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Comparison of pain levels of traditional radial, distal radial, and transfemoral coronary catheterization

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SUMMARY

OBJECTIVE: The aim of our study was to compare the traditional radial artery, distal radial artery, and transfemoral artery, which are vascular access sites for coronary angiography, in terms of pain level using the visual analog scale.

METHODS: Between April 2021 and May 2022, consecutive patients from three centers were included in our study. A total of 540 patients, 180 from each of the traditional radial artery, distal radial artery , and transfemoral artery groups, were included. The visual analog scale was applied to the patients as soon as they were taken to bed.

RESULTS: When the visual analog scale was compared between the groups, it was found to be significantly different (transfemoral artery: 2.7±1.6, traditional radial artery: 3.9±1.9, and distal radial artery: 4.9±2.1, respectively, p<0.001). When the patients were classified as mild, moderate, and severe based on the visual analog scale score, a significant difference was found between the groups in terms of body mass index, process time, access time, and number of punctures (p<0.001). Based on the receiver operating characteristic analysis, body mass index>29.8 kg/m^2 predicted severe pain with 72.5% sensitivity and 73.2% specificity [(area under the curve: 0.770, 95%CI: 0.724–0.815, p<0.0001)].

CONCLUSION: In our study, we found that the femoral approach caused less access site pain and a high body mass index predicts severe pain.

KEYWORDS: Visual analog scale. Coronary angiography. Radial artery. Femoral artery.

INTRODUCTION

Due to the lack of patient comfort in transfemoral artery (TFA), the development of complications related to bleeding at the vascular access site, the need for long-term follow-up and bed rest, and alternative intervention methods have come to the fore[1]. The radial approach appears to be a safe method, and many randomized clinical trials have shown that the transradial approach is more advantageous than TFA, with excellent success rates and very low complication rates in elective and acute procedures[2-4]. In addition, it was stated that, because of traditional radial artery (TRA), the patients' discomforts such as long-term bed rest and vascular compression due to the procedure were reduced[5]. Most operators prefer the right TRA as they work on the right side of their patients. However, right TRA occlusion, underdeveloped right TRA, excessive curvature, sclerosis, calcifications, arteria lusoria, and use of right TRA as a free arterial graft in the past or future cause operators to prefer left TRA[6]. Left TRA catheterization has a similar anatomical course to transfemoral access and is suitable for patients after coronary artery bypass grafting requiring left internal mammary artery angiography. However, access to the left TRA can be somewhat difficult as the operator has to lean over the patient to place the sheath on the left TRA. This unpleasant position may make the catheterization procedure inconvenient. An alternative way to maintain a comfortable position for both patient and operator is to access the distal radial artery (DRA) located in the anatomical snuffbox or the "fossa radialis" on the dorsal side of the hand[6]. If any obstruction occurs in the anatomical snuffbox area, antegrade flow continues through the superficial palmar arch and collaterals, thus preventing tissue ischemia[7].

One of the main challenges during TRA is radial artery spasm (RAS), which can reduce the success rate of the procedure. The small diameter of the radial artery may complicate

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the procedure, and multiple cannulation attempts may increase the risk of RAS[8]. In addition, moderate-to-severe pain during radial artery cannulation may precipitate the incidence of RAS[9]. There are less data in the literature on pain in the vascular access area associated with the radial and femoral approach.

Therefore, our aim in this prospective and randomized study was to compare the vascular access sites of TRA, DRA, and TFA for coronary angiography in terms of pain level using the visual analog scale (VAS).

METHODS

Patients from three centers were included in our prospective and randomized study. Patients were selected consecutively between April 2021 and May 2022. The patients were divided into three groups, namely, DRA, TRA, and TFA. A total of 540 patients, 180 in each group, were included. Patients with acute ST-elevation myocardial infarction, cardiogenic shock, hemodynamic instability, use of catheters other than 6 French, patient rejection, and patients over 75 years of age were excluded from the study. As the use of VAS in elderly patients is not reliable enough, we did not include patients over 75 years of age. The procedures were performed by experienced interventional cardiologists at each center. The choice of approach is left to the discretion of the operator.

Written informed consent for inclusion in the study was obtained from all patients. The study approval was obtained by the local ethics committee (Diyarbakır Gazi Yaşargil Training and Research Hospital Ethics Committee, date and number: 30/12/2022-303). The study was conducted in accordance with the Declaration of Helsinki (2013).

