td>
<td>0.56</td>
</tr>
<tr>
<td>Contrast volume(mL)</td>
<td>66.52 ± 22.54</td>
<td>70.63 ± 25.41</td>
<td>0.32</td>
</tr>
<tr>
<td>Serum creatinine(mg/dL),post-CAG</td>
<td>1.2 ± (5 ± 4.4)</td>
<td>1.3 ± 0.15(7 ± 2.5)</td>
<td>0.40</td>
</tr>
<tr>
<td>RAO</td>
<td>55(5.2)</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Vasospasm</td>
<td>29(2.6)</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Local site complication</td>
<td>4.2(3.9)</td>
<td>69(7.6)</td>
<td>0.04</td>
</tr>
<tr>
<td>Local site pain</td>
<td>20(1.9)</td>
<td>37(4.1)</td>
<td>0.04</td>
</tr>
<tr>
<td>Haemotoma</td>
<td>8(0.83)</td>
<td>12(1.4)</td>
<td>0.001</td>
</tr>
<tr>
<td>Local site paraesthesis</td>
<td>12(1.2)</td>
<td>18(2.1)</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*Including one for crossover; UFH: unfractionated heparin; CAG: Coronary Arteriography; RAO: radial artery occlusion.
2.4 Radiation Exposure

Observational studies and randomized data states that longer fluoroscopy procedure times with TRA procedures. However, assessments of radiation exposure are measured by the more accurate parameter of dose-area product and those have reported mixed results. Some studies indicated a higher dose-area product with TRA, whereas others reports have shown no difference, and our study reported a lower dose-area product with TRA. Most recently, RAD-MATRIX study has (Radiation Substudy of MATRIX) demonstrated greater radiation exposure with TRA even in this setting of experienced TRA operators involved in procedure.

The use of left versus right TRA also demonstrated/showed mixed findings for radiation exposure. However, some studies demonstrate that estimated radiation exposure to both the patient and the operator is reduced with the use of lower-dose fluoroscopy and, at centers with a higher annual TRA volume, lower radiation exposure to the operator with additional radiation protection drapes.

2.5 Comparison between the transradial and transfemoral techniques

Comparing with the trans femoral approach, the biggest benefit of the trans radial technique is the reduction in access site complications. Meta analyses of some smaller trials have suggested there are reductions in bleeding, as well as trends towards reductions in myocardial ischemic events and death due to reduction in bleeding. Patients who underwent coronary angiography procedures through the radial artery had a statistically significant reduction in both major and minor bleedings (4.2% vs 1.96%, \( P = 0.03 \)) and death or myocardial infarction (3.1% vs 0.6%, \( P = 0.005 \)). This reduction of bleeding was present when patients were randomized either towards radial artery or femoral artery access and was even more complicated in patients who were sickest (e.g., acute myocardial infarctions) and patients who were the most heavily anticoagulated. The second benefit from the trans radial approach is patient satisfaction. Since patients need not remain flat (as required after femoral access), they tend to have less overall discomfort related to their procedure, and this is reflected in improved satisfaction in patients also time.
2.6 Challanges with Transradial Procedures

One of the biggest involvement about performing cardiac catheterization through the radial artery is obtaining access site\textsuperscript{50}. The technique is also the same to the trans femoral technique, but given the size of the radial artery is smaller and the tendency of the radial artery to spasm, it is sometimes harder to place a sheath. If the operators have gained some experience in the micro puncture technique, it shows is very little difference in rates of successful access. There is also very low rate of crossover to a femoral site when converting from diagnostic angiography to angioplasty if the operator is well experienced\textsuperscript{41,50,52}. There are also challenges when it comes to catheter manipulation. Since the radial artery is of a caliber close to that of the catheter itself, radial artery spasm may occur, which will make manipulation of the catheters much more difficult\textsuperscript{53}. Much of this can be minimized by use of sheath sizes that are appropriate to the caliber of the patient’s radial artery as well as by using of medicines to reduce spasm\textsuperscript{51}. Some of the difficulties with catheter manipulation relates to the course of the catheter must try to navigate the right subclavian artery and to the ascending aorta. Although this manipulation is typically not overwhelming in experienced hands, but there is evidence that when we approach from the left radial artery it may minimize some of these difficulties\textsuperscript{55}. There are some significant variations in forearm arterial anatomy, some of which are difficult to traverse even with flexible coronary catheters.

