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# Radial Artery Occlusion Following Right Distal Transradial and Conventional Transradial Coronary Procedures: Incidence, Complications, and Predictors

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**Abstract** **Original Research Article**

***Background:*** The transradial approach is gaining popularity for reduced access-site complications, but radial artery occlusion (RAO) remains a concern. The distal transradial approach (dTRA) may preserve patency better than conventional (cTRA). This study aim was to compare RAO rates and procedural outcomes between dTRA and cTRA. ***Methods:*** This prospective observational study was conducted at NICVD, Dhaka, from March 2018 to February 2019. A total of 200 patients undergoing coronary angiography and/or percutaneous coronary intervention were divided into two equal groups: Group I (dTRA, n=100) and Group II (cTRA, n=100). Procedural variables, complications, and RAO were assessed. RAO was confirmed by duplex Doppler ultrasonography on the first post-procedural day. Multivariate logistic regression was performed to identify independent predictors of RAO. ***Results:*** Puncture time was significantly longer in dTRA (1.91±0.15 vs. 1.79±0.11 min, p=0.001), while hemostasis time was significantly shorter for both CAG (7.5±2.9 vs. 10.0±3.5 min, p=0.03) and PCI (19.0±5.6 vs. 23.0±7.2 min, p=0.03). RAO occurred significantly less in dTRA compared to cTRA (1.0% vs. 5.0%, p=0.04). Independent predictors of RAO included prolonged hemostatic compression time (OR: 8.48 for >4 hours in PCI), procedure time (OR: 1.44), access site complications (OR: 4.89), and cTRA (OR: 5.21, p=0.04). ***Conclusion:*** The distal transradial approach is a safe and feasible alternative to the conventional approach, offering significantly lower RAO rates, shorter hemostasis time, and fewer complications despite a slightly longer puncture time. It should be preferred when radial artery preservation is a priority.

**Keywords:** Radial artery occlusion, distal transradial approach, conventional transradial approach, coronary angiography, percutaneous coronary intervention.



## INTRODUCTION

Cardiovascular diseases are the leading cause of death globally, accounting for an estimated 17.7 million deaths in 2015, representing 31% of all global deaths. Over three quarters of these deaths occur in low- and middle-income countries [1]. In Bangladesh, the exact prevalence of coronary artery disease (CAD) is not well established. Early data from 1976 reported a prevalence of 0.33%, while more recent studies indicate CAD prevalence between 1.85% and 3.4% in rural populations and up to 19.6% in urban working professionals [2]. The incidence of ischemic heart disease is rapidly increasing in Bangladesh with socioeconomic improvement and urbanization [3]. Coronary angiogram (CAG) remains the gold standard for diagnosing CAD and establishing treatment strategies [4].

CAG can be performed via femoral, radial, brachial, ulnar or axillary arteries. Although transfemoral approach (TFA) remains the most common access site, it is associated with significant vascular complications such as bleeding, hematoma, arteriovenous fistula and pseudoaneurysm [5]. These access-site complications are correlated with increased morbidity and mortality [6]. The transradial approach (TRA) was first introduced for CAG by Lucian Campeau in 1989 and for PCI by Ferdinand Kiemeneij in 1992 [7,8]. Worldwide, approximately 22% of coronary procedures are performed via TRA, with rates as high as 32% in India [9]. The radial artery is preferred due to its easy compressibility, distance from major neurovascular structures, and dual blood supply through the palmar arch. TRA offers improved patient comfort, early ambulation, shorter hospitalization, reduced costs, and improved clinical outcomes including survival [10,11]. The STEMI-RADIAL trial demonstrated an 80% reduction in puncture site complications with radial access in STEMI patients [12], leading ESC Guidelines to prioritize TRA over TFA [4,13].

Despite these advantages, TRA has limitations. It requires a longer learning curve and is technically more challenging than TFA [14]. Vascular complications specific to TRA include radial artery spasm, compartment syndrome, and radial artery occlusion (RAO), along with bleeding, hematoma, perforation, dissection, arteriovenous fistula, pseudoaneurysm, and other rare complications [9]. Anatomical variations may further increase complication rates [15,16].

