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Clinical Outcomes and Vascular Safety of the Distal Transulnar Approach for Coronary Angiography and Angioplasty

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ABSTRACT

Background: The transradial approach has become the standard access for coronary angiography and intervention, yet limitations such as radial artery occlusion, spasm, and vessel loss for future grafting necessitate alternative access routes. The distal transulnar approach, utilizing the superficial palmar branch of the ulnar artery, has recently emerged as a promising option due to its favorable anatomy and collateral circulation.

Objective: To evaluate the feasibility, procedural performance, and vascular safety of the distal transulnar approach for coronary angiography and PCI.

Patients and Methods: This prospective observational study included 45 adult patients undergoing diagnostic or interventional coronary procedures via the distal transulnar route. Primary endpoints were procedural success, sheath insertion time, hemostasis time, and vascular patency. Secondary endpoints included access-site and systemic complications. Duplex ultrasonography and Barbeau testing were performed two weeks post-procedure.

Results: All 45 procedures (100%) were successfully completed without conversion to another access site. The mean sheath insertion time was 153.3 ± 79.8 s, total procedural duration 30.8 ± 14.9 min, and hemostasis time 87.1 ± 14.2 min. Minor complications included puncture-site pain (15.6%), numbness (8.9%), minor bleeding (11.1%), and small hematoma (11.1%), all resolving conservatively. Duplex ultrasound at follow-up showed preserved ulnar patency in 95.6% and antegrade flow in 88.9% of patients. No major bleeding, hand ischemia, neurological deficit, or major adverse cardiovascular or cerebrovascular events occurred.

Conclusion: The distal transulnar approach is a safe, feasible, and efficient alternative for coronary angiography and PCI, providing high procedural success, rapid hemostasis, and excellent vascular preservation with minimal complications.

Keywords: Distal Transulnar Approach, Coronary Angiography, Percutaneous Coronary Intervention, Vascular Safety, Ulnar Artery.

INTRODUCTION

Over the past two decades, the transradial approach (TRA) has revolutionized coronary angiography (CAG) and percutaneous coronary intervention (PCI), offering significant reductions in access-site bleeding, vascular complications, and mortality compared with the traditional transfemoral route [1,2]. These advantages have positioned TRA as the preferred access worldwide, endorsed by both European and American guidelines. Nevertheless, TRA is not without limitations—radial artery occlusion (RAO), spasm, anatomical variations, and the potential loss of the artery for future grafting or hemodialysis access remain relevant challenges [3-5]. As transradial techniques have matured, the search for equally safe but anatomically distinct alternatives has intensified, particularly to preserve radial artery integrity and reduce post-procedural complications [6].

In this context, the transulnar approach has emerged as a feasible and anatomically sound option for coronary procedures. The ulnar artery, with its larger caliber, straighter course, and abundant collateralization through the palmar arch, offers a compelling physiological basis for intervention. Several observational and comparative studies have demonstrated the safety and procedural success of ulnar access, reporting comparable rates of spasm, hematoma, and occlusion to TRA [7]. Additionally, the ulnar route may provide a valuable alternative in patients with radial artery occlusion, severe spasm, or prior radial harvest. Despite these promising results, operator adoption remains limited, largely due to concerns about ulnar nerve proximity, access difficulty, and limited large-scale outcome data [8].

With the evolution of distal access techniques, attention has shifted toward more distal puncture sites within the hand, beyond the wrist crease. The distal transulnar approach, performed through the superficial palmar branch near the hypothenar eminence, represents one of the most recent innovations in coronary access. This technique combines the ergonomic and hemostatic advantages of distal hand punctures with the anatomical benefits of ulnar flow preservation. Early pilot studies have suggested that distal ulnar puncture allows faster hemostasis, lower risk of major vascular complications, and maintained antegrade perfusion through the superficial palmar arch [9,10]. However, the current evidence base remains limited, with most available data stemming from small series and heterogeneous operator experience, warranting further clinical validation.

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Therefore, the present study aimed to evaluate the clinical outcomes and vascular safety of the distal transulnar approach for coronary angiography and angioplasty.

PATIENTS AND METHODS

Study Design and Participants

This prospective, single-center observational study was conducted at the Cardiology Department, Helwan University Hospital, Cairo, Egypt, over a two-year period.