2.7 Overall Benefits

Despite the above mentioned difficulties, the benefits of the trans radial procedure lie in earlier ambulation times and reduced need for painful clamps. Patients’ satisfaction is higher with the trans radial approach than with the trans femoral approach\textsuperscript{48,49}. There are cost savings with this approach directly due to reduced time. An example of a cardiac catheterization is performed through the radial artery approach. (a) A ventriculogram is performed using a multi-purpose catheter. (b) The same catheter is used for selective coronary injection, which shows a high-grade lesion in the left anterior descending artery. (c) A standard guiding catheter is used through the radial artery approach, through which a stent is placed across the coronary lesion (d) The result of the coronary intervention is good, without residual stenosis. By giving anticoagulation for the coronary intervention, no risk is involved of groin
complications and a minimal requirement for bed rest is required, as the entire procedure was performed through the wrist. Equipment needs and due to the reduced need for post procedure observation and also reduction in bleeding complications\textsuperscript{49,52}. The trans radial approach can even facilitate outpatient PCI on same-day discharge\textsuperscript{58,59}.

3. Recommendations and Best Practices for TRA

3.1 Operators Proficiency

Although there are relative benefits for TRA over TFA which are most noticeable in high-risk patient subgroups such as those with ACS, maintenance of adequate operator and center volume is important in realizing these benefits. Analyzing of the TRA learning curve suggests that operator’s proficiency which may reduce concerns about access site crossover, radiation exposure, contrast volume, delay in reperfusion time, and procedural success are all involved with the operator’s experience. Although essential procedure volumes are able to achieve and maintain procedures a year proficiency have been proposed for the operators, many factors determine operator and center expertise in the TRA technique. Furthermore, the relationship between volume and procedural success does not appear to have a threshold on operators. Predictions of PCI failure with TRA catheterization includes increasing age, female sex, previous CABG, cardiogenic shock, and short stature. So it is recommended that operators and centers which pursue a radial-first strategy and a graduated exposure to case complexity with a transition plan for the ACS setting. Plans to pursue TRA may need to be deferred until both the center and the operator have sufficient experience that to ensure operator and staff comfort in achieving acceptable procedural times and also patients safety.

4. TRA Technique

4.1 Patient Selection

Assuming appropriate operator experience and center experience, quality, a radial-first approach to an all new comer’s population is strongly encouraged. The relative benefits of TRA can be especially noticeable in patients on therapeutic oral anticoagulation, at risk of bleeding may be explained because of medical comorbidities (eg, at extremes of body mass index, chronic kidney disease, thrombocytopenia), or unable to receive blood transfusion. TRA is also preferable in
patients who have difficulty in lying flat (eg, those with congestive heart failure, low back pain and cognitive impairment).

Relative contraindications to the radial approach are limited but those are including severe vaso occlusive disease (eg, Raynaud disease, Takayasu arteritis, thromboangiitis obliterans), documented in small radial artery size, or known complex radial or brachiocephalic anatomy. The impact of TRA on subsequent utility of the radial artery as a bypass conductor or in patients who may have subsequently required arteriovenous fistula creation remains as an area of uncertainty.

Although a radial-first approach is strongly recommended for patients, appropriate TFA procedure volume and adherence to perform best practices in femoral access are important in maintaining the skills and experience necessary for operators when TRA is not an option. Accordingly, some operators they may choose to pursue TFA in low-risk elective patients or in select patient subgroups in whom TRA is anticipated to be difficult or is associated with some uncertainty risks involved. Alternatively, operator TFA volume can be maintained through peripheral vascular, structural heart, or ventricular assist device insertion procedures successfully.

4.2 Preprocedural Assessment

Although assessment of the radial artery pulse is important in patients, performing an Allen or Barbeau test has to be confirmed the latency of dual arterial circulation to the hand and intact palmar arch system is only of historical interest to be noted in recent reports of patients with normal and the abnormal pre procedural Allen test those who subsequently underwent TRA did not demonstrate differences in the thumb capillary lactate, grip strength, or incidence of ischemia between the two groups. Routine application of the Allen or Barbeau test is not as useful as triage strategy, and an abnormal test should not pre included in TRA. However, use of ultrasound imaging or the reverse Allen or Barbeau test may be helpful in identifying an occluded radial artery that fills via retrograde collaterals. In addition, the use of ultrasound imaging that is inclusive of the antecubital fossa may be helpful in reducing the crossover rates through the identification of radial loops and other vascular anomalies.
4.3 Access Site Selection and Patient Setup

Although the right radial artery is often preferred for reasons of operator’s comfort and limitations of typical catheterization in laboratory radiation safety equipment design the left radial artery is considered in certain situations such as in patients with a left internal mammary bypass or those of short stature and >75 years of age. Finally, some operators transitioning from trans femoral artery to trans radial artery may prefer the familiarity of catheter fit and engagement between trans femoral artery and left radial artery.