The objective of this study was to compare the incidence of radial artery occlusion (RAO) following coronary procedures performed via the right distal transradial approach (dTRA) versus the conventional transradial approach (cTRA), and to identify the predictors and complications associated with RAO.

## METHODOLOGY & MATERIALS

This prospective observational study was conducted in the Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh, from March 2018 to February 2019. Patients undergoing coronary angiography (CAG) and/or percutaneous coronary intervention (PCI) through the transradial approach during the study period were enrolled using purposive sampling. A total of 200 patients were included because of time constraints and were divided into two equal groups according to the vascular access site: Group I (n = 100) underwent the procedure through the right distal (anatomical snuffbox) transradial approach, while Group II (n = 100) underwent the conventional (forearm) transradial approach. Each group comprised 50 patients undergoing CAG and 50 patients undergoing PCI.

Patients with a palpable radial pulse who underwent transradial coronary procedures were included in the study. Patients with acute heart failure, congestive cardiac failure, cardiogenic shock, chronic kidney disease with an existing or planned arteriovenous fistula, deformities of the hand or forearm, peripheral vascular disease, or those unwilling to participate were excluded.

Written informed consent was obtained from all participants before enrollment, and the study protocol was approved by the Ethical Review Committee of NICVD. Baseline demographic and clinical characteristics, procedural details, and access-site variables were recorded using a predesigned data collection form. Radial artery patency was assessed clinically after the procedure and subsequently evaluated by duplex Doppler ultrasonography on the first post-procedural day. Radial artery occlusion was defined as the absence of antegrade flow or the presence of monophasic or reversed flow on Doppler examination. Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Appropriate statistical tests, including the unpaired Student's t-test, Chi-square test, Fisher's exact test, and multivariate logistic regression analysis, were performed. A p-value $<0.05$ was considered statistically significant.

## RESULTS

This prospective observational study was performed in the Department of Cardiology, National Institute of Cardiovascular Diseases, Sher-E-Bangla Nagar, Dhaka. The specified time period was from March 2018 to April 2019. Patients undergoing coronary intervention through transradial route, during index hospitalization were considered in this study. Study subjects were categorized into two groups on the basis of route of access during CAG/PCI. Group I (Distal Transradial route) and Group II (Conventional Transradial route). The main objective of the study was to assess the post procedural radial artery occlusion in patients undergoing coronary intervention through two different access site. Total 200 patients were included in the study, who were divided into two groups, each containing 100 patients. Equal number of CAG and PCI cases were taken in each group (50 cases of CAG and 50 cases of PCI). Distribution of exposures in terms of different statistics was shown in tabulated form and statistical analysis was done in both groups to see the statistical significance. P value less than 0.05 was considered as significant. Overall data entry and analysis were performed using SPSS software version 25. The findings are documented below.

In Table I minimum age of the respondent was 23 years and maximum 78 years. Age of all the patients were categorized into four classes. Major proportion (34%) were in 51-60 years age group; whereas few portions (12.5%) had age less than or equal 40 years. The mean age of the total population was 52.9±9.6 years. The patients of group I and group II were almost equal (52.8±9.7 vs. 53.1±9.6 years). Analysis revealed statistically no significant (p=0.80) mean age difference between the study groups.

**Table I: Age distribution of the study population (n=200)**

| Age group (years) | Group I (dTRA) (n=100) | | Group II (cTRA) (n=100) | | p- value |
|---|---|---|---|---|---|
| | Number | % | Number | % | |
| ≤40 | 14 | 14 | 11 | 11 | |
| 41 – 50 | 27 | 27 | 35 | 35 | |
| 51 – 60 | 34 | 34 | 34 | 34 | |
| > 60 | 25 | 25 | 20 | 20 | |
| Mean± SD | 52.8±.9.7 | | 53.1±9.6 | | 0.80 |

NS= Not significant (p>0.05), Unpaired t- test done to measure the level of significance.
dTRA = Distal Transradial Approach; cTRA = Conventional Transradial Approach.

