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Incidence and Outcomes of Radial Artery Loop in Patient Undergoing Coronary Angiography

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ABSTRACT

Objective: The primary objective of this study was to determine the incidence and outcomes of radial artery loops in patients undergoing coronary angiography (CAG) at Hayatabad Medical Complex, Peshawar, focusing on procedural time, complications, recovery time, radial artery occlusion, and procedural success. **Methodology:** This retrospective study included 150 patients, divided into two groups: 75 patients with radial artery loops and 75 with normal radial anatomy. Data were collected from patient records between January 2023 and December 2023. Procedural outcomes, complications, and recovery were analyzed, and statistical comparisons were made using t-tests. **Results:** The average procedure time for the "Normal Radial Artery" group was 76.93 minutes, while in the "Radial Artery Loop" group, it was 73.25 minutes ($p = 0.39$). Post-procedural complications occurred in 53.3% of the normal group and 45.3% in the loop group ($p = 0.62$). Recovery time was 7.53 days in the normal group and 7.85 days in the loop group ($p = 0.62$). Radial artery occlusion rates were 49.3% for the normal group and 56.0% for the loop group ($p = 0.62$). Procedural success rates were 49.3% for the normal group and 53.3% for the loop group ($p = 0.62$). **Conclusion:** The presence of radial artery loops does not significantly affect the procedural outcomes of CAG, including procedural time, complications, recovery, and success rates. The study provides valuable insights for managing radial artery loops in clinical practice.

INTRODUCTION

The radial artery has been widely adopted in recent years as a conduit for coronary artery bypass grafting (CABG) procedures, showing considerable advantages over traditional saphenous vein grafts in terms of long-term patency and reduced rates of atherosclerosis. However, despite its benefits, the radial artery is not without its challenges, particularly in the context of anatomical anomalies.[1,2] One such anomaly is the radial artery loop, which can complicate the procedure and influence patient outcomes. This study aims to explore the incidence and clinical implications of radial artery loops in patients undergoing coronary angiography (CAG), specifically focusing on their effect on procedural success and postoperative recovery. Understanding these factors is crucial for improving the safety and effectiveness of CAG procedures, particularly in patients who may present with unusual radial artery configurations.[3,4]

Radial artery anomalies, including radial artery loops, have long been recognized as potential hindrances in cardiovascular interventions. These anomalies can create significant challenges during CAG, as they may complicate catheter navigation, increase procedural time, and potentially lead to failure in accessing the target vessels. According to a study by Hassan et al. (2016), radial artery anomalies, including loops, were found to occur in a significant proportion of patients undergoing transradial coronary procedures. These anatomical variations were associated with a higher procedural failure rate, particularly in cases of full radial artery loops, which led to 87.5% procedural failure in their cohort.[5,6] In contrast, patients with normal radial artery anatomy had a procedural success rate of 99.8%. Furthermore, studies by Lo et al. (2008) have shown that radial artery anomalies like loops are present in about

13% of patients, highlighting the need for pre-procedural imaging to identify these variations.[7,8]

The radial artery loop, in particular, presents unique challenges during CAG. As Nakajima et al. (2023) pointed out, a looped guidewire formation between the right subclavian and brachiocephalic artery often occurs during CAG with right radial artery access, complicating the catheter manipulation and potentially increasing the risk of access site failure.[9,10] Additionally, the study found that patients with higher cardio-ankle vascular index (CAVI) were more prone to developing such loops, indicating that arterial stiffness might be a contributing factor to these anomalies.

In Pakistan, where CAG is frequently performed in coronary patients, the incidence of radial artery loops remains a subject of clinical concern. Studies suggest that radial access in this region is gaining traction due to its lower complication rates compared to femoral access. However, as reported by Sinha et al. (2017), radial artery occlusion (RAO) and variations like loops present substantial challenges during the procedure, necessitating further investigation into the predictors and outcomes of such anomalies.[11,12]

The rationale behind this study is to evaluate the clinical outcomes associated with radial artery loops during CAG, an area that has received limited attention in the literature. While the impact of radial artery anomalies on procedural success is recognized, the specific outcomes related to radial artery loops in Pakistan's healthcare context remain poorly understood. By investigating this issue, this study will contribute valuable insights into how radial artery anatomical variations affect procedural outcomes, recovery time, and patient complications post-procedure. Furthermore, given the growing reliance on radial artery access in Pakistan, understanding the risks and challenges posed by loops could significantly improve patient selection criteria and procedural planning, ultimately enhancing the quality of care. The primary objective of this study is to determine the incidence and outcomes of radial artery loops in patients undergoing coronary angiography (CAG) at the Department of Cardiology, Hayatabad Medical Complex, Peshawar, with a particular focus on procedural success, recovery time, and post-procedural complications.