Safe and successful PCI in the acute coronary syndrome setting requires appropriate patient setup. For right radial artery procedures, a platform that provides transitional support between the access site and procedure table for wires and catheters is recommended in laboratory. Operator comfort should be improved in left radial artery procedures by elevating the patient’s arm (like with sheets, pillow, or foam board) and retracting it across the patient’s body on operating table. An alternative approaches described include access of the left radial artery through the dorsal aspect of the thumb in the anatomic snuffbox, but on long-term safety implications of this technique and its application to the ACS setting are uncertain and all these are included on operators comfort.

Ulnar artery access is a potential alternative to the radial access. When compared with the radial artery, the ulnar artery is at a less favorable and deeper in anatomic position that is associated with a less readily palpable pulse and more challenging in hemostatic control. Unlike the radial artery, the ulnar artery is also immediately adjacent to the large nerve. All these issues are noted, and the data indicate that, in experienced hands, trans ulnar access is non inferior in safety and efficacy to trans radial artery. Adjunctive use of ultrasound to guide arterial access is recommended to help in minimizing the hematomas and patient discomfort.

4.4 Access Technique

In patients with acute coronary syndrome, especially those who are suffering with STEMI (ST Elevation Myocardial Infarction), are efficient and safe acquisition of arterial access is critical. TRA in patients is facilitated with the palm securely positioned, supinated and gently hyperextended at the wrist, and parallel to the floor.
Arterial access can be obtained via either single or double wall puncture techniques. Both the techniques are safe effective and are associated with low rates of RAO and other complications involved. However, the double wall technique is associated with a higher first pass success rate in patients. In addition, ultrasound imaging guidance may be beneficial particularly in patients with a weak pulse, hypotension, or cardiogenic shock or for ulnar access. The randomized RAUST trial (Radial Artery Access with Ultrasound Trial) has demonstrated and reduced the time and number of attempts to achieve arterial access with ultrasound guidance. In patients who are suffering with cardiogenic shock, ultrasound guidance and the administration of vasopressor therapy (eg, norepinephrine, 100-µg bolus) also those facilitate in TRA procedure.

Dedicated radial sheaths that feature a tapered dilator and hydrophilic coating engender less radial artery spasm and improve patient comfort in procedure. To reduce rates of RAO in patients, it is advisable to use the smallest-caliber sheath if possible. However, the “slender” approach (both sheath and catheter) to reduce rates of RAO and to facilitate hemostasis and recovery needs to be validated in larger trials. Finally, sheath length has not been demonstrated to affect patient comfort, radial artery spasm, radial artery obstruction, or procedural safety. Operators can consider securing the hydrophilic sheath in place with a transparent semipermeable dressing while performing the procedure.

4.5 Summary of Recommendations

- A radial-first approach is strongly recommended in all patients, but a graduated level of center and operator rich experience is recommended before TRA is pursued in patients with ACS in all laboratories.
- Noninvasive testing for collateral hand circulation (Allen or Barbeau test) does not predict adverse outcomes and it should not be used for access site triage.
- The choice between right radial artery versus left radial artery access is based on operator preference and experience.
- Ulnar artery access is an alternative among the experienced operators for patients with prohibitive right artery anatomy but it may be associated with a higher rate of discomfort or hematoma formation in patients.
- Ultrasound guidance facilitates in vascular access, particularly in the setting of a weak pulse, hypotension, cardiogenic shock, or trans ulnar access in patients.
- Low-profile hydrophilic sheaths should be used to reduce patient discomfort and to prevent right artery spasm in patients.

4.6 Pharmacology

Although the pharmacological management of patients with trans radial artery is similar to that in patients undergoing diagnostic coronary angiography or PCI, and pain management may also be even more important in this setting given the higher rate of active chest discomfort at rest during PCI procedure.

5. Result

A total no of 1997 consecutive patients were enrolled for the study in that for trans radial approach was used are 1076 patients (53.88%) and for trans femoral approach in 921 patients (46.12%) are used. Baseline characteristics of patients are summarized in Table 1, which were similar in both trans radial and trans femoral groups except for cardiomyopathy ($n = 7; 0.6\%$ versus $n = 38; 4.1\%: p = 0.05$), post-CABG ($n = 7; 0.6\%$ versus $n = 31; 3.3\%: p = 0.04$), and for valvular heart disease an awaiting replacement ($n = 4; 0.3\%$ versus $n = 23; 2.4\%: p = 0.02$) which were significantly higher in trans femoral than trans radial group. All trans radial procedure access in post-CABG group were performed through left radial approach.