Table II depicts the sex distribution of the study population. Among the 200 patients, male predominance was observed, with 176 patients (88.0%) being male and 24 patients (12.0%) being female. In Group I (distal transradial approach), 89 patients (89.0%) were male and 11 (11.0%) were female, while in Group II (conventional transradial approach), 87 patients (87.0%) were male and 13 (13.0%) were female. Statistical analysis revealed no significant difference in sex distribution between the two groups (p=0.66).

**Table II: Sex Distribution of the Study Population (n=200)**

| Sex | Group I (dTRA) (n=100) | Group II (cTRA) (n=100) | p-value |
|---|---|---|---|
| | n (%) | n (%) | |
| Male | 89 (89.0%) | 87 (87.0%) | 0.66 |
| Female | 11 (11.0%) | 13 (13.0%) | |

NS = Not significant (p > 0.05); Chi-square test applied for categorical variables.
dTRA = Distal Transradial Approach; cTRA = Conventional Transradial Approach.

The presence of some established risk factors were assessed by asking close ended questions and observing previous medical records. Patients with history of mentioned risk factors were insignificantly higher in group I compared to group II with p value >0.05 respectively. The above table also indicates that the mean BMI was almost identical in group I and group II (23.1±2.1 vs. 23.5±1.9 kg/m$^2$) statistically insignificant difference (p=0.98). The mean BMI of total patient was 26.5±1.5 kg/m$^2$) (Table III).

**Table III: Distribution of common Risk Factors of the Study Population (n=200)**

| Risk Factors | Group I (n=100) | | Group II (n=100) | | p- value |
|---|---|---|---|---|---|
| | Number | % | Number | % | |
| Smoking | 58 | 58 | 58 | 58 | 1.00 |
| Hypertension | 51 | 51 | 50 | 50 | 0.88 |
| Diabetes mellitus | 46 | 46 | 41 | 41 | 0.47 |
| Dyslipidemia | 40 | 40 | 34 | 34 | 0.38 |
| Family history of CAD | 13 | 13 | 10 | 10 | 0.51 |
| BMI (Mean± SD) | 23.1±2.1 | | 23.5±1.9 | | 0.98 |

NS= Not significant (p>0.05)
Chi-square test was done to measure the level of significant
Group- I: Distal radial artery approach for CAG/PCI
Group-II Conventional radial artery approach for CAG/PCI

Table IV compares procedural variables between the distal transradial approach (Group I) and conventional transradial approach (Group II). The mean puncture time for coronary angiography was significantly longer in Group I compared to Group II (1.91±0.15 vs. 1.79±0.11 minutes, p=0.001). Time to hemostasis was significantly shorter in Group I for both CAG (7.5±2.9 vs. 10.0±3.5 minutes, p=0.03) and PCI (19.0±5.6 vs. 23.0±7.2 minutes, p=0.03). However, no statistically significant differences were observed between the two groups regarding procedure time for CAG (8.79±0.73 vs. 8.69±0.58 minutes, p=0.44) or PCI (33.56±4.35 vs. 32.28±6.17 minutes, p=0.23), fluoroscopy time for CAG (4.64±0.56 vs. 4.60±0.51 minutes, p=0.73) or PCI (13.35±1.92 vs. 12.87±2.58 minutes, p=0.29), or heparin dosage for CAG (5000 vs. 5000 IU, p=0.18) and PCI (15,020±318.79 vs. 15,037±418.20 IU, p=0.18).

