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Complications Associated with Transradial Access in Coronary Angiography and Intervention

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ABSTRACT

Objectives: The study's goal is to compare distal and traditional methods in order to investigate the complications related to transradial access in coronary angiography and intervention. **Materials and Methods:** This study was conducted at the Department of Cardiology, AFIC, Rawalpindi, Pakistan in the period from January 2022 to December 2023 in patients with the age of 18 years and more who underwent coronary angiography or percutaneous coronary intervention via radial artery. Inclusion required the participant to sign an informed consent form and for data capture a complete record review. **Results:** The study conducted among 300 patients showed that the complication rate of the procedure was 10%. In particular, there was a significant and highly statistically significant difference to complications where distal transradial intervention had a rate of 5% and conventional approach had 15%. The most frequent complication documented was radial artery spasm which was managed using appropriate medications. **Conclusion:** Transradial access for coronary procedures are safe particularly with the distal located access which can potentially add more value to the improvement of the patient. These studies underscore the importance of technical improvement involving general and procedural aspects of care to prevent complications during cardiology procedures.

INTRODUCTION

Coronary angiography and percutaneous coronary intervention (PCI) are the key procedures in the assessment of CAD; both are highly informative as diagnostic and therapeutic approaches. In the past, these procedures used to be performed with femoral access; however, there has been an increased practice with transradial Access (TRA) due to the benefits associated with it. These advantages include, therefore, fewer incidences of complications like bleeding and formation of hematomas and improved comfort of the patient with quicker recovery rates. Moreover, with the help of the TRA approach, patients get better mobility during and after the intervention, which increases their satisfaction. However, several issues can still be associated with the use of trans-radial access, including radial artery spasms and access site complications.

The key advantage of transradial access is that it is related to reduced risk of bleeding compared to femoral access. Experience from multiple trials has uniformly shown that TRA is associated with reduced incidence of major bleeding events, hematoma formation, and complications related to the vascular access site (1,4). For example, a meta-analysis of 38 studies reported that the use of radial access as a means of site of intervention is associated with reduced significant complications

and mortality in patients undergoing coronary procedures (4). This trend has not only helped to increase the adoption of TRA among interventional cardiologists but has also shifted the entire practice among cardiologists, as most of them prefer TRA compared to femoral access for coronary angiography and percutaneous coronary intervention (PCI). Furthermore, the reduced incidence of complications following TRA has field safety benefits, accelerates shorter hospital stays, and results in improved outcomes.

Nonetheless, the use of the transradial access (TRA) procedure has been hailed as safer than femoral access for coronary interventions, though it is not without its adverse effects. Concerning complications of the radial approach, radial artery spasm while performing the procedure is a well-known problem, as well as occlusion and distal ischemia. These complications can lead to either procedural disorder or alterations in the procedures that are being followed and also influence the outcome of the patient's course of action. Several investigations have described increasing incidence of radial artery patency after the procedure, some even up to 10% (2). The incident shows that there is a need to closely monitor the patient and, more importantly, manage this patient in the postoperative period. Another significant adverse effect related to TRA is radial artery spasm, which can occur due to patient stress, very winding blood vessels, and some anatomical features. There is also an increased risk of achieving the desired results of the procedure, and the spasm may require conversion to a femoral approach or more pharmacological agents to effectively combat the spasm (2, 5). Such complications call for clinicians to use strategies that may help to avoid such risks, as indicated below. These may include the use of vasodilators,pre-procedural sedation techniques, and adequate choice of catheter that will ensure the patient's comfort and success of the procedure.

More recently, distal transradial access (dTRA) has raised interest as an approach to address some issues related to conventional TRA. These trials show that dTRA may reduce complications; therefore, more benefits than traditional TRA, including reduced discomfort and lower risk of vascular complications (3, 6). Furthermore, the meta-analysis of the systematic review established that dTRA for coronary procedures is safe and feasible with a trend toward reduced access site complications than TRA (1, 3). However, moving towards the management and use of dTRA on hashtable requires an increased understanding of some of the issues related to dTRA, as well as the differences in efficiency between the two types of access methods.

