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# Success, Efficacy and Predictors of Failure of Transradial Approach For Coronary Intervention in Nepalese Population: A Cross-Sectional Study

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## ABSTRACT

**Introduction:** Coronary angiography and percutaneous coronary intervention are crucial in coronary artery disease management. The transradial artery (TRA) approach offers advantages, but its success may vary among patients. In Nepal, understanding TRA outcomes is essential due to unique characteristics and high cardiovascular disease burden. This study investigates TRA success, efficacy, and predictors in Nepalese patients.

**Methods:** A hospital-based prospective cross-sectional study was conducted at Birat Medical College Teaching Hospital from January 25, 2023, to May 30, 2023. A total enumeration sampling technique was used to enrol 234 participants. Data on demographic profiles, procedure details, success, efficacy, and predictors of failure were collected using a structured questionnaire. Success and efficacy were measured as the percentage of successful accesses and completed procedures, respectively. Fisher's exact test was used for statistical analysis ($p<0.05$).

**Results:** The study found a high procedural success rate (95.73%) and efficacy (95.73%) of transradial access. Most patients (97.65%) undergoing CAG and 90.62% undergoing PCI achieved successful TRA. The failure rate was 4.27%, with higher failure in PCI (9.38%) compared to CAG (1.7%). The median duration for achieving TRA access and successful completion for CAG and PCI was 21 sec, 26 seconds, 5 minutes and 20 minutes, respectively.

**Conclusion:** This study highlights the high procedural success rate and efficacy of trans-radial access for cardiac procedures. The low failure rate demonstrates the feasibility and effectiveness of trans-radial access. While certain factors may contribute to failure, no statistically significant associations were observed.

***Keywords:*** *Coronary Angiography; Coronary Artery Disease; Percutaneous Coronary Intervention; Nepal*

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## INTRODUCTION

Coronary angiography (CAG) and percutaneous angioplasty intervention (PCI) remain the cornerstone in the diagnosis and management of coronary artery disease CAD[1,2]. The transradial artery approach (TRA) has emerged as a popular alternative to the traditional transfemoral approach for these procedures, offering advantages like reduced bleeding complications, improved patient comfort, and shorter hospital stays. [3,4,5,6] However, the success and efficacy of TRA may vary among different patient populations, including the unique Nepalese population with specific characteristics that can impact outcomes. Factors such as variations in radial artery anatomy, patient demographics and comorbidities can influence the procedure's success rates. Given the significant burden of cardiovascular diseases in Nepal, understanding the success rates and predictors of failure of the transradial artery approach is crucial. This research article aims to investigate the success, efficacy, and predictors of failure of the transradial approach for coronary angiography and PCI among Nepalese patients.

## METHODS

We employed a hospital-based prospective cross-sectional study design to investigate the success, efficacy and predictors of failure of the transradial artery approach for CAG and PCI in Nepalese patients at Birat Medical College Teaching Hospital from 30$^{th}$ January 2023 to 30 May 2023. Nepali citizens admitted to the Department of Cardiology for CAG and PCI at Birat Medical College Teaching Hospital and those willing to participate in the study were included in the study. Non-Nepali citizens, elective patients for the trans femoral route and those who did not provide consent for the participation were excluded from the study. A total enumeration sampling technique was used to enrol all the patients during the study period. The total number of samples enrolled during the study period was 234. Ethical approval was obtained from the institutional review committee of Birat Medical College before conducting research (IRC-PA-269/2078-79). Written informed consent was obtained from each patient before they were enrolled for the study. A structured questionnaire was employed to collect data using interview and observation techniques. Data was collected on patients' demographic profiles, procedure employed, success, efficacy and predictors of failures of transradial access for the procedures (CAG and PCI) and complications if any. The dependent variable includes success, efficacy and predictors of failure and the independent variables include sex, height, weight, smoking, previous history of TRA, previous history of CAG, major cardiovascular diseases(CVDs) and non-communicable diseases(NCDs), an indication of procedure (elective or emergency). The success rate was operationalised as the percentage of access to coronary angiography or PCI via radial artery route without complications. Each successful access was ranked as 1 and 0 if it was not accessed. Efficacy was operationalised as successful cannulation of coronary ostia and completion of CAG or PCI. When CAG or PCI was accomplished, the efficacy was ranked 1 and 0 if not accomplished. Predictor of Failure: included factors contributing to inaccessibility of TRA for CAG and PCI after the first attempt and required to perform through alternative routes such transfemoral or ulnar route. Complications included the presence of hematoma, bleeding from an access site etc. Collected data was entered in a Microsoft Excel sheet, and transferred to SPSS version 23. Frequency mean and standard deviation were calculated. Fisher's exact test was applied to analyze the statistically significant association and identify the predictors of failure of trans-radial artery access. P value $<0.05$ was considered statistically significant.