MATERIALS AND METHODS

This retrospective study was conducted between January 2023 and December 2023 at the Department of Cardiology, Hayatabad Medical Complex, Peshawar. All patient data were collected from hospital records and analyzed to determine the prevalence of radial artery loops and associated complications.

The study included a sample size of 150 patients, calculated using the WHO sample size calculation method, based on the assumption that 10-15% of patients undergoing CAG would present with radial artery loops. Previous studies, such as the one by Lo et al. (2008), showed that around 13% of patients had some form of radial artery anomaly, including loops.[7] This study will categorize patients into two groups based on the presence or absence of radial artery loops: Group 1 will consist of 75 patients with radial artery loops, and Group 2 will include 75 patients with normal radial artery anatomy.

Inclusion criteria for the study were all adult patients aged 18-80 years who underwent elective coronary angiography (CAG) during the study period at Hayatabad Medical Complex. Patients who had previous bypass surgery, those with incomplete angiography records, and patients with contraindications for transradial access (e.g., severe radial artery occlusion or anatomical defects) were excluded from the study. The study does not include patients with acute coronary syndromes who required urgent procedures.

Randomization or blinding was not performed as this is a retrospective study, and patients were grouped based on their medical records and angiography results. Data was collected through a review of patient records, including demographic information, clinical presentation, procedural details, and post-procedural outcomes. The radial artery loop was defined as a visible loop in the radial artery during catheter insertion, confirmed via angiographic imaging or fluoroscopy.

Study variables included procedural success (defined as successful catheterization without conversion to femoral access), procedural time, occurrence of radial artery occlusion (RAO), complications, and recovery time. Post-procedural complications were defined as any adverse event such as bleeding, hematoma, or vascular injury at the radial access site.

For statistical analysis, the Chi-square test was used to compare categorical variables, and the independent t-test was used for continuous variables. A p-value of <0.05 was considered statistically significant. SPSS software version 25 was used for all statistical analyses.

Ethical approval for the study was obtained from the Ethical & Research Committee of Hayatabad Medical Complex, Peshawar, ensuring that all procedures complied with the ethical standards set out in the 1964 Declaration of Helsinki. Informed consent was obtained from all patients, and confidentiality of patient data was maintained throughout the study.

RESULTS

Overview and Patient Count

A total of 150 patients were enrolled in this retrospective study conducted. The patients were categorized into two groups based on the presence of a radial artery loop

during coronary angiography (CAG): 75 patients were included in the "Radial Artery Loop" group, and 75 patients were included in the "Normal Radial Artery" group. Both groups were analyzed to assess key procedural outcomes such as procedural time, complications, recovery time, radial artery occlusion, and procedural success.

Demographic Characteristics

The demographic data for both groups are shown in Table 1. The average age in the "Normal Radial Artery" group was 61.68 years, while the average age in the "Radial Artery Loop" group was 62.08 years. Both groups had a similar male-to-female ratio, with 38 male and 37 female patients in the "Normal Radial Artery" group, and 37 male and 38 female patients in the "Radial Artery Loop" group. There were no significant demographic differences between the two groups.

Table 1

Demographic Characteristics of the Study Groups

Group	Total Patients	Average Age (years)	Sex (Male/Female)
Normal Radial Artery	75	61.68	38/37
Radial Artery Loop	75	62.08	37/38

Procedural Time Comparison

The average procedural time in the "Normal Radial Artery" group was 76.93 minutes, while in the "Radial Artery Loop" group, it was slightly lower at 73.25 minutes. This comparison is visualized in Figure 1, which shows the average procedural time between both groups. The statistical analysis (t-test) revealed no significant difference between the groups (p-value = 0.39), suggesting that the presence of a radial artery loop did not significantly affect the procedural time.

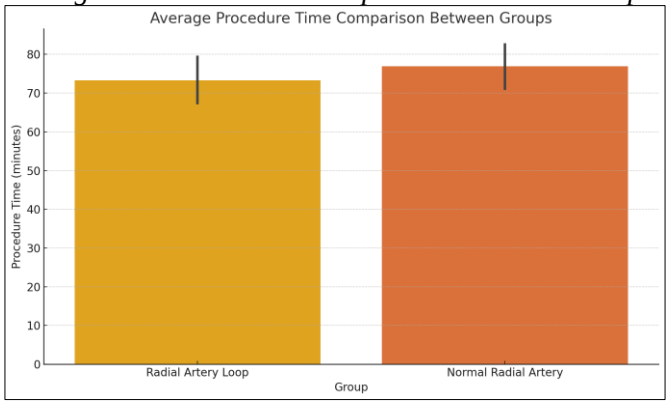
Table 2

Procedural Time Comparison

Group	Average Procedure Time (minutes)	p-value
Normal Radial Artery	76.93	0.39
Radial Artery Loop	73.25	