Procedures

Transfemoral access

After local anesthesia with 15–20 mL of lidocaine, the right femoral artery was entered using the Seldinger technique with an 18 g needle. 6-F Judkins right and left catheters were used for diagnostic angiography. After angiography, the sheath was removed immediately in patients who did not undergo PCI and after 4–6 h in patients who did. After the sheath was removed, hemostasis was achieved with manual compression for 15–20 min. Afterward, a sandbag was placed instead of the sheath, and compression was applied for 4–6 h.

Traditional radial access

The arm was placed on a board at an angle of 60–70° relative to the body. The radial artery was punctured at an angle of 30–45°, 1 cm proximal to the radial styloid process. A 6-French radial hydrophilic sheath was placed on the patients. Afterward, 2,500 units of unfractionated heparin and 200 µg nitrate were administered through the sheath. After the procedure, the sheath was removed immediately and hemostasis was achieved using a transradial band.

Distal radial access

The deep palmar artery point between the first metacarpal bone and the second metacarpal bone was determined as the entry site. After local anesthesia with 2–3 mL of lidocaine was applied to the inlet, the needle was directed toward the point where the pulse was strongest. Afterward, a 6 French radial hydrophilic sheath was placed. All patients were given 2,500 units of unfractionated heparin (50 IU/kg) and 200 µg nitrate over the sheath. Subsequently, coronary angiography was performed.

Visual analog scale

The VAS is a vertical line between 0 and 10 cm, in which 0 represents no pain and 10 represents the most severe pain imaginable. Pain levels of all patients were evaluated with VAS. Each patient indicated the severity of pain by choosing a point on the line. This scale was applied as soon as the patients were taken to bed after the procedure. In addition, patients were classified as mild (0–3), moderate (4–7), and severe (8–10) based on the VAS score.

Statistical analysis

Analyses were performed using the SPSS 25.0 (Armonk, NY: IBM Corp.) statistical analysis software. Kolmogorov-Smirnov test was used to determine whether each variable showed a normal distribution. Normally distributed continuous variables were defined as mean±standard deviation. One-way analysis of variance (ANOVA) test was used to compare more than two groups for normally distributed continuous variables. Categorical variables were given as numbers and percentages and compared using the Pearson chi-square test. p-value<0.05 was considered significant. BMI cutoff value was estimated by receiver operating characteristic (ROC) curve analysis to predict severe pain (>7 points on VAS) with corresponding sensitivity and specificity.

RESULTS

While 434 of the patients presented with stable angina pectoris, 106 patients presented with myocardial infarction without ST elevation. A total of 172 patients underwent percutaneous coronary intervention (PCI). The main clinical

features are summarized in Table 1. Age distribution between the groups was found to be significantly different (TFA: 64.2±11.0, TRA:58.4±9.8, and DRA: 58.6±11.0, respectively, p<0.001). Especially the radial group was younger than the transfemoral group.

VAS between the groups was found to be significantly different when compared (TFA: 2.7±1.6, TRA: 3.9±1.9, and DRA: 4.9±2.1, respectively, p<0.001) (Figure 1). The procedure time did not differ between groups (TFA: 39.3±11.5, TRA: 41.4±12.0, and DRA: 40.7±12.4, respectively, p=0.249). The duration of access was found to be the shortest TFA and the longest DRA, and it was significantly different between the groups (TFA: 38.1±7.0, TRA: 41.8±12.6, and DRA: 53.0±16.4, respectively, p<0.001). The number of punctures was significantly different between the groups (TFA: 1.4±0.5, TRA: 1.6±0.6, and DRA: 1.7±0.7, respectively, p<0.001). There was no difference between the groups in terms of PCI (TFA: 57 (31.7%), TRA: 63 (35%), and DRA: 52 (28.9%), respectively, p=0.460). Only one patient in the TRA group developed mortality.

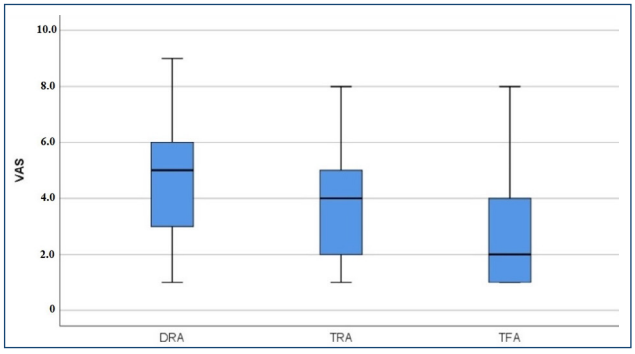

Figure 1. Box plots of visual analog scale scores of access groups.