Crossover from right radial artery access to trans femoral approach was occurred in 31 cases (2.8%) because of puncture failure in 15 patients (1.4%), hairpin loop in 3 patients (0.27%), vasospasm (0.65%) in 7 patients, and epiaortic failure in 6 patients (0.6%) while there were 3 (0.3%) crossovers in the trans femoral group ($p = 0.001$) (Figure 2). Comparing with the trans radial and trans femoral approaches, fluoroscopy time ($2.46 \pm 1.22$ versus $2.83 \pm 1.31$ min, $p = 0.32$), procedure duration is $8.89 \pm 2.72$ versus $9.33 \pm 2.82$ min, $p = 0.56$), radiation dose ($24.2\pm4.21$ versus $22.3\pm3.46$ Gycm$^2$, $p = 0.43$), contrast volume is ($67.52 \pm 22.54$ versus $71.63 \pm 25.41$ mL, $p = 0.32$), and post procedural serum creatinine ($1.3 \pm 0.2$ versus $1.4 \pm 0.15$ mg/dL, $p = 0.41$) were not significantly different between in both trans radial and trans femoral groups (Table 2).
28 patients (2.6%) has developed vasospasm who has responded to additional doses of nitroglycerin and diltiazem except in 7 patients who did not respond and went crossover to trans femoral route procedure. Radial artery occlusion (RAO) was observed in 56 patients (5.2%) in whom pulse was palpable in 29 patients (51%) on the next day. Local site pain (n = 21; 1.9% versus n = 38; 4.1%; p = 0.04), patients with local haematoma (n = 9; 0.83% versus n = 13; 1.4%; p = 0.001), and local site paraesthesia (n = 13; 1.2% versus n = 19; 2.1%; p = 0.03) were significantly higher in trans femoral when compared with the trans radial group.

6. Discussion

Trans radial approach for cardiac catheterization (TRC) is an appealing alternative technique to trans femoral access procedure for both diagnostic and therapeutic purposes though it requires a steep learning and vast experience curve initially. Because of its anatomy and inherent nature, technical challenges will always be there. In Trans radial access has been associated with a greater access crossover rate, which was reported to be 4%–7% in various studies. Louvard et al. reported the crossover rate from trans radial to trans femoral approach in 8.9% and 8.1% vice versa in their patient’s study. That might be because of octogenarian population, lesser number of patients enrolled in their study, and mixed population of both angiography and percutaneous interventions. Kim and Yoon in their study had crossover rate of 3.5% for trans radial catheterization. In our study, however the crossover rate in trans radial catheterization group was 2.8%, while there was 0.3% crossover in trans femoral group. This was because of proper selection of suitable radial cases, accurate puncture technique, gentle and delicate maneuver of catheter, and methods for dealing with tortuous epiaortic anatomy. Puncture failure is one of the first obstacle during the early learning period of trans radial catheterization because radial artery which is being small, and is prone to spasm. Wrist pain at puncture site is an important factor leading to radial spasm and puncture failure in this technique. As puncture is the gateway of radial access, it should be of near perfect. Also, improvements in devices technology and increase in expertise of operator have narrowed the gap of access site crossover from the earlier period of trans radial access.
in the modern era.

Louvard et al.\textsuperscript{62} reports states that, the fluoroscopy time was longer in trans radial group than trans femoral group (4.5 ± 3.7 versus 6.0 ± 4.4 min; \( p < 0.05 \)) for coronary angiography which sometimes has become more demanding and longer in elderly patients because of the frequent presence of specific vascular abnormalities, calcification, or arterial loops. Plourde et al.\textsuperscript{64} in their meta-analysis reported that trans radial access was associated with a small but there is significant increase in fluoroscopy time for diagnostic coronary angiography which narrows down over time; the clinical significance of this small increase is uncertain and but it’s unlikely to outweigh the clinical benefits of trans radial access procedure. Again, meta regression analysis showed that overall difference in fluoroscopy time between the radial and femoral procedures has decreased significantly by 75\% over past two decades from 2 min to nearly 30 s (\( p < 0.0001 \)) because of expertise in operators and improved hardware, an observation was similarly noted by Agostoni et al.\textsuperscript{65} and Brasselet et al.\textsuperscript{66}. Fluoroscopy time in our study too among both groups was not significantly much different.

The procedural duration from first puncture attempt to removal of last catheter was noted 9.87 minutes as reported by Chag and Gupta\textsuperscript{67}. Similar were the observations made by Brueck et al.\textsuperscript{68}. All of them noted that left radial procedure approach consumes lesser time than right radial approach even though, in our study, the majority were done by right radial approach with procedural time of 9.33 ± 2.82, which is not significantly different from trans femoral group. In our study, most of them were single wall puncture which is considered to be ideal and best; some of the procedures were done through puncture and retraction technique as well. But single successful puncture in first attempt thus cutting down the procedural time should might have made a difference as well.