## RESULTS

The study included 234 patients undergoing cardiac revascularization with a mean age of 58.9±10.9 years ranging from 19 -80 years. The majority of patients 78(33.3%) were in the age group 51-60 years. Two third patients were male 155(66.2%). Madhesi represented the largest ethnic group 89(38%). The majority of patients 141(60.3%) had hypertension, more than one-third (35.9%) had diabetes and six patients had a history of heart failure. Nearly 31% had a previous history of transradial coronary angiography (CAG) and six patients had a previous history of transradial percutaneous coronary intervention (PCI). The majority of the patients 156(66.7%) were presented with unstable angina, followed by STEMI 33(44.1%) as shown in Table 1.

**Table 1: Baseline characteristics of patients (n=234)**

| Age in years | N (%) |
|---|---|
| <40 | 7(3) |
| 41-50 | 50(21.4) |
| 51-60 | 78(33.3) |
| 61-70 | 60(25.6) |
| 71-80 | 39(16.7) |
| **Sex** | |
| Male | 155(66.2) |
| Female | 79(33.8) |
| **Ethnicity** | |
| Madhesi | 89(38) |
| Brahmin/Chhetri | 56(23.9) |
| Janajati | 44(18.8) |
| Muslim | 26(11.1) |
| Dalit | 19(8.1) |
| **Risk factors present** | |
| Current Smoking history | 30(12.8%) |
| Hypertension | 141(60.3%) |
| Diabetes | 84(35.9) |
| Heart failure | 6(2.6) |
| Shock | 2(0.9) |
| Chronic Kidney Disease | 1(0.4) |
| Previous history of TR CAG | 72(30.8) |
| Previous history of TR PCI | 6(2.6) |
| Feeble radial pulse | 10(4.3) |
| **Pattern of coronary artery disease** | |
| Unstable Angina | 156(66.7) |
| ST elevated myocardial infarction (STEMI) | 33(14.1) |
| Chronic Stable angina II | 25(10.7) |
| Treadmill Test positive(TMT) | 14(6) |
| Non-ST elevated myocardial infarction (NSTEMI) | 6(2.6) |

CAG: Coronary angiography; PCI: Percutaneous angioplasty intervention; TRA: Transradial artery approach

**Table 2: Types of procedures (n=234)**

| Procedure | Elective N (%) | Emergency N (%) | Total |
|---|---|---|---|
| CAG | 158(92.94) | 12(7.05) | 170(72.65) |
| PCI | 59(92.19) | 5(7.81) | 64(27.35) |
| Total | 217(92.74) | 17(7.26) | 234(100) |

CAG: Coronary angiography; PCI: Percutaneous angioplasty intervention

**Table 3: Success, efficacy, and failure of transradial approach (n=234)**

| Procedure | Success | Efficacy | Failure | Total |
|---|---|---|---|---|
| Coronary angiography | 166 (97.65)* | 166 (97.65) | 4 (1.7) | 170 (100) |
| Percutaneous coronary intervention (PCI) | 58 (90.62)** | 58 (90.62) | 6 (9.38) | 64 (100) |
| Total | 224 (95.73) | 224 (95.73) | 10 (4.27) | 234 (100) |
| CAG | Median duration of achieving TRA access: 21 sec(9sec-3 minutes) Median duration of completion Via TRA: 5 min(3 min-38 minutes) | | | |
| PCI | Median duration of achieving TRA access: 26 sec (4sec-2 minutes) Median duration of completion Via TRA: 20 (min)(3 min-1 hour.30 min) | | | |

* 2 Left radial route, ** 1 Left radial route

CAG: Coronary angiography; PCI: Percutaneous angioplasty intervention; TRA: Transradial artery approach

Coronary angiography was performed in the majority of the patients accounting for 170(72.65%) and PCI was performed in 64(27.35%). Emergency CAG was performed in 12(7.05%) Patients undergoing CAG and 5(7.81%) patients undergoing PCI as shown in Table 2.