The study included adult patients aged 18 years or older who were referred for diagnostic coronary angiography or percutaneous coronary intervention through upper-limb access and had a well-palpable distal ulnar pulse at the hypothenar region. Patients with ulnar artery occlusion or inadequate distal ulnar pulse on physical examination were excluded. Other exclusion criteria were previous radial or ulnar artery harvesting for coronary artery bypass grafting, chronic renal failure with an ipsilateral arteriovenous fistula, known severe peripheral vascular disease, Raynaud's phenomenon, or hand deformity. Patients receiving full-dose anticoagulation with an international normalized ratio (INR) greater than 1.5 and those with known carpal tunnel syndrome or ulnar neuropathy were also excluded from participation.

Pre-procedural assessment

All participants underwent a comprehensive clinical evaluation including medical history, cardiovascular risk assessment, and detailed examination of hand perfusion. Baseline electrocardiography (ECG) and transthoracic echocardiography (ECHO) were performed to evaluate cardiac function and detect ischemic abnormalities. Laboratory investigations comprised complete blood count, renal and hepatic function tests, coagulation profile, and cardiac biomarkers when indicated. The Barbeau test was performed prior to the procedure to assess collateral circulation between the radial and ulnar arteries through the superficial palmar arch, and patients with abnormal results were excluded from the study.

Distal transulnar approach technique

All procedures were performed in a dedicated cardiac catheterization laboratory under aseptic conditions. The patient's forearm was positioned in supination with slight wrist flexion and the hand resting on a firm support. After sterile preparation, 2–3 mL of 1% lidocaine was injected subcutaneously at the level of the pisiform bone overlying the hypothenar eminence. The distal ulnar artery was punctured using a 20-gauge needle at an angle of approximately 30–45 degrees, and upon confirmation of arterial entry, a 0.018-inch guidewire was advanced to facilitate the introduction of a 5F or 6F hydrophilic sheath. Following sheath insertion, a vasodilator cocktail containing verapamil (2.5 mg) and nitroglycerin (200–250 µg) was administered intra-arterially to minimize spasm. Anticoagulation was achieved using unfractionated heparin in doses ranging from 2,500 to 5,000 IU according to the type of procedure. Diagnostic and interventional catheters were advanced under fluoroscopic guidance. Ulnar angiography was performed both at the beginning and at the end of the procedure to evaluate vessel integrity and rule out complications such as dissection or perforation.

After sheath removal, hemostasis was achieved by gentle manual compression for approximately 10–15 minutes, followed by application of a light compressive dressing. In patients undergoing PCI, a radial compression band was occasionally applied to reinforce hemostasis. Patients were encouraged to move their fingers during compression to maintain adequate collateral flow through the palmar arch.

Outcome measures and follow-up

The primary outcomes included the feasibility of distal transulnar access, defined as successful sheath insertion and completion of the intended procedure via this route, as well as procedural performance parameters such as sheath insertion time, total procedure duration, hemostasis time, and length of post-procedural hospital stay. Secondary outcomes comprised access-site complications, including pain, numbness, hematoma, bleeding, spasm, arterial occlusion, dissection, or perforation within two weeks after the procedure. Vascular patency and antegrade flow of the distal ulnar artery were assessed using duplex ultrasonography at two weeks post-procedure. Major adverse cardiovascular and cerebrovascular events (MACCE), including acute myocardial infarction, stroke, acute heart failure, or death, were also recorded during the follow-up period.

All patients were examined immediately after the procedure, before discharge, and at a scheduled follow-up visit two weeks later. The Barbeau test was repeated to assess palmar arch integrity, and duplex ultrasonography using a 7.5–10 MHz linear transducer was performed to detect any occlusion or stenosis at the puncture site. Any vascular or systemic complication was documented in detail.

Ethical considerations

The study was approved by the local Research Ethics Committee of Helwan Faculty of Medicine, and all participants provided written informed consent before enrollment. The research complied with the ethical standards of the Declaration of Helsinki for human studies.

Data Management

Data were collected, organized, and analyzed using Microsoft Excel (Microsoft Corporation, USA). Continuous variables were summarized as mean ± standard deviation (SD), while categorical variables were expressed as numbers and percentages.

RESULTS

Baseline Characteristics

The study included 45 patients who underwent coronary angiography and/or percutaneous coronary intervention using the distal transulnar (superficial palmar) approach. The mean age of participants was 53.4 ± 10.5 years, and 66.7% were males. The average body weight was 80.2 ± 14.3 kg, and the mean height was 1.7 ± 0.07 m, resulting in an average body mass index of 27.7 ± 5.6 kg/m².

Among cardiovascular risk factors, 48.9% of patients had diabetes mellitus, 48.9% had hypertension, 40% had dyslipidemia, and 44.4% were active smokers. A positive family history of coronary artery disease was present in 28.9% of cases. Electrocardiographic examination revealed ischemic changes in 26.7% of patients, while echocardiographic abnormalities indicating wall motion or functional impairment were found in 24.4%.