Contrast volume during the procedure was not significantly different among radial and femoral groups though lesser volume in trans radial group as noted by Rao et al.\textsuperscript{69} and Kawashima et al.\textsuperscript{70}. The higher percentage of contrast volume post-CABG patients in the trans femoral in our study may partly account for the higher volume though but not significant contrast dose in the femoral group and the subsequently
significant higher in utilization of radiation dose during procedure is to visualize the graft bypass vessels in addition to native coronary arteries in procedures. Also this explanation can be applied to procedural times, which were longer in the femoral than the radial group; however, it did not reach a statistically significant difference. Post procedural serum creatinine did not show any significant rise among radial and femoral groups to show that risk of contrast induced nephropathy remains the same in both radial and femoral of the groups.

Radiations doses and the combination of DAP (dose area product) fluoroscopy and DAP fluorography were not that different among both groups though Brueck et al. had reported that higher radiation exposure in trans radial than trans femoral group. This was partly because of the larger number of post CABG cases in trans femoral group. We performed all trans radial procedures with single preshaped catheter (Tiger catheter) and thereby we cannot exclude that the use of this preshaped catheter one could contribute to a further reduction in radiation exposure thereby equating both the groups. Also the operator’s experience will play a major role in the success rate and procedure duration and therefore radiation exposure for both patients, operator and staff.

The incidence of RAO and vasospasm were similar as reported by Brueck et al. When patients with RAO were further examined, pulse was still palpable in 51% of patients after completion of procedure. Local complications like local site pain, haematoma, and local site paraesthesia which were significantly higher in trans femoral group as reported by Jolly et al.

The trans radial approach technique for cardiac catheterization is a common alternative procedure to trans femoral procedure both for diagnostic coronary angiography and percutaneous coronary interventions procedure. The radial approach is an appealing best technical strategy to reduce bleeding complications in patients with coronary artery disease who are undergoing the percutaneous invasive management procedure. A major effort in increasing the rate for invasive procedures performed through the trans radial approach is accepted worldwide and in the next years new results will show up supporting the radial approach.
The radial artery access has been associated with a greater access crossover rate, which were reported to be 4% to 7% in previous studies as showed\textsuperscript{77,78}. The crossover rate from the radial to femoral procedure approach has occurred in 24 patients (4.1%) in our study for the radial group, while there was no crossover was noted in the femoral group (P = 0.003). Louvard et al.\textsuperscript{78} reported that the crossover from the radial approach to the femoral approach procedure was 8.9% and from femoral to radial occurred in 8.1% of their patients’ study (P = NS). Roberts et al.\textsuperscript{79} reported the incidence of the crossover from radial to femoral access to be 1% in their study, which is an lower crossover rate. They attributed this level of success to the accurate selection of suitable radial cases and the use of specific techniques, careful guide catheter choice, methods for dealing with tortuous subclavian anatomy, and specific guide catheter manipulation techniques have also developed alongside increasing use of radial access, and reflect the practice of high volume experienced radial operators.

Fluoroscopy time in our study for both the radial and femoral approaches was not much significantly that different (3.43 ± 1.19 vs 3.86 ± 1.49 min respectively, P = 0.215). Louvard et al.\textsuperscript{80} reported fluoroscopy time was significantly shorter in the femoral group (3.1 ± 1.7 min) than in both radial groups (right: 3.8 ± 2.2 min; left: 4.2 ± 1.7 min), P < 0.01. Again Louvard et al.\textsuperscript{80} conducted another study to show and compare both the trans radial and trans femoral approaches for coronary angiography and angioplasty in octogenarians and they reported that the fluoroscopy time was shorter in the femoral group versus the radial group (4.5 ± 3.7 vs 6.0 ± 4.4 min; P < 0.05) for the coronary angiography. They commented that the radial approach is much more demanding and but it takes longer in elderly age patients because of the frequent presence of specific vascular abnormalities, such as calcification or arterial loops. Kawashima et al.\textsuperscript{81} reported that the fluoroscopy time in coronary angiography was shorter in the left radial procedure than in the right radial approach group (3.7 ± 2.5 vs. 5.0 ± 3.3 min; P < 0.001). Behan et al.\textsuperscript{82} reported the median fluoroscopy time was 4.4 vs 3.9min (P = 0.16), for the right radial approach procedure with the standard X-ray protection group versus standard protection plus the trans radial radiation protection board group, respectively.
Louvard et al. reported the procedural duration from the time of first puncture attempt to removal of last catheter after surgery was significantly longer with the left radial (14.2 ± 3.3 min) approach than the femoral approach procedure (11.2 ± 3.3 min); P < 0.001. While procedure duration was 12.4 ± 5.8 min in right radial access without any significant differences between the femoral artery and right radial approach. Again Louvard et al. reported in another study for octogenarians population that procedure duration was 15.9 ± 9.5 in the femoral group vs 18.5 ± 10.5 min in the radial group (right and left radial in a common pool); P < 0.05. Kawashima et al. reported the procedural duration in coronary angiography time noted from the initiation of local anesthesia to completion of the full procedure was shorter in the left radial than in the right radial approach group (11.4 ± 4.8 vs. 13.7 ± 6.4 min; P < 0.001). Sciahbasi et al. reported procedural noted time the time from local anesthesia to the end of the final procedure was not significantly different between the right and left arms, and left radial approach 13 min vs right radial approach 13 min; P = 0.56. Behan et al. reported Median total procedure duration total noted in-laboratory time was 35 vs 35 min; P = 0.14, for the right radial approach with the standard X-ray protection group versus standard protection plus the trans radial radiation protection board group, respectively. The overall procedure time between the patient entering and leaving the catheter laboratory in our study total in laboratory time rather than the time puncturing to skin time was not significantly different (31.87 ± 9.61 vs 33.24 ± 10.33 min respectively, P = 0.170) for both radial and femoral approaches procedures.

