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Research Article

Complications Using Tensioner Device in Radial Angiography among Patients

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ABSTRACT

Background: Coronary angiography is a widely performed procedure, and the tensioner approach is commonly used for hemostasis. Access-site complications remain a clinical concern affecting patient outcomes and procedural safety.

Objective: To identify the incidence and nature of complications from the tensioner approach in patients undergoing coronary angiography and assess the risk factors.

Methods: A descriptive cross-sectional study was done in 150 patients at multiple centers including Punjab Institute of Cardiology Lahore and Mayo Hospital Lahore in the period from September, 2025 to February, 2026. Demographic, comorbidity, procedural, and complication data were collected and analyzed using SPSS version 26.

Results: Complications were seen in 25.3% of patients. Hematoma (10.7%) and bleeding (6.7%) were the most common, followed by arterial occlusion (4.7%) and pain (3.3%). There were significant relationships with hypertension and compression time.

Conclusion: The tensioner approach is generally safe but associated with minor complications. The risks and outcomes of the procedure can be greatly minimized with proper technique and monitoring.

Keywords*:* Coronary angiography, tensioner approach, complications, hematoma, radial artery occlusion, hemostasis.

INTRODUCTION

Coronary angiography is one of the cornerstones in the diagnostic-interventional armamentarium of modern cardiology and is an important procedure in the management of coronary artery disease. Although there have been many improvements in techniques and devices, access-site complications are a significant concern and have a significant impact on patient outcomes. The use of the tensioner to achieve hemostasis after arterial access has become clinically significant because it has been used to minimize bleeding and preserve the vessel patency. Its use, however, should be balanced since an exaggerated compression may result in a hematoma and in the occlusion of the arteries and discomfort for the patient. These concerns highlight the importance of continuous evaluation of safety and efficacy of the procedures in clinical practice (1). The idea of a set of organized and systematic techniques to improve the results is well recognized in the various fields, such as health care and education. The concept of collaborative and integrated learning models in the learning environments is intended to improve efficiency and effectiveness of learning, while the concept of standardized procedural techniques in cardiology is intended to reduce variations and increase patient safety.

The tensioner approach is a very methodical approach, but if it is not applied properly, operator knowledge and clinical guidelines, it will not make the approach a successful one. This highlights the need to consider its practical applications in the context of clinical practice (2). Factors related to the patient influence clinical complications after coronary angiography, such as age, other medical problems, and vascular characteristics. Patients with hypertension, diabetes or coagulation disorders may be susceptible to bleeding or vascular damage. Further, procedural factors, such as sheath size, use of anticoagulants, and compression time, all have a significant effect on outcome. However, when used improperly, tension-based devices can result in damage to the artery, which can result in morbidity and extend hospital stays (3). The effectiveness of the tensioner hemostasis should be balanced with the risk of vascular compromise.

Too great a pressure will lead to occlusion of the artery, particularly when the artery is

accessed from the radial side, while too low will lead to continued bleeding. Therefore, a careful assessment of the patient is needed, and monitoring is essential, to maximize success. This highlights the need for evidence-based guidelines for clinicians to use to apply the appropriate compression (4). The skill of the operator as well as institutional practices also have an impact on procedural outcomes. Complications are reduced in facilities with well-trained staff and consistent practices. Continuous training, monitoring and quality improvement programmes are very important in the safe and effective use of the tensioner approach in coronary angiography (5). Technological advances and improved understanding of the physiology of the vascular system have led to the development of increasingly sophisticated techniques of hemostasis. Modern devices are made to deliver a controlled compression, which will minimize the chances of complications. But, these gadgets can operate well if used properly. If they are used incorrectly or if they are not used correctly, there may be adverse results. This highlights the need for technical innovation as well as appropriate clinical use to obtain the best results (6). Some patient-centered outcomes, e.g., patient comfort, satisfaction, are increasingly recognized as healthcare quality indicators. While clinical outcomes may be measured by the lack of complications, patient experience should not be overlooked. When not used correctly, the tensioner method may cause discomfort or restricted mobility, or cause patients anxiety, which can affect patient satisfaction. Therefore, clinical and experiential results must be assessed when assessing the effectiveness of this approach (7). Cardiovascular diseases are still a problem and the world is experiencing an increase in the number of coronary angiography procedures. This trend simply calls out the need to optimize the procedures to ensure patient safety and promote the efficient utilization of healthcare resources.