Table 1. Baseline characteristics of the study population and comparison of pain groups.

Baseline characteristics	TFA (n=180)	TRA (n=180)	DRA (n=180)	p-value
Gender (female), n (%)	65 (36.1)	59 (32.8)	53 (29.4)	0.403
Age (years)	64.2±11.0	58.4±9.8	58.6±11.0	**<0.001**
Body mass index (kg/m²)	28.2±3.9	28.2±4.0	27.7±4.1	0.414
HT, n (%)	62 (34.4)	58 (32.2)	65 (36.1)	0.738
DM, n (%)	55 (30.6)	64 (35.6)	55 (30.6)	0.503
HPL, n (%)	7 (3.9)	10 (5.6)	10 (5.6)	0.704
CRF, n (%)	45 (25)	49 (27.2)	55 (30.6)	0.494
Smoker, n (%)	8 (4.4)	9 (5)	8 (4.4)	0.959
EF (%)	48.2±10.7	49.1±10.8	48.9±10.8	0.708
VAS	2.7±1.6	3.9±1.9	4.9±2.1	**<0.001**
Processing time (min)	39.3±11.5	41.4±12.0	40.7±12.4	0.249
Access time (s)	38.1±7.0	41.8±12.6	53.0±16.4	**<0.001**
Number of punctures	1.4±0.5	1.6±0.6	1.7±0.7	**<0.001**
PCI, n (%)	57 (31.7)	63 (35)	52 (28.9)	0.460
Mortality, n (%)	0 (0)	1 (0.6)	0 (0)	0.367
Comparison of pain groups	**Mild pain (n=264)**	**Moderate pain (n=236)**	**Severe pain (n=40)**	**p-value**
Body mass index (kg/m²)	28.1±4.0	27.6±4.1	30.8±1.8	**<0.001**
Processing time (min)	36.3±7.3	42.5±12.6	56.2±16.5	**<0.001**
Access time (s)	40.8±9.5	44.6±13.1	65.8±23.3	**<0.001**
Number of punctures	1.4±0.5	1.6±0.6	2.5±0.8	**<0.001**
Access zone, n(%)	TFA: 130 (49.2)	TFA: 47 (19.9)	TFA: 3 (7.5)	**<0.001**
	TRA: 78 (29.6)	TRA: 97 (41.1)	TRA: 5 (12.5)	
	DRA: 56 (21.2)	DRA: 92 (39.0)	DRA: 32 (80)	

TFA: transfemoral access; TRA: traditional radial access; DRA: distal radial access; HT: hypertension; DM: diabetes mellitus; HPL, hyperlipidemia; CRF: chronic renal failure; EF: ejection fraction; VAS: Vascular Analog Scale; PCI: percutaneous coronary ıntervention. Bold indicates statistically significant values.

In addition, when the patients were classified as mild, moderate, and severe according to the VAS score, a significant difference was found between the groups in terms of body mass index, processing time, access time, and number of punctures (p<0.001) (Table 1). Severe pain was detected in 40 patients and was more especially in the DRA (n:32, 80%) group. Based on the ROC analysis, BMI>29.8 kg/m^2 predicted severe pain with 72.5% sensitivity and 73.2% specificity [(area under the curve (AUC): 0.770, 95%CI: 0.724–0.815, p<0.001)] (Figure 2).

DISCUSSION

Coronary interventional procedures are performed by the radial and femoral routes. There are two different approaches to radial access, namely, TRA and DRA. Many studies have been done comparing these access routes[2-4,10]. However, there are limited data in the literature comparing these three entry points according to pain levels. To the best of our knowledge, our study is the first to compare the pain levels of all three access routes according to the VAS. In our study, pain levels were determined by VAS as soon as the patients were taken to bed immediately after the procedure. Pain levels were the lowest in the TFA group and the highest in the DRA group. Long process and access time, high BMI, and high number of punctures were found to increase the severity of pain.

Many studies have shown that transradial access can address many of the deficiencies in femoral access. Transradial access has a lower complication rate. In addition, mortality and major adverse cardiac events are less in STEMI patients[11]. The radial artery is more superficial than the femoral artery and can be compressed more easily. The DRA and the deep palmar branch of the ulnar artery form a deep palmar arch with abundant collateral circulation. Therefore, the incidence of Ischemia in the hand after radial artery puncture is low[12]. However, the standard radial artery approach also has a disadvantage, such as radial artery occlusion (RAO). DRA, on the other hand, increases the comfort of the procedure by providing a more comfortable position to the operator during the procedure. In addition, this technique has a shorter hemostasis time and less RAO rate.