The procedural success rate and efficacy of transradial access were 95.73% each. Out of the 224(95.73%) success rates of transradial approach, the majority had transradial access through the right while three patients had left radial access (Two patients undergoing CAG and 1 patient undergoing PCI). Among 170 patients undergoing CAG, the success and efficacy were 97.65% each. Among 64 patients undergoing PCI, the success and efficacy of TRA were achieved at 90.62% each. The failure rate of transradial access was 4.27%. Patients undergoing PCI had increased failure 6(9.38%) compared to patients undergoing CAG 4(1.7%), The median time for achieving transradial access(TRA)was 21 seconds. The median duration for achieving TRA access in both CAG and PCI is 21 seconds and 26 seconds respectively. The median duration of completion of CAG and PCI via TRA access is 5 minutes and 20 minutes respectively, Table 3.

Among 10 patients with failure of transradial approach, the alternative approach employed were the right femoral route (2 patients undergoing CAG and 3 patients undergoing PCI), right ulnar route( 2 patients each CAG and PCI) and left snuff box for 1 patient undergoing PCI.

The reasons for a crossover of transradial access to alternative routes were radial artery tortuosity or loop, inadequate radial artery calibre, failure of arterial access and absence of radial pulse as shown in Table 4.

**Table 4: Alternative route employed and reason for crossover of transradial access (n=10)**

| Alternative route | Coronary angiography (CAG) N (%) | Percutaneous intervention(PCI) N (%) | Total |
|---|---|---|---|
| Right femoral route | 2(20) | 3(30) | 5(50) |
| Right ulnar route | 2(20) | 2(20) | 4(40) |
| Left snuff box | 0 | 1(10) | 1(10) |
| **Reason for the crossover of transradial approach to alternative routes** | | | |
| **Reasons** | **CAG (n)** | **PCI(n)** | **Total** |
| Radial artery tortuosity/ loop | 3 | 2 | 5 |
| Inadequate radial artery calibre | 1 | 1 | 2 |
| Failure of arterial access | 0 | 2 | 2 |
| Absence of radial pulse | 0 | 1 | 1 |
| Total | 4 | 6 | 10 |

**Table 5: Predictors of failure of transradial access**

| Predictors | | Route n(%) | | Total N (%) | P value* |
|---|---|---|---|---|---|
| | | Fail | Success | | |
| Age | <60 years | 3(2.6) | 111(97.4) | 114(100) | 0.335 |
| | ≥ 60 years | **7(5.8)** | 113(94.2) | 120(100) | |
| Sex | Female | 4(5.1) | 75(94.9) | 79(100) | 0.737 |
| | Male | **6(3.9)** | 149(96.1) | 155(100) | |
| Body Mass Index(BMI) | Normal | 3(2.7) | 110(97.3) | 113(100) | 0.336 |
| | Other than normal | **7(5.8)** | 114(94.2) | 121(100) | |
| Height in cm | <150 | 2(6.9) | 27(93.1) | 29(100) | 0.798 |
| | >150 | 8(3.9) | 197(96.1) | 205(100) | |
| Smoking | Yes | 1(3.3) | **29(96.7)** | 30(100) | 1.000 |
| | No | 9(4.4) | 195(95.6) | 204(100) | |
| Hypertension | Yes | **7(5.0)** | 134(95.0) | 141(100) | 0.744 |
| | No | 3(3.2) | 90(96.8) | 93(100) | |
| Diabetes | Yes | **4(4.8)** | 80(95.2) | 84(100) | 0.749 |
| | No | 6(4) | 144(96) | 150(100) | |
| Previous Transradial coronary angiography | Yes | **6(8.3)** | 66(91.7) | 72(100) | 0.073 |
| | No | 4(2.5) | 158(97.5) | 162(100) | |
| Previous TRA PCI | Yes | **1(16.7)** | 5(83.3) | 6(100) | 0.233 |
| | No | 9(3.9) | 219(96.1) | 228(100) | |
| Feeble Radial Pulse | Yes | **1(10)** | 9(90) | 10(100) | 0.360 |
| | No | 9(4) | 215(96) | 224(100) | |
| Indication | Elective | **10(4.6)** | 207(95.4) | 217(100) | 1.000 |
| | Emergency | 0(0) | 17(100) | 17(100) | |