**Table IV: Comparison of Procedural Variables Between Study Groups**

| Variables | Group I (dTRA) (n=50) | Group II (cTRA) (n=50) | p-value |
|---|---|---|---|

| | Mean ± SD | Mean ± SD | |
|---|---|---|---|
| **Puncture Time (min)** | | | |
| CAG | 1.91 ± 0.15 | 1.79 ± 0.11 | 0.001* |
| **Procedure Time (min)** | | | |
| CAG | 8.79 ± 0.73 | 8.69 ± 0.58 | 0.44 |
| PCI | 33.56 ± 4.35 | 32.28 ± 6.17 | 0.23 |
| **Fluoroscopy Time (min)** | | | |
| CAG | 4.64 ± 0.56 | 4.60 ± 0.51 | 0.73 |
| PCI | 13.35 ± 1.92 | 12.87 ± 2.58 | 0.29 |
| **Time to Hemostasis (min)** | | | |
| CAG | 7.5 ± 2.9 | 10.0 ± 3.5 | 0.03* |
| PCI | 19.0 ± 5.6 | 23.0 ± 7.2 | 0.03* |
| **Heparin Dose (IU)** | | | |
| CAG | 5000 | 5000 | 0.18 |
| PCI | 15,020 ± 318.79 | 15,037 ± 418.20 | 0.18 |

*Significant ($p<0.05$)
Unpaired t-test for quantitative variables were applied to measure the level of significance.
dTRA = Distal Transradial Approach; cTRA = Conventional Transradial Approach.

Table V compares procedure-related complications between the distal transradial approach (Group I) and conventional transradial approach (Group II). The only statistically significant difference observed was in the occurrence of hematoma following PCI, which was significantly higher in Group II compared to Group I (10.0% vs. 2.0%, p=0.04). Most hematomas resolved with consecutive blood pressure cuff inflation for 15-minute intervals repeated three to five times, with occasional reapplication of pressure bandage required. Although radial artery spasm during PCI appeared more frequent in Group II (8.0% vs. 2.0%), this difference did not reach statistical significance (p=0.05). Similarly, ecchymosis rates were higher in Group II for both CAG (6.0% vs. 2.0%, p=0.07) and PCI (8.0% vs. 4.0%, p=0.09), but these differences were not statistically significant. No cases of arteriovenous fistula were observed in either group. Post-procedurally, mild pain attributable to compressive pressure bandaging or venous congestion was reported by a few patients but remained tolerable, with no signs of critical hand ischemia documented. Clinical examination revealed absence of radial pulse in five patients—four from Group II and one from Group I. However, duplex ultrasonography performed 24 hours post-procedure detected one additional case of occlusion in a patient with a palpable radial pulse, confirming a total of six occlusions, and highlighting the superior sensitivity of Doppler evaluation over clinical palpation alone.

**Table V: Procedure-Related Complications Among the Study Population (n=200)**

| Variables | Group I (dTRA) (n=100) | Group II (cTRA) (n=100) | p-value |
|---|---|---|---|
| **Hematoma** | **n (%)** | **n (%)** | |
| CAG (n=50) | 0 (0.0%) | 2 (4.0%) | 0.15 |
| PCI (n=50) | 1 (2.0%) | 5 (10.0%) | 0.04* |
| **Radial Artery Spasm** | | | |
| CAG (n=50) | 2 (4.0%) | 1 (2.0%) | 0.55 |
| PCI (n=50) | 1 (2.0%) | 4 (8.0%) | 0.05 |
| **Ecchymosis** | | | |
| CAG (n=50) | 1 (2.0%) | 3 (6.0%) | 0.07 |
| PCI (n=50) | 2 (4.0%) | 4 (8.0%) | 0.09 |
| **AV Fistula** | | | |
| CAG (n=50) | 0 (0.0%) | 0 (0.0%) | NA |
| PCI (n=50) | 0 (0.0%) | 0 (0.0%) | NA |

dTRA = Distal Transradial Approach; cTRA = Conventional Transradial Approach; CAG = Coronary Angiography; PCI = Percutaneous Coronary Intervention; AV = Arteriovenous; NA = Not Applicable.
Statistically significant ($p < 0.05$). Fisher's exact test applied for categorical variables.