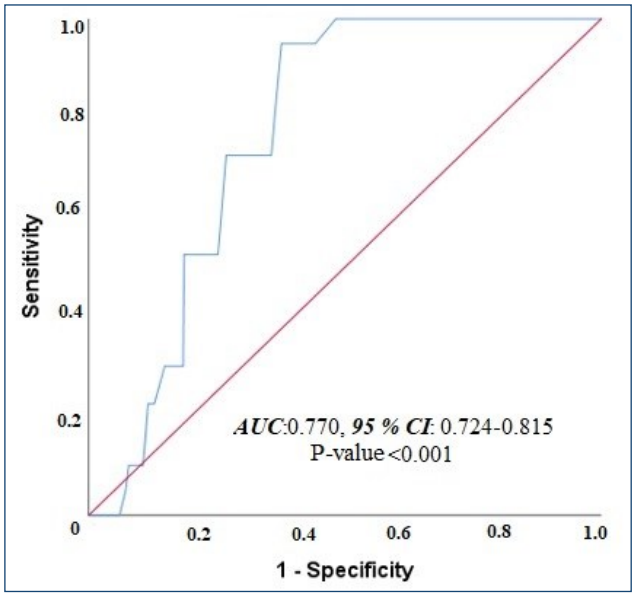

Figure 2. Receiver operating characteristic curve analysis of body mass index to predict severe pain.

In our study, the highest level of pain was in the DRA access route. It was followed by TRA and TFA, respectively. The anatomical snuffbox, in which the DRA is located, is between two tendons, namely, extensor pollicis longus and extensor pollicis brevis. This region contains the radial artery, the radial nerve (superficial branches), and the cephalic vein. Injury to the superficial branch of the radial nerve can cause pain and paresthesia in this area[13]. Robson et al. found a close relationship between the radial nerve and the radial artery[14]. In addition, more punctures in the DRA group in our study may explain the high VAS score. With increasing experience, the number and duration of punctures will be improved. A randomized trial comparing TRA and DRA showed a high rate of cannulation failure of 30% in the DRA group versus only 2% in the TRA group (p<0.001)[15]. The authors cited the reasons for this low success rate as the smaller diameter of the radial artery in the anatomical snuffbox with an increased risk of vasospasm, increased curvature that causes the wire to fail to advance at this level, and a longer learning curve. Lee et al. showed in a large prospective study that the learning curve for the puncture time stabilized after about 150 cases[16]. Aktürk et al. compared the pain level between TRA and TFA[17]. Consistent with our study, they found lower pain levels in the TFA group. The low VAS scale in the TFA group can be attributed to reasons such as wider vessel diameter, less number of punctures, and shorter access time.

According to the VAS scale, the pain felt by the patients was classified as mild, moderate, and severe. BMI, access time, process time, and number of punctures were found to be higher in patients in the severe pain class. A BMI>29.8 kg/m^2 predicted severe pain. In patients with high BMI, the need for more local anesthetic drugs, the difficulty of reaching the artery due to the increase in adipose tissue, the increase in the number of punctures, and the prolongation of the procedure may explain the severe pain in this patient group. Aktürk et al., consistent

with our study, found that BMI>37 kg/m^2 was associated with the severity of pain in patients who underwent femoral angiography[17]. They attributed this to hematomas and soft tissue hemorrhages in the procedure area.

LIMITATIONS

Although this trial included three centers, it was a regional study and the number of patients was relatively low. Patients with high post-procedure VAS scores were not routinely evaluated by ultrasound examination. The diagnosis of RAS was made according to subjective criteria. Although these procedures are performed in experienced centers, we cannot completely exclude the impact of operator experience on results.

CONCLUSION

We found that although the radial artery has many advantages over the femoral artery in coronary angiography, it is associated with higher pain severity. In addition, a high BMI is also a factor that increases the severity of pain. Although radial artery interventions (DRA and TRA) seem advantageous and popular, femoral intervention should not be ignored in suitable patients.

AUTHORS' CONTRIBUTIONS

RK: Conceptualization, Formal Analysis, Investigation, Methodology, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. **TG:** Data curation. **AA:** Validation. **BA:** Software. **MA:** Investigation. **SG:** Investigation. **MZK:** Project administration.

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