Baseline laboratory investigations were within normal limits, with mean serum creatinine of 0.9 ± 0.2 mg/dL, hemoglobin level of 11.7 ± 1.1 g/dL, platelet count of 274.6 ± 73.9 × 10⁹/L, and international normalized ratio (INR) of 1.0 ± 0.04.

Procedural Characteristics

Out of the 45 procedures performed through the distal transulnar approach, 15 cases (33.3%) were percutaneous coronary interventions, and 30 cases (66.7%) were diagnostic coronary angiographies. The mean time required for sheath insertion was 153.3 ± 79.8 seconds, while the average total procedural duration was 30.8 ± 14.9 minutes. The time needed to achieve complete hemostasis averaged 87.1 ± 14.2 minutes, and the mean hospital stay following the procedure was 107.8 ± 14.0 minutes.

All procedures were successfully completed through the distal transulnar access without conversion to another vascular site. Catheter manipulation was smooth in all cases, and intra-arterial administration of vasodilators and anticoagulation was well tolerated. No technical failure or significant intra-procedural complication was encountered.

Vascular Assessment

Before the procedure, all patients had a normal Barbeau test, indicating satisfactory collateral circulation through the palmar arch. At the two-week follow-up, 86.7% of patients maintained a normal waveform, while 13.3% exhibited mild alterations without evidence of hand ischemia. Duplex ultrasonography performed at the same follow-up interval showed preserved arterial patency in 95.6% of patients, with antegrade flow present in 88.9% of cases. The mean distal ulnar artery diameter measured 2.19 ± 0.31 mm at follow-up.

Access-Site Complications

Local complications were minor and self-limited. Pain at the puncture site was reported in 7 patients (15.6%), and numbness occurred in 4 patients (8.9%). Minor bleeding was noted in 5 patients (11.1%), and small localized hematoma developed in 5 patients (11.1%), all of which resolved with conservative management. No patient experienced major bleeding, arterial dissection, perforation, pseudoaneurysm, or compartment syndrome.

Arterial occlusion was detected by duplex imaging in 4 patients (8.9%), all were asymptomatic and managed conservatively. No neurological deficits, ulnar nerve injury, or hand ischemia were observed. Throughout the two-week follow-up period, no major adverse cardiovascular or cerebrovascular events such as myocardial infarction, stroke, heart failure, or death occurred.

DISCUSSION

Our study demonstrated that the distal transulnar (superficial palmar) approach is a feasible, safe, and efficient vascular access route for coronary angiography and percutaneous coronary intervention. All procedures were successfully completed without the need for conversion to another site, confirming the high reliability of this distal access. The mean sheath insertion time was 153.3 ± 79.8 seconds, the total procedure duration averaged 30.8 ± 14.9 minutes, and hemostasis was achieved after 87.1 ± 14.2 minutes. Duplex ultrasonography performed two weeks post-procedure revealed preserved ulnar artery patency in 95.6% of cases, with antegrade flow maintained in 88.9%. Access-site complications were minimal and self-limited, consisting mainly of mild pain, numbness, and small hematomas, with no major vascular or neurological events. These findings highlight the procedural practicality and vascular safety of the distal transulnar approach when performed with careful technique and appropriate patient selection.

In harmony with our results, **Valsecchi *et al.*** [11] evaluated the distal ulnar palmar approach in seventeen consecutive patients undergoing coronary angiography and intervention at a tertiary Italian center. They achieved a procedural success rate of 88% (15 of 17 patients) with no major access-related complications. The mean diameter of the distal ulnar artery in their series was adequate for catheterization, supporting its anatomical suitability for coronary procedures. Similar to our experience, they reported no cases of bleeding, dissection, or vascular injury, confirming that the distal ulnar route is both safe and technically practical. The slightly lower success rate in their cohort may reflect the smaller sample size and early operator experience, while our study benefited from a larger population and a more standardized technique.

In accordance with our findings, **Abu-Serea *et al.*** [12] investigated the transulnar approach for coronary angiography and PCI in ninety patients and demonstrated high procedural success and overall

safety. Their reported puncture time of 1.7 ± 0.3 minutes indicates that ulnar access is both achievable and efficient in experienced hands. In our series, the average sheath insertion time was approximately 2.5 minutes, which reflects the expected technical challenge of engaging the superficial palmar branch of the ulnar artery, a smaller and more curved vessel. Nevertheless, both studies confirmed that the ulnar route provides consistent procedural success with minimal risk when operators are adequately trained.