Table VI demonstrates the distribution of radial artery occlusion among the study population. The overall incidence of RAO was significantly higher in the conventional transradial approach group compared to the distal transradial approach group (5.0% vs. 1.0%, p=0.04). This finding indicates that patients undergoing coronary procedures via the conventional transradial approach had a five-fold higher risk of developing radial artery occlusion compared to those undergoing the distal transradial approach, and this difference was statistically significant. The distal transradial approach was associated with a markedly lower RAO rate of just 1.0%, suggesting a protective effect against this complication.

**Table VI: Distribution of Radial Artery Occlusion Among the Study Population (n=200)**

| RAO Status | Group I (dTRA) (n=100) | Group II (cTRA) (n=100) | p-value |
|---|---|---|---|
| | n (%) | n (%) | |
| Present | 1 (1.0%) | 5 (5.0%) | 0.04* |
| Absent | 99 (99.0%) | 95 (95.0%) | |

dTRA = Distal Transradial Approach; cTRA = Conventional Transradial Approach; RAO = Radial Artery Occlusion. Statistically significant ($p < 0.05$). Fisher's exact test applied for categorical variables.

Figure 1 illustrates the comparison of procedure-related complications between Group I and Group II within the study population. In Group I, the incidences of complications were relatively low, with hematoma and radial artery occlusion (RAO) occurring in 1 patient each, while spasm and ecchymoses were observed in 3 patients each. Conversely, Group II demonstrated a notably higher frequency of complications, where hematoma and RAO were the most prevalent issues, affecting 7 patients each, followed by spasm and ecchymoses, which occurred in 5 patients each.