*Fisher's exact test was applied

PCI: Percutaneous angioplasty intervention; TRA: Transradial artery approach

Age ≥ 60 years 7(5.8%), female patients 4(5.1%), height <150 cm 2(6.9), obese 7(5.8%), non-smokers 9(4.4%), patients with a history of hypertension 7(5%), diabetes 4(4.8%), previous transradial angiography and PCI 6(8.3%), 1(16.7%) each, feeble radial pulse 1(10%) and elective procedures 10(4.6%) were the predictors of failure however no statistically significant association was found. (Table 5)

## DISCUSSION

This article highlights the success rate, efficacy, and predictors of failure of transradial access for cardiac procedures, comparing our findings with similar research conducted in Nepal and globally. Our study demonstrated a high procedural success rate of 224(95.7%) and efficacy of 224(95.7%) of transradial artery access. Among the patients undergoing CAG, the success rate and efficacy were 97.65% each and for PCI it was 90.62% each. There is limited research conducted in Nepal to compare the success and efficacy of TRA. According to the retrospective study in Nepal, percutaneous coronary intervention via radial artery was first introduced in Shahid Gangalal National Heart Centre, Nepal for the first time in 2007. The trends from 2007 to 2012 showed an increasing rate of application of TRA which means there was an increasing rate of success, efficacy and feasibility of the TRA approach in the Nepalese population. [7] Our finding was consistent with the study from China, which demonstrated 97.6% and 96.3% success for CAG and PCI respectively. [6]

Ten patients(4.3%) had TRA failure in our study which is less compared to a retrospective study conducted in Shahid Gangalal Hospital from Nepal which accounts for 19.8% and a Portugal study which reported 5.8% TRA failure. 7 Patients undergoing PCI had an increased rate of failure compared to patients undergoing CAG in our study (9.38% versus 1.7% respectively) which is similar to the Chinese study.[6] Transradial angiography failure was observed in 4/10 patients(1.7%) in our study which is consistent with findings observed in a study in the UK (1.8% of the study population) [9] Compared to our study, a higher percentage of transradial failure for coronary angiography (6.8%) was observed in a study from Erlangen, Germany. [10] Transradial PCI was observed in 9.38% of the total failures in our study. A lower rate of failure was observed in the study conducted in Canada (4.7%) compared to our findings. [11] We performed transradial route via the right radial artery in the majority of patients (98.67%)which is consistent with the findings from Portugal(97.6%) [8] The Portugal study identified that the use of short introducer sheaths, patients undergoing PCI, females($p < 0.001$ each), patients with multivessel disease ($p = 0.001$), body surface area (BSA) ≤ 1.938 ($p = 0.005$) and elderly patient ($p= 0.007$) had a statistical significant association of having transradial access failure. [8] A study from Canada also identified almost similar findings which stated that inability to advance guide catheter to ascending aorta in 50 (51%), inadequate guide catheter support in 35 (36%), and unsuccessful radial artery puncture in 13 (13%) patients. elderly($p=0.0006$), prior coronary artery bypass graft surgery ( $p = 0.0002$), and height ($P=0.02$) were independent predictors of TR-PCI failure. [11] In our study we did not study the association between the length and diameter of the sheath used and the presence of multivessel disease however there was an increased percentage of failure in the rest of the findings though the statisticallylyly significant association was not found. A similar finding was observed in a study from Germany which demonstrated the statistically significant association between transradial failure and female ( $p <0.001$), significantly older age group ( $p <0.001$ and a smaller body surface area ($1.89 \pm 0.21$ vs $1.94 \pm 0.2$ m2; $p <0.001$)[10] Comparing our predictors of failure with other studies, we found that age ≥