An understanding of the anatomical and procedural conditions of complications in TRA is highly important for safe practice and for achieving favorable results. Dispositions such as the size and position of the radial artery have a relatively large effect on both the TRA and the dTRA with regard to success rates. They can pose certain issues during the catheterization of arteries and increase the possibility of spasms or complete occlusion. However, capability and the period of the operation affect these complications immensely. Some published works have also shown that the extent of procedural documentation done in PTA-VSD and PTCA procedures is a factor of the invades operators' expertise level. Al fact works as supporting evidence for the author's idea about general positive outcomes of extensive, thorough training when it comes to employing both kinds of access (9, 11). Such kind of training is very useful in the enhancement of expertise in possible anatomical problems in interventions.

Despite the fact that the current discourse regarding the safety of the transradial approach is still ongoing, patient-specific factors of complications should not be overlooked. Many procedural aspects are influenced by patients' characteristics, such as age, sex, comorbidities, and anatomical features of a patient (8, 10). Different works have noted that elderly patients ages 65 years and above and those with co-morbid conditions are at a greater risk of developing complications than comparatively younger patients with no disease or single disease (12, 13).

The issue of management of complications relating to Transradial Access (TRA) has also evolved tremendously in the recent past. New approaches, techniques, and devices have been developed predominantly to minimize the risks of complications arising from this type of access. One such improvement is the use of ultrasound as the case progresses in order to maximize the chances of gaining radial access. It is not only useful concerning the rate of finding the radial arteries,

but it also decreases complications of hematoma formation and arterial spasm at the site of puncture (13, 15). Moreover, new hemostatic devices are the gear to improve the closing of the vessel used as the access site and minimize the risks of bleeding in the subsequent period (7, 14). These devices have been designed to enable closure while requiring minimal force due to their being time-consuming and uncomfortable for many patients.

OBJECTIVE

This research aim is to assess the complications associated with transradial access in performing coronary angiography and intervention, where the distal technique will be contrasted against the standard technique. Thus, reviewing the recent publications, the concern is to identify the risk factors, procedural outcomes, and management strategies that may help to enhance patients' safety and strengthen the existing recommendations in the context of cardiovascular techniques.

MATERIALS AND METHODS

Study Design: Cross-Sectional Study.

Study setting: The present research was conducted at Department of Cardiology, AFIC, Rawalpindi, Pakistan.

Duration of the study: The study was conducted from January 2022 to December 2023.

Inclusion Criteria

Inclusion criteria incorporate the patients aged 18 years and above, who underwent coronary angiography or had percutaneous coronary intervention through the radial artery in the course of the study period. The results also included patient who had a signed consent forms and whose medical records were also complete.

Exclusion Criteria

Exclusion criteria for the study included those patients who had prior radical interventions, emergency cases, and patients with absolute contraindications to radial access, like severe arterial disease or coagulopathy.

Methods

Data were retrieved from the patient's charts who had undergone coronary angiography and percutaneous coronary intervention through a trans-radial approach in the cardiac catheterization laboratory, Department of Cardiology, AFIC, Rawalpindi, Pakistan from January 2022 to December 2023. Data collected included the patient characteristics and procedural features, as well as complications, including radial artery spasm or occlusion, hematoma formation, or other related problems with the access site. The nature and handling of the complications were noted for the purposes of evaluating their influence on the success of the procedure. Data analysis was conducted using the statistical package SPSS, while descriptive statistics were used to analyze the demographic characteristics of the patients and the overall incidence of complications. Data was analyzed with Categorical variables analyzed using the Chi-square test, while continuous variables were analyzed by use of t-tests at a $p < 0.05$ level of significance.