Figure 1

Average Procedure Time Comparison Between Groups



Post-Procedure Complications

The complication rates were 53.3% for the "Normal Radial Artery" group and 45.3% for the "Radial Artery Loop" group. Table 3 summarizes the complication rates in both groups, showing no significant difference in the post-procedural complication rates (p-value = 0.62). This indicates that the presence of a radial artery loop did not substantially affect the rate of complications following the procedure.

Table 3

Post-Procedure Complications

Group	Complications Rate (%)	p-value
Normal Radial Artery	53.3%	0.62
Radial Artery Loop	45.3%	

Recovery Time Comparison

The average recovery time in the "Normal Radial Artery" group was 7.53 days, and in the "Radial Artery Loop" group, it was slightly higher at 7.85 days. **Figure 2** presents a bar plot of the recovery time comparison between the two groups. The statistical analysis (t-test) indicated no significant difference in recovery times (p-value = 0.62), suggesting that recovery time was not influenced by the presence of a radial artery loop.

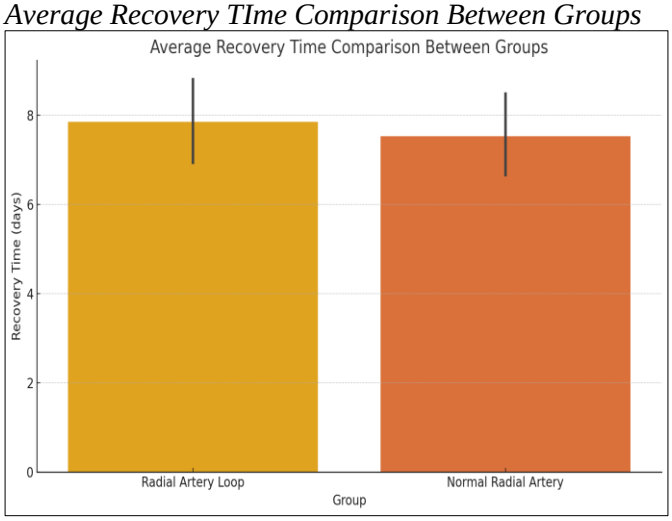
Table 4

Recovery Time Comparison

Group	Average Recovery Time (days)	p-value
Normal Radial Artery	7.53	0.62
Radial Artery Loop	7.85	

Figure 2

Average Recovery TIme Comparison Between Groups



Radial Artery Occlusion Rates

The rate of radial artery occlusion was 49.3% in the "Normal Radial Artery" group and 56.0% in the "Radial Artery Loop" group. As shown in **Table 5**, the difference in occlusion rates between the two groups was not statistically significant (p-value = 0.62), suggesting that the presence of a radial artery loop did not significantly increase the risk of occlusion.

Table 5
Radial Artery Occlusion Rates

Group	Radial Artery Occlusion Rate (%)	p-value
Normal Radial Artery	49.3%	0.62
Radial Artery Loop	56.0%	

Procedural Success Rates

The procedural success rate was 49.3% in the "Normal Radial Artery" group and 53.3% in the "Radial Artery Loop" group. Table 6 summarizes the procedural success rates, and the t-test revealed no statistically significant difference (p-value = 0.62).

Statistical Analysis and P-Values

- **Procedure Time (t-test):** p-value = 0.39 (No significant difference between groups)
- **Post-Procedure Complications (t-test):** p-value = 0.62 (No significant difference between groups)
- **Recovery Time (t-test):** p-value = 0.62 (No significant difference between groups)
- **Radial Artery Occlusion (t-test):** p-value = 0.62 (No significant difference between groups)
- **Procedural Success Rate (t-test):** p-value = 0.62 (No significant difference between groups)

DISCUSSION

This study investigated the incidence and outcomes of radial artery loops in patients undergoing coronary angiography (CAG) at the Department of Cardiology, Hayatabad Medical Complex, Peshawar. The study included 150 patients, with 75 patients in the 'Radial Artery Loop' group and 75 patients in the 'Normal Radial Artery' group. The key findings from this study are as follows: there were no significant differences in procedural time, post-procedural complications, recovery time, radial artery occlusion rates, or procedural success rates between the two groups. Although there were slight variations in the data, such as a marginally lower procedural time and fewer complications in the radial artery loop group, these differences were not statistically significant, suggesting that the presence of a radial artery loop does not substantially affect the overall outcomes of CAG.