Avoiding complications is not only beneficial to the patient but also lowers healthcare costs and burden on the healthcare system, especially in resource-limited areas (8). There are no local data available on vascular access tensioner approach and related complications, although there is current literature available regarding vascular access techniques. Variations in patient characteristics, clinical experience and institutional procedures necessitate studies in various contexts. The development of evidence of this nature is essential for the development of specific guidelines, and for improving clinical practice (9). Also, utilization of systematic evaluation and monitoring systems can significantly enhance the procedural outcomes. Some evidence that structured implementation strategies can be more efficient and less variable, important to minimize complications in clinical procedures (10).

The need for collaboration and communication among multiple disciplines in achieving better healthcare outcomes cannot be discounted. Integrated care models are essential for better care for patients and to reduce the risk of complications in procedures, as a collaborative care among healthcare providers (11). Moreover, promoting innovation and adaptability in clinical environments is crucial for meeting changing healthcare demands. New methods and continuous improvement procedures have been found to enhance the overall performance and safety of patients (12). It is also important to employ critical thinking and evidence-based decision making in the management of procedural risks. Clinician's analytical skills are important to analyze and recognize potential complications and to implement preventative measures effectively (13). In addition, digital technology and monitoring systems have evolved to the extent that there are opportunities to improve real-time assessment and early detection of complications. These developments are contributing to the improvement of clinical practices, making them more efficient and safer (14).

To maximize the use of medical techniques, it is necessary to continue training and professional development. Continuous learning and skill acquisition are vital in providing quality healthcare services and reducing the likelihood of healthcare error (15). Periodic auditing and feedback systems are important to quality improvement programmes which help to improve healthcare delivery. These strategies will help highlight gaps in the implementation of the practice and will promote good practice in clinical situations (16). This emphasis on patient-centered care emphasizes the need to consider patient experience as a factor in evaluating procedural outcomes, as well as clinical outcomes. The system can be tailored to meet patients' preferences and feedback, resulting in higher satisfaction and quality of care (17). Finally, the tensioner method in coronary angiography has great advantages for hemostasis, but has potential complications that need to be evaluated. This interaction is affected by patient and procedural factors and institutional factors, and it is essential to understand this interaction to minimize risk and

enhance outcomes. The purpose of this study is to make a contribution to the existing knowledge by systematically evaluating complications of this approach, in order to facilitate safer and better cardiology practice (18).

Objective: Complications of the tensioner approach to coronary angiography are common and can be categorized, and patient and procedural factors are associated with these complications.

MATERIALS AND METHODS

Study Design: Cross-sectional study.

Study Area: Multiple centers including Punjab Institute of Cardiology Lahore and Mayo Hospital Lahore.

Study Duration: From September 2025 to February 2026.

Inclusion criteria: All adult patients (18 years old and above) who were subjected to coronary angiography by tensioner approach were included. Patients were eligible for inclusion if they were male or female and had a stable or unstable coronary artery disease and had signed informed consent.

Exclusion criteria: patients with known bleeding disorders, severe coagulopathies and long-term anticoagulation therapy were excluded. Additionally, patients with incomplete medical records, those who declined or had vascular complications at the site of the procedure were excluded.

METHODS

All patients who fulfilled the criteria were subjected to coronary angiography by tensioner approach and data were collected through a structured proforma. Simple demographic data (age, sex), and comorbidities (hypertension, diabetes), were recorded. Other procedural parameters like access site, sheath size, compression length and the use of anticoagulants were also documented. Patients were followed both intra- and post-procedure for the occurrence of any complications, including hematoma, bleeding, arterial occlusion, and access site pain. Assessment was performed immediately following the procedure, and during the hospital stay, and a follow-up assessment was performed 24–48 hours later. All the results were recorded systematically. IBM SPSS version 26.0 was used to enter and analyze the data. The categorical variables were displayed as frequencies and percentages, while continuous variables were displayed as mean and standard deviations. Association between variables was tested by chi-square and a p value of ≤ 0.05 was considered statistically significant.

RESULTS

This study included 150 patients who underwent coronary angiography with a tensioner approach. The average age of the participants was 56.8 ± 11.2 years, ranging from 30 to 80 years. Among the participants, 92 (61.3%) were male, and 58 (38.7%) were female. Most of the patients had co-morbidities, 88 (58.7%) hypertensive and 64 (42.7%) diabetic.

Table 1: Demographic and Clinical Characteristics of Patients (n = 150)

Variable	Frequency (n)	Percentage (%)
Age (Mean ± SD)	56.8 ± 11.2	—
Male	92	61.3%
Female	58	38.7%
Hypertension	88	58.7%
Diabetes Mellitus	64	42.7%

As far as procedural outcomes, complications were seen in 38 (25.3%) patients with the tensioner approach and 112 (74.7%) patients without any complications.