RESULTS

Altogether, 250 patients took part in the research, and the age of the respondents was diverse, with an average age of 58 (±10.5). With regard to gender, 60% of participants were male while 40% were female, an incidence noted in most patients with CAD. All these patients underwent coronary angiography or percutaneous coronary intervention during their treatment. In particular, 60% of patients, 150 patients with known coronary artery disease, received conventional transradial access or recently popular distal transradial access (TRA), and 40% of patients, 100 patients, received standard distal transradial access (dTRA).

Table 1

Patient Demographics

Demographic Characteristic	Total (n=250)	Conventional access (n=150)	Distal Access (n=100)	Demographic Characteristic
Age (years, mean ± SD)	58 ± 10.5	59 ± 11.2	56 ± 9.5	Age (years, mean ± SD)
Gender				Gender
Male	150 (60%)	90 (60%)	60 (60%)	Male
Female	100 (40%)	60 (40%)	40 (40%)	Female

Complications in this study occurred in 25 patients (10.0%), meaning that although the complication rate is moderate, it is workable during the entire duration of the study. A relatively large variation

was observed between the two access groups. The complication rate in the TRA group was 15 %, while in the dTRA group, it was 5%. This work further supports the notion of the safety of dTRA as a safer approach than other conventional prescriptions. The most common problem was hand pain in 10% of patients, which resulted in radial artery spasms, which may cause technical challenges throughout the procedure. Besides, hematomas were registered in 3 % of patients, which is manifested by localized swelling and bruising and radial artery occlusion in 2 % of patients, which may have consequences for the patency of the radial artery in the future.

Table 2
Complication Rates

Complication Type	Total (n=25)	Conventional access (n=22)	Distal Access (n=3)
Radial Artery Spasm	10 (4%)	8 (5.3%)	2 (2%)
Hematoma	8 (3%)	6 (4%)	2 (2%)
Radial Artery Occlusion	5 (2%)	5 (3.3%)	0 (0%)
Other (e.g., pain, bleeding)	2 (0.8%)	3 (2%)	0 (0%)

The vast majority of complications could be treated conservatively by medications for radial artery spasm and pressure application to hematoma. Radial artery occlusion was observed in one patient on post-procedure day 2, and surgical intervention was done for the same. In terms of procedural success, 95% were achieved while there was no significant difference in the success rate of the two access methods. Still, distal access approach appeared to have lower complication rate in general, though this difference did not reach statistical significance in this study.

Table 3
Management of Complications

Complication Type	Management Approach	Number of Cases (n=25)
Radial Artery Spasm	Pharmacological (nifedipine)	10
Hematoma	Compression and observation	8
Radial Artery Occlusion	Surgical exploration	1
Other (e.g., pain)	Observation	6

Finally, the results reveal that despite the fact that complication rates related to transradial access are still reasonably low, there is a difference between conventional and distal methods. The distal transradial approach seems to provide the advantage of lower complications suggesting that more assessment and training of this technique should be done as it can provide better results to the patients.

DISCUSSION

The transradial approach for coronary angiography and intervention has had increased acceptance because of several factors, such as its safety profile and fewer complications compared to the transfemoral technique. The purpose of this research was to identify the main complications in the use of transradial access with reference to conventional and distal access methods. The results showed that although transradial access is relatively safe, differences in the complication rates between the two techniques warrant a better understanding of their significance at the clinical level.

The demographic profile of the studied population revealed that there were more males than females, which is further supported by research as men are more likely to suffer from coronary artery disease. The age distribution of the participants also meant a normal distribution, as would be expected of patients who would undergo coronary artery interventions. However, it is worth understanding that this demographic distribution of patients dictates that adequate and effective strategies involving their management have to be developed relying on the demographic risks identified as the most effective amongst the patients who belong to the high-risk category. These findings support the study by Bajraktari et al. (2021), who noted that the characteristics of the patients are key determinants of procedural outcomes as well as complications.

Out of the total sampled patients, complications were noted in ten percent of the patients; this is on par with research literature that records different rates of complications associated with trans-radial access. However, the rate of complications in the conventional access group was 15%, while that of the distal access group was only 5%. These differences emphasize the advantages of distal trans-radial access, which was mentioned by Ferrante et al. (2022) and Hamandi et al. (2020) about possible reduction of the vascular complications by avoiding the apportion

of the proximal radial artery that demonstrates variability in anatomy.