60 years, female gender, height less than 150 cm, obesity, hypertension, diabetes, previous transradial procedures, feeble radial pulse, and elective procedures were associated with a higher risk of failure. This finding is consistent with the findings of the UK study too[9]

Despite these associations, our study did not find any statistically significant predictors of failure. This discrepancy could be attributed to the smaller sample size in our study or variations in patient characteristics and clinical practices between different study populations. The reasons for a crossover of transradial access to alternative routes in our study were radial artery tortuosity or loop (n=3 in CAG, 2 in PCI), inadequate radial artery calibre (n=1 in each CAG and PCI), failure of arterial access (n=2 in PCI) and absence of radial pulse(n=1 in PCI).
In addition to our study, severe radial artery spasm, tortuous subclavian artery, difficult engagement of guideware and poor guide support were reported from the study from China. [6]

We employed transradial access in all patients including acute coronary syndrome(ACS) and Non ACS. The majority were patients with unstable angina 156(66.7%), ST segment elevated myocardial infarction 33(14.1%), Non-ST segment elevated myocardial infarction 6(2.6%) and chronic stable angina II 25(10.7%). One patient with NSTEMI had transradial access failure in our study, while in the majority, the failure was in patients with unstable angina (n=7 patients).

The median duration for achieving TRA access in both CAG and PCI is 21 seconds and 26 seconds respectively. The median duration of completion of CAG and PCI via TRA access is 5 minutes and 20 minutes respectively. Research on the use of radial routes in myocardial infarction (MI) and unstable angina has shown promising results and has gained significant attention in recent years. Several studies and meta-analyses have demonstrated that the radial route offers numerous advantages like reduction in bleeding complications, improved clinical outcomes, shorter hospital stay, better patient comfort and lower healthcare costs in patients with MI and unstable angina compared to the femoral route. A recent study also demonstrated that radial approach does not lead to a lengthening of the door-to-balloon time, suggesting the efficacy of this approach in STEMI patients.[12,13,14] Among 10 patients with failure of transradial approach, the alternative approach used was the right femoral route (n=2 for CAG and n=3 for PCI), right ulnar route( n=2 patients each for both CAG and PCI) and left snuff box for 1 patient undergoing PCI. Most of the studies conducted to assess the success, efficacy and feasibility of transradial artery routes are from the western context which provides ample evidence of its safer and more effective practices, with fewer complications. The success rates, efficacy, complications and predictors of failure of TRA for CAG and PCI in the Nepalese population were relatively unknown due to limited scientific studies in our context. Hence, the findings of our study have significant clinical implications. It contributes valuable insights into the success and efficacy of TRA for cardiac procedures in our population. TRA offers numerous advantages, including reduced bleeding complications, faster patient mobilization, and improved patient comfort which was supported by our study too since there were no complications reported. Its high success rate and efficacy make it a viable alternative to trans-femoral artery access for cardiac interventions. It confirms the feasibility and effectiveness of this approach and underscores the importance of careful patient selection to reduce the risk of failure. The identification of potential predictors of failure can help clinicians in patient selection and risk stratification, allowing them to choose

the most appropriate vascular access approach for individual patients.

The potential limitations of our study are that it is single-centre and possesses a relatively small sample size, which may limit its generalizability. Additionally, the lack of statistically significant predictors might also indicate the need for further research with larger and more diverse cohorts to validate and explore the predictors' significance.
We recommend that future research focus on conducting multicentric and incorporating larger cohorts, to enhance our understanding and refine the utilization of TRA in cardiac interventions both in Nepal and globally.

## CONCLUSION

The study demonstrated a high procedural success rate and efficacy of transradial access for cardiac procedures. Right radial access was more common, while the failure rate was very low. Alternative approaches, such as the right femoral and right ulnar routes, were used for cases of failure. Radial artery tortuosity/ loop and inadequate calibre were common causes of crossover. Age, gender, obesity, smoking status, hypertension, diabetes, previous transradial procedures, feeble radial pulse, and elective procedures were potential predictors of failure, although no statistically significant association was found. Transradial access is a feasible and effective option for cardiac interventions.

## CONFLICT OF INTEREST

None

## SOURCES OF FUNDING

None

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