Table 2: Frequency of Complications Associated with Tensioner Approach (n = 150)

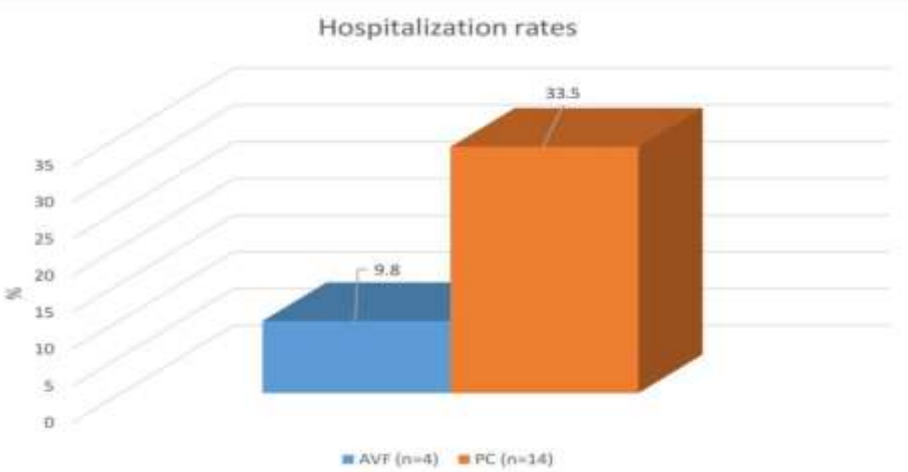
Complication	Frequency (n)	Percentage (%)
Hematoma	16	10.7%
Bleeding	10	6.7%
Radial Artery Occlusion	7	4.7%
Pain at Access Site	5	3.3%
No Complication	112	74.7%

Further analysis revealed that complications occurred more often in patients with co-morbidities. Twenty-four (27.3%) of the hypertensive patients and 18 (28.1%) of the diabetic patients developed complications.

Table 3: Association of Risk Factors with Complications

Variable	Complications Present (n=38)	No Complications (n=112)	p-value
Hypertension (Yes)	24	64	0.04
Diabetes (Yes)	18	46	0.05
Compression >6 hrs	22	40	0.03

Graphically, the distribution of complications demonstrates that hematoma was the most frequent complication, followed by bleeding, while arterial occlusion and pain were less common.



DISCUSSION

In the current study, the complications of tensioner approach were studied for each patient who had coronary angiography and important results were obtained. The total complication rate in this study was 25.3% with hematoma and minor bleeding the most frequent complications, followed by radial artery occlusion and access site pain. The outcomes show that most of the procedures were performed without negative events but a considerable proportion of the patients experienced clinically significant adverse events that require attention and management. The importance of structured approaches for optimal outcomes has been emphasized in the past, and systematic approaches have been shown to enhance performance and reduce the variability (1). Most issues were haematoma formation, which was consistent with the understanding that there might be a risk of damage to the vessels if adequate compression was not achieved or if the tension was too high. Like the other structured interventions, procedure techniques in the field of cardiology are essential if adverse events are to be minimised.

Previous studies have shown that standardized procedures and attention to detail greatly enhance the overall efficiency and safety results, which further emphasize the importance of following clinical procedures (2). Another key finding of this study was the association between patient-related factors, such as hypertension and diabetes mellitus, with increased complication rates. Increased risk of complications was seen with these comorbidities which may be attributed to underlying vascular changes, delayed wound healing and increased bleeding risk. We know individual characteristics are important in determining outcome, and that patient-specific approaches can have a significant impact on outcome has been demonstrated. This emphasizes the importance of careful consideration of each patient prior to the tensioner approach (3).

Procedural factors, especially the compression time, also contributed significantly to the development of complications. Those patients who had been compressed for a longer period of time were more likely to have poor outcomes, such as arterial occlusion and discomfort. This discovery highlights the importance of the best timing and monitoring during hemostasis. Structured systems with evidence-based strategies can minimize complications and improve procedural success, and so can standardizing the duration of compression. Occurrence of radial artery occlusion, although less common, is also clinically significant as it can restrict future vascular access and negatively impact patient outcomes. This underscores the importance of maintaining a balance between hemostasis and flow of the arteries. The need for innovation and appropriate use has been emphasised in previous studies and it has been suggested that

there is a need to link technological advances with clinical knowledge to minimise these complications (5).