Radial artery spasm was mentioned as the most frequent complication recognized in 4% of the cases. This finding is in consonance with the study that was carried out by Roy et al. (2022), which established that radial artery spasm is usual in transradial intervention. The spasm can bring procedural delays and thus augment the discomfort of the patients, which is not suitable for them. Nonetheless, in the present case, the spasm was effectively managed in medical management with nifedipine, a calcineurin inhibitor acknowledged for treating arterial spasms (Xie et al., 2021).

Hematomas occurred in 3% of the patients, with the majority in the conventional access group. This complication arises from a secondary intimal injury that results from forces involved in puncture or inadequate coagulation during the closure phase of the procedure. Di Santo et al. (2021) and authors Srinivasan & Desai, Álvarez-Larriva et al., Khandhar et al. who analyzed the peculiarities of the interaction between the access-site-related hematoma and other complications underline the importance of technique since it was stated that the technique is closely related to the occurrence of hematomas and other complications. This study has shown that compression and observation were adequate to address the hematoma and maintains the fact this complication is not as dangerous as it might seem.

The rate of radial artery occlusion was 2% of the total study sample, and all the patients conformed to the criteria for the traditional access group. This result aligns with a meta-analysis performed by Sedhom et al. (2021) on arterial occlusion rates which found that conventional radial access entails higher rates more than the distal approaches. These restrictions can influence the future workflow of cardiovascular interventional procedures. Thus, the rare case in which we identified a patient requiring surgical exploration of the treated site highlights that access site and technique should be chosen judiciously. Cai et al. (2020) stated that the possibility of handling the long-term sequelae of occlusion depends on the ability to maintain proper collateral circulation.

The procedural success rate of 95% in the present study is promising and is consistent with the research studies available. Incremental improvements in technology and the methods used in the procedure have also positively contributed to the high success rates associated with transradial access (Mizuguchi et al., 2020). Notably, although our study showed a comparable trend of reduced complications when using distal transradial access, the overall success was similar with both techniques. This implies that when complications have been identified, they do not mean that the success of the procedure will be small (Hirzallah et al., 2020).

Most of the complication management reported in this study was conservative, reaffirming the changing paradigm in cardiology, where fewer invasive interventions are performed to manage complications related to radial access. Majority of cases in the present series involving radial artery spasm and hematoma were treated conservatively and pharmacologically, stressing the roles of a multidisciplinary team in the treatment of such complications. Furthermore, a low number of serious complications support the view that the transradial approach is safe compared to femoral access for coronary procedures.

However, trans-radial access safeguards have benefits that hinder wide acceptance in some ways. That is one of the techniques' challenges; learning how to conduct the study can be quite a task. In a study by Krittanawong et al. (2024), it was pointed out that due to operator experience, many transradial procedures are safe and effective. Developing and maintaining training and mentorship may also help to break this gap and ensure that healthcare professionals are properly prepared to perform the specified procedures safely.

CONCLUSION

In conclusion, this work reveals that the transradial coronary angiography and intervention approach is safe and efficient, with an overall complication rate of only 10%. They also highlight a variation in complications between conventional and distal transradial access, where the latter having the lowest number of complications at 5% as compared to 15%. This was replaced by spasm of radial artery which was the most frequently reported complication that could nonetheless be managed medically. The procedural success rate gotten to

95% also supports the use of transradial access. On the basis of present findings, it can be postulated that distal TRA may enhance the safety of patients without compromising procedures' effectiveness. Training and experience are paramount to enhancing specific techniques on the part of the operators in a bid to avoid discouraging accidents. Therefore, more extensive and larger-scale research is needed to affirm these findings and use them to improve the transradial approach in coronary interventions, thus improving patients' outcomes within cardiovascular therapy.

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