Total contrast utilized during the process of coronary angiography procedure was significantly lower in the radial approach than the femoral approach in our study (67.63 ± 25.49 vs 81.53 ± 24.80 mL respectively, P = 0.03). Louvard et al. reported that the volume of contrast was similar in both the radial and femoral approaches for coronary angiography. Kawashima et al. reported that the amount of contrast material in coronary angiography was not that differentiating between the left radial and right radial approach group (79 ± 27 vs. 83 ± 25 mL; P > 0.05). Sciahbasi et al. reported a trend toward a lower dose of contrast media being used during diagnostic
coronary procedures in the left radial approach procedure comparing with the right radial approach procedure (65 ± 32 and 68 ± 35 mL respectively, P = .098). Behan et al. \(^8^2\) reported the median total contrast load was 100 vs 100 mL; P = 0.9, for the radial approach procedure with the standard X-ray protection group versus standard protection plus the trans radial radiation protection board group, respectively.

Our results are from a high volume center experienced in the trans radial approach, and results might look different from laboratory with lower experience in this approach. As for the beginner in the trans radial approach, it may consume extra time to access the radial artery compared with the experienced ones, and the fluoroscopy time may be longer but, as for the femoral approach, after adequate training, this gap narrows.

The current study is justified by the importance of radiation exposure in interventional cardiology laboratories. This topic is getting more importance nowadays but there is still low awareness about it. It promotes unsafe practices by workers in the cath lab affecting both of them and to the patients.

There is low concern regarding protection and exposure to ionizing radiation in labs, it may explain the low amount of research about this topic. In Latin America there are scarce number of publications and studies in this valuable field explain about radiation exposure.

Recently the International Commission on Radiological Protection (ICRP) recommended that an reduction in the annual dose limit for occupational exposure for the lens of the eye from 150 to 20 mSv, averaged over a period of 5 years, with the dose in a single year not exceeding 50 mSv for all operators.

The personal dose equivalent Hp is now the internationally recommended for operational quantity in the field of radiation protection by individuals monitoring. It is the dose received by the tissue effective dose at an 10 mm depth from the skin surface and is considered to be the dose for the whole body. The dose limit for workers proposed by the ICRP was established as an annual effective dose. An effective dose limit of 20 mSv each year has been set for those persons who are employed in radiation work.
They attributed this level of success to the accurate selection of suitable radial cases and the use of specific techniques, careful guide catheter choice, methods for dealing with tortuous subclavian anatomy, and specific guide catheter manipulation techniques have also been developed alongside while increasing use of radial access, and reflect the practice of high volume experienced radial operators.

Interventional procedures from the different categories and routes of access where included in the study. Fluoroscopy time and radiation dose where measured in each procedure and specially there was an comparison between the radial access and femoral access. This is the first time that a study of this type is done in the hospital.

In interventional cardiology procedures, it is widely known and accepted that femoral access is related with a higher rate of complications such as: hematomas, arteriovenous fistulae, pseudoaneurysms and bleeding in the site of access. More over the femoral route procedure is also associated with a longer postoperative recovery, more immobility while deccanulation has been done and with longer transit of patients in the interventional cardiology department especially in ambulatory procedures. For the entire above mentioned, radial access is preferred over femoral route, unless there is a contraindication to be used.

In the group of interventional radiologists evaluated there has been no significant agreement about the radiation protection tools nor its mandatory use. One of them does not use eyewear protection due to un comfort. Two of the three professionals routinely perform the procedures through radial access and the other one prefers the femoral route.

This study showed that there is no significant difference on radiation dose or length of procedures among three interventional radiologists when comparing radial vs. femoral access. This could let to suggest routine using of radial access supported also by many other advantages of this route discussed above. Increasing adherence to radiation protection tools, especially eyewear protection is critical. Professionals working in the catheterization lab must standardize the routine use of a protective screen to diminish cranial radiation and they may be advised to use a leaded protective cap.
With an comparative analysis of data from invasive coronary procedures performed in patients with history of CABG in an center that favors the radial technique as its first vascular access option, it was established that the femoral approach remains the most used technique in this subgroup of patients for diagnostic catheterizations providing a venue for the radial technique with respect to percutaneous coronary interventions at the expense of a significant increase in fluoroscopy time and need for crossover. This analysis also showed that, in the contemporary practice of a reference service, the rate of vascular complications is low, regardless of the technique used.