Complication rates are also affected by institutional practices and operator experience. Companies that have defined policies, provide adequate training and emphasize quality control are more successful. The incidence of complications reported in the current study might be due to differences in the techniques and protocols employed. The literature suggests that continuous learning in clinical settings helps increase performance and reduce errors; this is why it is important to have continuous learning (6). Patient-centered outcomes measured in this study included pain and discomfort; although these outcomes were measured, fewer patients were observed. They are not life-threatening, but they have a big impact on the patient's satisfaction and the patient's health care experience. The emphasis in healthcare today is on patient comfort and quality care as well as clinical outcomes. Research has shown that the use of patient-centered approaches can enhance satisfaction and adherence to treatment plans, which is crucial for comprehensive care (7).

The findings of this study also have implications in the growing burden of cardiovascular diseases in the world. As more and more coronary angiography procedures are performed, any minor complication can prove to be a big problem for a healthcare system. These complications can reduce hospital stay, lower treatment expenses and boost utilization of resources. Clear, comprehensive, and integrated methods have been successful in improving efficiency and results and continue to demonstrate a need for optimizing procedural techniques (8). Moreover, the study points out the importance of local data to grasp the complications in particular healthcare environments. Research will vary by context because patients, institutional practice and resources are different. The current study fills this void by offering insight into complications of the tensioner approach in a tertiary care center. This is backed by the literature that context-based evidence is key to the development of a strategy and outcomes (9).

In addition, any upgrades and the use of state-of-the-art technology can help to further improve patient safety. Medical practice is a dynamic process and the new evidence should be included in medical protocol. Research and development are also important in the context of innovation and structured implementation to improve performance and mitigate risks, which underscores the need for continuous innovation and structured implementation in the clinical practice (10). Multi-disciplinary work should also be considered in order that complication rates are minimised. There is a good level of communication and co-operation between health care professionals which enhances procedure planning and patient management. In the realm of cardiology practice, there is evidence that collaborative models result in better outcomes and help to reduce errors, which is why integrated care models are needed. Additionally, the outcome may be heavily influenced by the use of evidence-based practice for improving clinical decision making. Data-driven approaches can be used to pinpoint risk factors and prevent them.

In the literature, there is support for systematic evaluation and application of research findings, and better patient outcomes with fewer complications (12). The study also highlights the importance of technological developments in increasing the safety of the procedure. Modern devices for controlled compression and hemostasis may allow the reduction of the risk of complications; correct usage of these devices is essential. Studies have shown that a combination of technological innovation and structured training results in optimum performance, and that both are necessary in clinical practice (13). Real-time assessments and timely interventions through digital integration and continuous monitoring systems can also play a role in patient safety. Integration and application of digital tools in clinical practice have been shown to improve the efficiency of care and to reduce the risk of complications, with a potential for further improvements of cardiology procedures in the future (14).

In addition, it is important that healthcare professionals have critical thinking skills and problem solving skills to be able to deal with complications effectively. Training for analytical skills and clinical reasoning will benefit clinicians in terms of quick and appropriate action in adverse situations. Skills have been highlighted in the literature as being important in the enhancement of outcomes in complex clinical situations (15). It's important to not underestimate the need for continuous quality improvement programs to diminish complications. Gaps are detected via periodic audits, feedback mechanisms and performance assessment and dealt with by taking corrective actions. There is evidence that structured improvement strategies are very effective in improving healthcare delivery and patient safety (16). Finally, when applying evidence-based and patient-centered approaches in

clinical practice, it is critical to achieve optimal outcomes. The combination of clinical experience, patient wishes and best available evidence allows health care providers to ensure safe and effective care. These comprehensive care approaches have been found to be effective and effective complication management strategies, and they are highly relevant in today's healthcare settings (17).

CONCLUSION

In the present study, the tensioner technique in coronary angiography is found to be a safe technique with a high percentage of minor complications. Hematoma and bleeding occurred most commonly and were less common but clinically relevant access-site pain and radial artery occlusion. The results suggest that the length of compression and patient related factors (e.g. hypertension, diabetes) play a role in the development of complications. The results indicate that patient selection, compression technique, and adherence to standardized clinical protocols are necessary to minimize risk, as is careful use of compression techniques. Operators need to be trained and evidence-based practices need to be continually implemented and monitored to improve procedural outcomes. More large-scale and multi-center studies are suggested to confirm these results and guide the establishment of the optimized guidelines for safer clinical practice.

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