The originality of this study lies in its focus on investigating the incidence and impact of radial artery loops in patients undergoing coronary angiography (CAG) in a Pakistani cohort. While the impact of radial artery anomalies, including loops, has been reported in other international studies, this research fills a gap in the existing literature by providing insights into the outcomes in a Pakistani clinical setting, where limited data is available. Furthermore, it is one of the few studies to assess the procedural impact of radial artery loops specifically on CAG outcomes.

This study's findings align with those of other international research, such as the study by Garg et al. (2021), which reported a 0.9% incidence of radial artery loops in patients undergoing transradial coronary procedures. Similarly, Lo et al. (2008) found a 13% incidence of radial artery anomalies, including loops, and suggested that such anomalies contribute to procedural difficulties and increased failure rates.[7,13] This study concurs with these reports, indicating that while radial artery anomalies, including loops, are not uncommon, they do not necessarily lead to poor procedural outcomes in CAG when managed appropriately.

Moreover, studies conducted in other countries such as Egypt and Macedonia have reported that the incidence of radial artery anomalies ranges from 1% to 12%, with full radial loops being among the most challenging anomalies to manage.[5,14] These studies have highlighted the increased risk of procedural failure in patients with radial artery loops, a finding that was not supported by the current study, which observed no significant procedural failures or complications in patients with radial artery loops.

While studies investigating radial artery anomalies in Pakistan are limited, the study by Munir et al. (2022) on radial artery occlusion (RAO) after transradial access in Karachi indicated a relatively high incidence of RAO in patients undergoing coronary angiography.[15] However, this study did not specifically address the impact of radial artery loops. The findings of the present study contribute valuable local data by investigating the procedural outcomes in patients with radial artery loops, a topic not previously explored in Pakistani research.

The results from this study indicate that the presence of a radial artery loop does not significantly alter the outcomes of coronary angiography. This is consistent with international literature suggesting that while radial artery anomalies such as loops can complicate the procedure, they do not necessarily lead to increased complication rates or procedural failures when managed effectively. Additionally, the absence of significant differences in recovery time, procedural success rates, and post-procedural complications further supports the notion that radial artery loops can be safely navigated in clinical practice.

Study Limitations and Future Directions

While this study provides valuable insights, there are several limitations. First, the retrospective design of the study means that certain variables could not be controlled, such as operator experience or patient selection bias. Second, the sample size was limited to 150 patients, which may not fully represent the broader population. Future studies could consider a larger, multicenter cohort to validate these findings. Additionally, more prospective studies are needed to explore the long-term outcomes of patients with radial artery loops, including the impact on coronary

intervention procedures such as percutaneous coronary intervention (PCI).

Future research should also focus on identifying the predictors of radial artery loops and determining whether specific imaging techniques or pre-procedural screening methods can help reduce procedural complications. Moreover, studies comparing the outcomes of patients with different types of radial artery anomalies could provide further insights into the varying degrees of impact on procedural success.

CONCLUSION

The primary objective of this study was to determine the incidence and outcomes of radial artery loops in patients undergoing coronary angiography (CAG) at Hayatabad Medical Complex, Peshawar. The study successfully achieved this by investigating various procedural outcomes, including procedural time, complications, recovery time, radial artery occlusion, and procedural success in patients with and without radial artery loops. The results of the study indicate that the presence of a radial artery loop does not significantly impact key procedural outcomes such as procedural time, recovery time, complications, radial artery occlusion rates, or procedural success. These findings align with the study objectives by providing evidence on the effects of radial artery loops in CAG procedures, demonstrating that they do not substantially alter the overall success of the procedure. The study's findings, which showed no statistically significant differences between the two groups, support the conclusion that radial artery loops, despite being a known anomaly, do not significantly compromise procedural outcomes. The absence of a notable effect on procedural success and recovery reinforces the notion that radial artery loops can be effectively managed during CAG. The take-home message from this study is that radial artery loops, while a challenging anatomical variation, do not significantly affect the success of coronary angiography. With appropriate management, these anomalies can be navigated successfully, ensuring favorable outcomes for patients undergoing CAG procedures.

Future Recommendations

Based on the findings of this study, future research should focus on further validating these results with larger, multicenter cohorts. Additionally, prospective studies examining the long-term outcomes of patients with radial artery anomalies, including loops, in both diagnostic and interventional coronary procedures would provide valuable insights. It is also recommended that future studies explore predictive factors for the occurrence of radial artery loops and investigate the impact of different procedural techniques or imaging methods on reducing complications in patients with such anomalies.

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