In the randomized trial Radial versus Femoral Access for Coronary Artery Bypass Graft Angiography and Intervention (RADIAL-CABG), involving patients, the use of the radial access was associated with more consumption of contrast and higher numbers of catheters, procedure duration, surgeon’s exposure to radiation, and the need for crossover (17.2 vs. 0.0%; p < 0.01).

The high failure rate with the use of the radial technique could be justified due to its undertaking by the less experienced surgeons, and the other findings are consistent with those observed in the present study. The exception would be the larger number of catheters in the femoral group, justified by the additional use of the pigtail catheter in procedures conducted by this route. However, the higher proportion of 6F catheters in the radial group is explained by the choice of this route in 90.1% of all percutaneous coronary interventions in the sample.

Previous CABG surgery is a recognized variable predictive of radial technique failure, as are age and female gender. In fact, this represents a subgroup of patients requiring care in the selection of the access, given the propensity to radial spasm due to excessive handling and frequent exchange of catheters, the difficulty of selective cannulation of grafts and of obtaining an adequate support, the need to use the left radial artery owing to the prevalence of anastomoses involving the left internal mammary artery, and to surgeries with the use of double mammary or of an ipsilateral radial graft, which makes this process more challenging. Although feasible, as demonstrated in this registry, the cannulation of the left internal mammary artery through the contralateral radial access will encounter difficulties inherent to the
angulations and tortuosity often found; therefore, this option should be reserved for exceptional situations.

Thus, the radial technique in patients previously treated by CABG would not represent the first choice for interventional cardiologists in the beginning of the learning curve, but this option can be integrated gradually into their routine as experience is being gained, until high success rates with low complication rates are achieved. Compliance with aspects such as knowledge of the number and type of grafts, the use of the radial access ipsilateral to the internal mammary graft, and the appropriate selection of the catheter to obtain an adequate support are important steps to be achieved in this process. Currently, the identification of situations in which the reduction of vascular complications and the comfort afforded to the patient outweigh the increased fluoroscopy time, and hence the radiological exposure, as well as the higher failure rate, are subject to debate and require individualization of cases.

HOSPITAL EXPERIENCE Until a few years ago, most radial procedures at hospital experiences were performed on patients because of difficulties obtaining femoral access. Radial procedures were relegated to those patients who had severe peripheral arterial disease like occluded distal aorta or who were morbidly obese. With the newer generations of sheaths, the newer catheter shapes, and the renewed interest of the interventional community in the trans radial approach, it is increasingly being utilized as a routine strategy for patients undergoing coronary angiography and angioplasty. In our catheterization lab, the patient’s femoral artery is prepped and draped in standard fashion as a backup access site in case the trans radial approach fails. Hydrophilic sheaths and micro puncture kits are used universally for obtaining radial access. Once the sheath is in place, a 5-mg dose of verapamil is used as the agent of choice to reduce radial artery spasm. A lower dose of heparin (2500 U, not weight based) is used as a baseline antithrombotic, and then bivalirudin is used if ad hoc angioplasty is performed. In general, for smaller patients, a 5 Fr diagnostic catheter is used and then upsized to 6 Fr if intervention needs to be performed. The catheters used for diagnostic evaluation vary, but most cases begin with a multipurpose catheter such as a Jacky or Tiger catheter (Terumo Cardiovascular, Ann Arbor, MI), which can be used for both ventriculography and coronary angiography. Most of the time, a single catheter is needed for the entire procedure. If a coronary
intervention is necessary, standard guides are used. At this time, we are typically not using the trans radial approach for cases of acute myocardial infarction. However, this approach has been used in our lab in such cases when femoral access is not feasible. After the procedure, all equipment is removed, and a TR Band hemostatic device (Terumo Cardiovascular, Ann Arbor, MI) is placed over the arteriotomy and inflated. The sheath is then removed in the lab before the patient leaves. In our diagnostic-only cases, patients go directly to the floor. The nursing staff has a protocol for removal of the hemostatic band.

Patients who receive angioplasty or stents go to a recovery area for approximately an hour and then go to the floor, where the TR Band is removed per protocol. Since very little heparin is given for diagnostic cases, typically hemostasis is achieved with in less than 2 hours. Our interventional patients, most of them who receive bivalirudin, spend several hours after leaving the recovery area with the hemostatic band in place before it is removed by the nursing staff on the floor. The success rate for diagnostic angiography through the radial artery is well over 90%, and it is rare to need to switch to a femoral approach. To date, there have been no major access site complications related to any radial artery procedure at our institution.