Parallel to our results, **Shafiq *et al.*** [13] conducted a prospective single-center study in Egypt to assess the feasibility and safety of the transulnar technique for coronary procedures. They documented low complication rates, including minor pain, hematoma, and artery occlusion, without major bleeding or ischemic events. Our findings closely mirror theirs, as we also observed only mild, transient local reactions—pain in 15.6%, numbness in 8.9%, and small hematoma in 11.1%—all resolving conservatively. The consistency between the two Egyptian studies supports the reproducibility of ulnar access outcomes in real-world interventional practice.

Supporting our hemostatic and recovery results, **Roghani-Dehkordi *et al.*** [14] evaluated distal hand accesses, including the trans-palmar ulnar technique, in 175 patients undergoing coronary procedures. They reported rapid hemostasis and early ambulation, with patients discharged within 15–30 minutes after angiography and 1–2 hours after angioplasty. Similarly, in our cohort, hemostasis was achieved within approximately 87 minutes, contributing to shorter post-procedure observation times and earlier discharge. These comparable outcomes highlight the superficial course of the distal ulnar artery as an advantage for achieving efficient hemostasis and minimizing post-procedural hospitalization.

Comparable to our duplex findings, **Zarea *et al.*** [15] demonstrated that ulnar arterial puncture, when preceded by proper collateral assessment using the Barbeau test, does not compromise hand perfusion. Their conclusion aligns with our observation that 95.6% of patients maintained patent ulnar flow on duplex evaluation without clinical ischemia. This confirms the vascular safety of the distal transulnar approach and its negligible impact on the palmar arch circulation.

In agreement with our vascular assessment, **Maqsood *et al.*** [16] performed a comprehensive network meta-analysis including 47 randomized trials and 38,924 patients evaluating different upper-limb and femoral access routes. They found that ulnar access significantly reduced the incidence of severe bleeding and access-site hematoma compared with femoral access (OR 0.34, 95% CI 0.24–0.48). Our results corroborate these pooled findings, as no major bleeding or large hematomas occurred in our series. Collectively, these data support ulnar access—particularly its distal variant—as a safe and patient-friendly option for coronary interventions.

Similarly, **Valsecchi *et al.*** [11] observed that although the distal ulnar artery has a smaller caliber than the main ulnar trunk, it is adequate for the passage of standard diagnostic and interventional catheters. Our measured diameter of 2.19 ± 0.31 mm supports this anatomical adequacy and explains the comparable procedural efficiency achieved in our study. The small vessel size may account for slightly longer puncture times but does not compromise procedural safety or blood flow preservation, as confirmed by post-procedural duplex results.

Finally, consistent with our absence of major complications, **Abu-Serea *et al.*** [12] and **Shafiq *et al.*** [13] both reported no cases of death, stroke, or hand ischemia following ulnar access. Our experience mirrors theirs, reinforcing that when performed with precise technique and patient selection, the distal transulnar approach carries minimal risk of significant vascular or neurological complications while maintaining high procedural success and vascular integrity.

LIMITATIONS

This study has several limitations that should be acknowledged. It was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings. The short follow-up period of two weeks did not allow assessment of long-term arterial patency or delayed vascular complications such as late occlusion or aneurysm formation. All procedures were performed by operators experienced in transradial and transulnar interventions, which may not reflect outcomes in centers with less technical expertise or in the early phase of the learning curve. In addition, real-time ultrasound guidance was not routinely employed for puncture in all cases, and this could have influenced the rate of successful cannulation and access-related minor events. Finally, the study design focused on immediate feasibility and early vascular outcomes without evaluating patient-reported comfort, long-term functional recovery, or cost-effectiveness, which warrant further investigation in future multicenter trials.

CONCLUSION

The present study demonstrates that the distal transulnar (superficial palmar) approach is a feasible, safe, and effective vascular access option for coronary angiography and percutaneous coronary intervention. It provides reliable procedural success, rapid hemostasis, and a low incidence of access-site complications, with preserved arterial patency and antegrade flow on follow-up imaging. Owing to its superficial location, rich collateral circulation, and favorable hemostatic profile, the distal transulnar approach represents a promising alternative for patients in whom the radial artery is unsuitable or needs to be preserved for future use. With proper operator training and careful patient selection, this access technique can expand the

repertoire of safe distal entry sites in coronary interventions. Larger prospective studies with longer follow-up are recommended to validate these findings and further define the role of distal transulnar access in contemporary interventional practice.

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