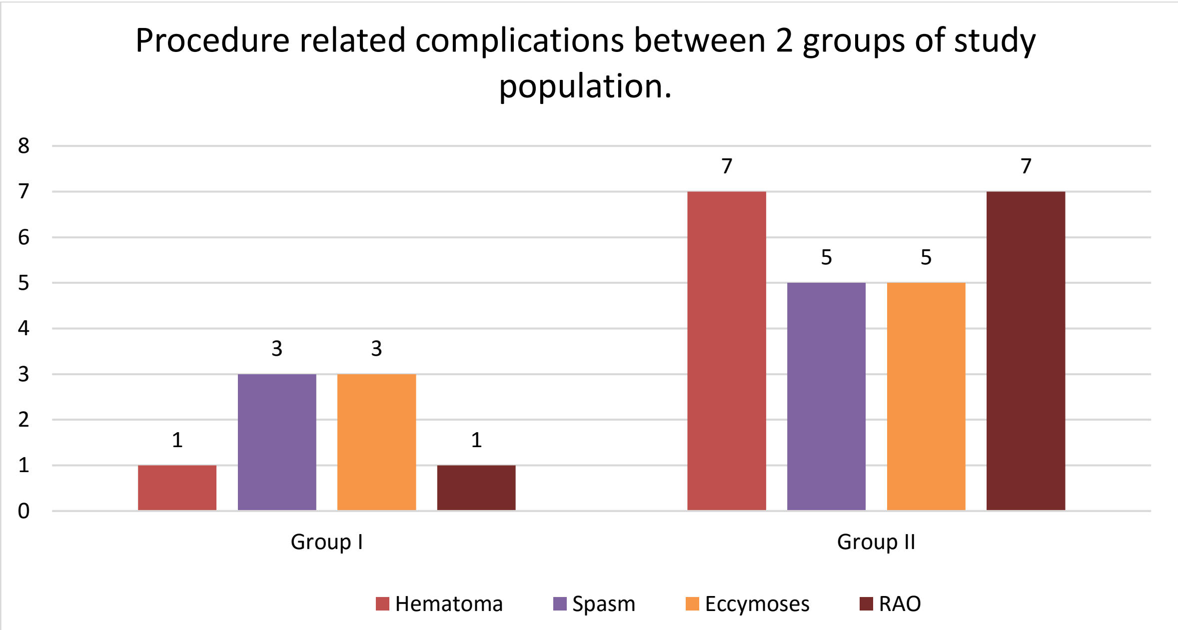


**Figure 1: Bar chart showing procedure related complications between 2 groups of study population**

Table VII presents the multivariate logistic regression analysis identifying independent predictors of radial artery occlusion. The following variables were entered into the regression model as independent predictors: age >60 years, male gender, hypertension, diabetes mellitus, body mass index, hemostatic compression time, procedure time, access site complications, and conventional transradial approach (cTRA). Among these, five variables emerged as significant independent predictors of RAO. Duration of hemostatic compression time >2 hours for CAG was associated with a 2.19-fold increased risk of RAO (OR: 2.19, 95% CI: 1.387–12.447, p=0.03), while compression time >4 hours for PCI showed an even stronger association with an 8.48-fold increased risk (OR: 8.48, 95% CI: 1.497–48.098, p=0.01). Procedure time was also identified as a significant predictor, with each unit increase conferring a 1.44-fold higher risk of RAO (OR: 1.44, 95% CI: 1.041–7.061, p=0.02). The presence of access site complications was associated with a 4.89-fold increased risk of RAO (OR: 4.89, 95% CI: 1.267–22.017, p=0.01). Most notably, the conventional transradial approach was found to be independently associated with a 5.21-fold higher risk of developing RAO compared to the distal transradial approach (OR: 5.21, 95% CI: 1.398–45.426, p=0.04), confirming that cTRA is a strong independent predictor of radial artery occlusion.

**Table VII: Multivariate Logistic Regression Analysis of Variables Associated with Radial Artery Occlusion (n=200)**

| Variables of Interest | Odds Ratio (OR) | 95% Confidence Interval | p-value |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Hemostatic compression time >2 hrs (CAG) | 2.19 | 1.387 – 12.447 | 0.03* |
| Hemostatic compression time >4 hrs (PCI) | 8.48 | 1.497 – 48.098 | 0.01* |
| Procedure time | 1.44 | 1.041 – 7.061 | 0.02* |
| Access site complication | 4.89 | 1.267 – 22.017 | 0.01* |
| cTRA (vs. dTRA) | 5.21 | 1.398 – 45.426 | 0.04* |

CAG = Coronary Angiography; PCI = Percutaneous Coronary Intervention; cTRA = Conventional Transradial Approach; dTRA = Distal Transradial Approach; CI = Confidence Interval.
Statistically significant ($p < 0.05$). Multivariate logistic regression analysis with RAO as the dependent variable.

## DISCUSSION

This prospective observational study was conducted to identify the difference between post-procedural occlusive complication of coronary angiography and Intervention done through Right distal radial (anatomical snuffbox) artery approach and conventional forearm radial artery approach. In total 200 patients, half of them (100) underwent CAG/PCI through dTRA approach and another half (100) underwent CAGI/PCI through cTRA approach. This study showed marked differences in between two study groups in terms of procedural outcomes.

Distal radial artery access in the anatomical snuffbox has been described for first time by Dr. Babunashvili, in order to open occluded ipsilateral radial arteries in a retrograde fashion [16]. Failure of puncture of the radial artery, spasmodic or anatomical barriers such as radial arterial loop, and failure of coronary artery engagement are the most common causes of procedural failure via transradial approach. In a study conducted by Dehghani, et al., the causes of procedural failure via transradial approach were radial arterial spasm, subclavian tortuosity, inadequate catheter support, failure of radial artery canulation, radial arterial dissection and radial arterial loop [15].

In this study, the incidence of the primary outcome, RAO on the next day after the procedure as defined by duplex ultrasound, was significantly lower in dTRA group patients (1% vs. 5%, P=0.04, respectively). The over-all incidence of RAO was 3%. Ten clinical and procedural variables were entered into a multivariate analysis to find independent predictors of RAO. Multivariate analysis identified several independent predictors of RAO, among which prolonged hemostasis defined as >2 hours for CAG and >4 hours for PCI was the strongest predictor.