7. Conclusion

The present study shows that transradial access for coronary angiography is safer among the patients when compared to transfemoral access with lower rate of local vascular complications. The trans radial approach procedure for coronary angiography is one of best option and an alternative option for trans femoral route and it’s also an excellent opportunity for operators to train for trans radial coronary interventions.

The higher significant contrast dose in the trans femoral group in our study may partly account for the higher percentages of post CABG patients in the trans femoral group and the subsequently there is significant higher utilization of contrast dose during procedure to visualize the graft bypass vessels in addition to the native coronary vessels. Also this explanation can be applied for the fluoroscopy and its procedure times, which were longer in the trans femoral procedure than the trans radial group; however, it did not reach the significant difference. But we should keep
in mind that we performed all trans radial procedures with the preshaped catheters, for
the trans femoral approach and we cannot exclude that the use of preshaped catheters
are dedicated for the trans radial approach and they contribute to a further reduction
in procedure duration and X-ray exposure time.

From all of the above data, we can conclude that trans radial coronary angiography procedure can be performed with the same safety for the patient and the professional staff members who are in cath lab as for the trans femoral approach. Moreover, improvements and technology in catheters and X-ray systems can be expected to shorten the procedural duration and fluoroscopy time further and decrease the amount of contrast material, procedural time and cost. The operator’s experience plays a major role in the success rate, procedure duration and patient safety. Our results are obtained in an experienced center in the trans radial approach, and conclusions might look different in catheter laboratory with lower experience in the same approach. And for the beginners in the radial approach, it will sometimes take more time to access the radial artery comparing with the experienced ones, and the fluoroscopy time can be longer because new operators struggle for cannulation of the coronary arteries. But, when compared with the femoral approach, after an adequate training, the trans radial approach for coronary angiography is no longer merely an alternative strategy when the femoral approach is impossible and can potentially result in an increased number of outpatient procedures. Coronary angiography procedure is furthermore, an excellent opportunity for operators to train for trans radial coronary intervention techniques.

The radial technique approach is a safer and effective option for invasive coronary procedures in patients with history who underwent coronary artery bypass graft surgery, especially with respect to percutaneous interventions procedure. When comparing to femoral access, the radial artery approach is associated with a significant increase in fluoroscopy time and some times in technical failure rates. This study clearly shows that patients who are undergoing invasive cardiac procedures, both diagnostic and therapeutic, are exposed to higher radiation levels through radial access. However, surgeons who have vast experience with this technique can counteract this disadvantage in relation to the femoral access.
The higher significant contrast dose in the femoral group in our study which may partly account for the higher percentage who underwent post CABG patients in the femoral group and the subsequent it’s significant that higher utilization of contrast dose during this procedure is to visualize the graft bypass vessels in addition to native coronary vessels. Also this explanation clearly can be applied to fluoroscopy and procedure times, which took longer in the femoral than the radial group; however it did not show an significant difference. But we should keep in our mind that we performed all trans radial procedures with the help of preshaped catheters for the transfemoral approach, and we cannot exclude that the use of preshaped catheters are dedicated for the trans radial approach\textsuperscript{88} which could contributes to a further reduction in procedure duration and X-ray exposure time.

From all of the above data, we can conclude that trans radial coronary angiography can be performed with the same safety for the patient and the professional staff members as for the trans femoral approach. Moreover, improvements in catheters and new X-ray systems can be expected to shorten the procedural duration and fluoroscopy time further and decrease the amount of contrast material used in procedures.\textsuperscript{87} The operator’s vast experience plays a major role in the success rate and procedure duration in both the procedures.\textsuperscript{89} Our results are obtained in an experienced center in the trans radial approach, and conclusions might look different in catheter laboratory with lower experience operators in this approach. As for the beginners in the radial approach, it will take sometimes to move forever to access the radial artery when compared with the experienced ones, and the fluoroscopy time can be longer because people struggle for cannulation of the coronary arteries in the radial procedure.\textsuperscript{90} But, as for the femoral approach procedure, and after adequate training, the trans radial approach for coronary angiography is no longer merely an alternative strategy when compared with the femoral approach is impossible\textsuperscript{90} and it can potentially result in an increased number of outpatient procedures. Coronary angiography procedure is furthermore, an excellent opportunity for operators to train for trans radial coronary interventions procedures.\textsuperscript{86}
8. Limitation

As I planned before starting my article to do very briefly and to elaborate more in detail regarding the Safety, feasibility and variable procedurals between Trans radial and Trans femoral Access in Coronary Angiography. But due to lack of time and also less availability of material and time period which is required for my thesis so I couldn’t discuss much more in detail. And I collected some information from old articles.

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