Patients with Vascular Doppler documented RAO can still have palpable radial pulse. In our study, vascular Doppler examination of the radial artery was done both in patients with palpable and non-palpable radial artery one day after transradial coronary procedures. We found palpable radial artery in 2 patients with RAO (33 % of patients with RAO). Garg et al., also found 30% patients with RAO had palpable radial artery [17]. Matin, found 16.67% patients with RAO had palpable radial artery [18]. This is very much important findings because patients with RAO can have palpable radial pulse even with occluded proximal segment of the radial artery because of collateral circulation from the palmar arch [19]. Thus our study had determined the true frequency of RAO after transradial coronary procedures.

In a study done by Pancholy and Patel, Rashid et al., found hemostatic compression time is a significant predictor of RAO (p = 0.025) [20,21]. In another study by Garg et al., found diabetes, female sex, lower BMI were predictor of RAO on univariate analysis. In our study BMI was a predictor of RAO on multivariate analysis [17]. But female sex and diabetes was not predictors of RAO on multivariate analysis.

In a study done by Dharma et al., explored the gender-based analysis between women and men and also women age ≥ 60 years Vs women age < 60 years [22]. They had shown that the use of nitroglycerin, as compared with placebo, did not significantly reduce the risk of RAO in women patients [odds ratio, 0.69; 95% confidence interval (CI), 0.38 to 1.26; P=0.147]. The risk of RAO was higher in women age < 60 years as compared with women age ≥ 60 years [5.6% vs. 3.5%; odds ratio, 2.16; 95% CI, 1.18 to 3.94; P=0.008]. They used 60 years as a cut-off for the age sub-group because at this age the estrogen has begun to reach its plateau level in women [23]. The mechanism of why women do not response with nitroglycerin is most likely based on gender and age specific hormonal status. Estrogen maintains the dominancy of vasodilation function of the endothelium (via NO release) in younger women and not affected by exogenous NO. However, in older women (≥ 60 years), the estrogen level is lower and endothelium-dependent release of NO is reduced, thus the addition of nitroglycerin at this stage may be of benefit in maintaining the vasodilatation effect including the radial artery [23]. But in our study female population was only 22 and all of them was <60 years. So we could not compare this.

Among other complications, radial artery spasm is the most important factor that can develop during TRA and which may affect the success of the procedure. Rate of radial artery spasms was different on the basis of use of prophylactic spasmolytic in different studies. In one study conducted by Coppola et al., found that spasm rate was 12.2% with nitroglycerine, 14.3% with nitroprusside and 9.5% in combined use of nitroglycerine and nitroprusside [24]. In another study done by Kiemeneij et al., found 8% patient had radial artery spasm with use of verapamil and nitroglycerine cocktail as spasmolytic

[25]. In our study, a total of 8 (4%) patients; (3 % in Group-I and 5% in Group-II) developed transient radial artery spasms despite use of verapamil and nitroglycerine spasmolytic cocktail. which was statistically significant. In studies done by Vilela et al., and Kiemeneij, it has been shown snuffbox technique reduces the chances of radial artery spasm at the site of wrist level access [26,27]. Probably due to deep injection of local anesthesia causing irritation of the periosteum of the styloid process of radius bone. There is more chance of pain in conventional radial artery approach. In angiographic series via TRA, pseudoaneurysm was reported rarely and surgery was not required. In our study no pseudoaneurysm was developed in any patient.

Study done by Matin, found 4% patients developed grade-I hematoma and only 0.8% patient developed grade-II hematoma [18]. In our study a single case (1%) developed puncture site hematoma of grade-I (less than 05 cm) in Group-I and seven cases (7%) in Group-II respectively, with statistically significant different between two groups. These findings were similar with previous studies of [28,29,30]. Hematoma was less, because of distal radial artery is more superficial and patent, hemostasis is easier than forearm radial artery.

In our study the mean time to hemostasis after completion of CAG in Group-I and Group-II was 7.5±2.9 & 10.0±3.5 minutes respectively. Which was statistically significant (p=0.03). We also found hemostatic compression time was shorter in Group I, in comparison to Group II in PCI patients, which was 19.0±5.6 vs. 23.0± 7.2 (p=0.03) with statistically significant association. These findings were similar with previous studies done by Kiemeneij, Vilela et al., and Bayam et al., [26,27,28]. Short hemostasis time, because of superficial position of the radial artery in the snuffbox. If the patient flexes his/her wrist, hemostasis will not be affected since compression is exerted on the palmar side of the hand.

The arterial remodeling that occurs after transradial catheterization has important clinical implications. Sakai et al., studied patients undergoing repeated transradial interventions in the same arm and found that the rate of radial access-site failure increases with successive procedures [30]. This appears to be due to progressive narrowing of the artery due to increase in intimal hyperplasia and intima media thickness with repeated TRA [31,32]. That’s why; prior radial angiography or angioplasty done through the same radial artery used for the current procedure would result in a higher number of RAOs compared with procedures done in a radial artery being used for the first time. However, in our study, repeat radial artery cannulation was not an independent predictor for RAO, which may be due to the small number of patients (two patients) having previous history of TRA and absence of other predictors in them. Moreover in two non-diabetic male patient who underwent transradial coronary procedures for three times (first CAG and then staged PCI in two different occasion) within two months duration did not developed RAO. Every time his hemostatic compression time was not more than two hours.

On multivariate logistic regression analysis, in our study, hemostatic compression time more than two hours (more than four hours in case of PCI), procedure time were found to be the predictors of radial artery occlusion. Study done by Matin, found female gender, diabetes mellitus, hemostasis compression time more than two hours as predictor of RAO [18]. Garg et al., also found female gender, diabetes mellitus as predictors of RAO on univariate regression analysis in their study [17]. But in our study female gender was not predictor of RAO. Females have relatively smaller average radial artery diameters, and are much more susceptible to vascular spasm and could be the reason for higher RAO in females [33].

Patients with long-term diabetes mellitus have the propensity to develop arteriopathy and accelerated atherosclerosis. Ruengsakulrach et al., and Chowdhury et al., also demonstrated that factors predictive of intimal hyperplasia and atherosclerosis in radial arteries were age and diabetes [34,35].

However, in our study prolonged hemostatic compression time was one of the predictors of RAO, but hypertension, diabetes mellitus amount of heparin used, were not predictor of RAO on multivariate logistic regression analysis.

Heparin therapy is necessary for the prevention of RAO [31]. In a study conducted by Spaulding et al., RAO rates were 70%, 24%, and 4.3% in groups without heparin, 2000-3000 IU heparin and 5000 IU of heparin respectively [36]. In our study, minimum 5000 IU heparin was used during CAG and maximum 16000 IU of heparin (according to ACT) during PCI.

Comparable with previous studies, Right Distal transradial approach has higher procedural success, low complication rates, and lower rates of post procedural occlusion in experienced hands for the diagnosis and treatment of CAD. By no means it is inferior to conventional transradial approach. It would be certainly beneficial for the patients to preserve radial artery patency and ensure its further use.

## LIMITATIONS OF THE STUDY

There were several limitations in the present study. Firstly, the study was a single center study with the limitations of small number. Secondly, almost all snuffbox approaches were performed by a single experienced radial operator. Therefore, some selection bias might have influenced the results and our results cannot be generalized. Thirdly, vascular complications were only evaluated during hospitalization. No follow-up visit and Doppler evaluation was done to find out late radial occlusion. Nevertheless, our study might be meaningful for the cardiologists to understand the lesser possibilities of radial artery occlusion through this new technique.

## CONCLUSION

The distal transradial approach is a safe, feasible, and effective alternative to conventional transradial access for coronary procedures. Despite a slightly longer puncture time, it offers significant advantages including lower radial artery occlusion, reduced hematoma, shorter hemostasis, less pain, and better patient tolerance. It effectively preserves distal radial patency and should be preferred when radial artery preservation is a priority for future interventions, CABG, or hemodialysis access.

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