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Journal of Clinical Cardiology and Cardiovascular Interventions
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Research Article

Distal Trans Radial Approach for Cardiac Catheterization – An Early Clinical Experience and Future Directions: An Observational Study

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Received date: August 28, 2025; **Accepted date:** September 24, 2025; **Published date:** October 16, 2025

Citation: Ankur Sabherwal, Reddy Matli RK, Sunitha Arumulla, Uma D. Karuru, Neusha Doddi, et al, (2025), Distal Trans Radial Approach for Cardiac Catheterization – An Early Clinical Experience and Future Directions: An Observational Study, *J Clinical Cardiology and Cardiovascular Interventions*, 8(14); **DOI:10.31579/2641-0419/512**

Abstract

Background:

The trans radial approach (TRA) is the preferred access for coronary angiography (CAG) and percutaneous coronary intervention (PCI) due to its lower complication rates and quicker recovery compared to transfemoral access. The distal trans radial approach (dTRA), accessed via the anatomical snuffbox, has recently emerged as a viable alternative, potentially reducing radial artery occlusion (RAO), shortening hemostasis time, and improving patient comfort. The study aims to evaluate the real-world feasibility, safety, and effectiveness of distal transradial access (DRA) as the default access site for routine coronary angiography (CAG) and percutaneous coronary intervention (PCI), and to compare it with traditional transradial access (TRA).

Materials and Methods:

We conducted a prospective observational study from January 2020 to December 2021, enrolling 100 patients undergoing CAG or PCI. Patients were assigned to either the dTRA or conventional TRAgroup. Baseline characteristics, procedural data, and access-related complications were collected. All procedures were performed by experienced radial operators using manual palpation method without ultrasound guidance.

Results:

Baseline demographics were similar between groups. Procedural success rates were high, with only two crossovers in the dTRA group. Minor vascular complications occurred in two dTRA patients; no major complications or surgical interventions were required. The dTRA group showed faster haemostasis. The left anterior descending artery was the most frequently stented vessel in both groups. Complex interventions were successfully performed using dTRA with acceptable safety.

Conclusions:

The distal trans radial approach is a safe and effective alternative to traditional TRA for CAG and PCI. It provides additional benefits such as reduced RAO risk, quicker recovery, and enhanced patient comfort. Larger, randomized studies are needed to validate these findings and potentially support dTRA as the default access method in interventional cardiology.

Kew Words: distal access; trans radial approach; cardiac catheterization; snuff box; coronary angiogram

Introduction

The radial artery (RA) has emerged as a valuable vascular access site for coronary interventions, with the trans radial approach (TRA) becoming the preferred technique since its introduction in 1993 [1- 4]. A novel variation of the trans radial approach involves accessing the distal RA through the anatomical snuffbox (radial fossa) on the dorsal aspect of the hand. The anatomical snuffbox is a concave area located on the radial side of the wrist when the thumb is extended, bordered posteriorly by the tendon of the extensor pollicis longus and anteriorly by the tendons of the extensor pollicis brevis and abductor pollicis longus. The RA traverses the floor, formed by the scaphoid and trapezium bones [5]. First described by Babunashvili et al. [6] for retrograde recanalization of occluded ipsilateral radial arteries, the left distal trans radial access (ldTRA) in the anatomical snuffbox was later detailed by Kiemeneij [7] as a potential default approach. As an advancement of the conventional proximal

transradial access (pTRA), this technique offers advantages in terms of patient comfort, operator ease, and reduced risk of proximal RA occlusion. The distal RA can accommodate 4, 5, and 6 Fr sheaths and catheters [8]. One notable feature of this approach is the puncture site, located proximal to the pollicis brevis artery and distal to the branch supplying the superficial palmar arch. Occlusion at this site preserves antegrade flow through the superficial palmar arch, reducing the risk of retrograde thrombus formation in the proximal RA—a common complication associated with puncture trauma or hemostasis failure at traditional RA access sites. Importantly, this ensures continued blood flow to the thumb via the superficial palmar arch, preventing ischemia and hand dysfunction. RA preservation is particularly critical for patients requiring future hemodialysis access, coronary artery bypass grafting (CABG), or repeat trans radial access (TRA) procedures [9]

Despite these benefits, the distal trans radial approach (dTRA) does have limitations. The smaller

artery size and increased angulation at this access point contribute to a steeper learning curve and a higher failure rate when advancing the wire or cannulating the distal RA (10). To evaluate the feasibility and safety of using distal trans radial access (dTRA) as the default approach for routine coronary angiography (CAG) and percutaneous coronary intervention (PCI), we conducted a prospective observational registry. At our institution, traditional trans radial access (TRA) has been the standard technique for coronary interventions. However, the distal radial access (DRA) approach has been increasingly adopted in recent practice. The study aims to evaluate the real-world feasibility, safety, and effectiveness of distal transradial access (DRA) as the default access site for routine coronary angiography (CAG) and percutaneous coronary intervention (PCI), and to compare it with traditional transradial access (TRA).

Materials And Methods

This observational study was conducted on consecutive patients admitted for Percutaneous Transluminal Coronary Angioplasty (PTCA) at our department from January 2020 to December 2021. Details of the study were explained to the patients in a language they understood, and an information sheet along with a consent form was provided. Consent was obtained from patients who voluntarily agreed to participate in the study. All enrolled patients underwent reperfusion therapy via Percutaneous Coronary Intervention (PCI), with the access route determined at the discretion of the attending clinician.

Inclusion Criteria

Patients aged 18-80 years Undergoing PTCA at the cardiac catheterization laboratory

Exclusion Criteria :

Patients with Raynaud's disease or upper limb vascular disorders

Patients with neural disorders affecting the radial nerve innervation area (specifically for the trans- snuffbox approach)

Patients with chronic tenosynovitis or osteomyelitis

Patients with significant deformities of the hand

Patients with a recent fracture of the scaphoid bone

Technique:

The presence of an appropriate pulse in the anatomical snuffbox was first verified by manual palpation. To minimize patient discomfort and arterial spasm, intravenous (IV) midazolam (1-2 mg) and/or sublingual trinitroglycerin (TNG) (0.4 mg) was administered, as needed. The forearm was positioned on a soft surface, with the wrist in ulnar deviation and semi-flexion for optimal palpation and access to the snuffbox artery. Local anesthesia was administered using 2-5 ml of 2% lidocaine subcutaneously in the snuffbox cavity. A 20 G or 21G needle was then used to puncture the artery at a 35–45-degree angle, directed towards the site of the strongest pulse [7,8]. Following successful arterial puncture, a 0.018-inch guide wire was gently passed while the wrist was held in a semi abducted and extended position, minimizing pressure from the abductor pollicis longus and extensor pollicis brevis tendons (Figure 01).

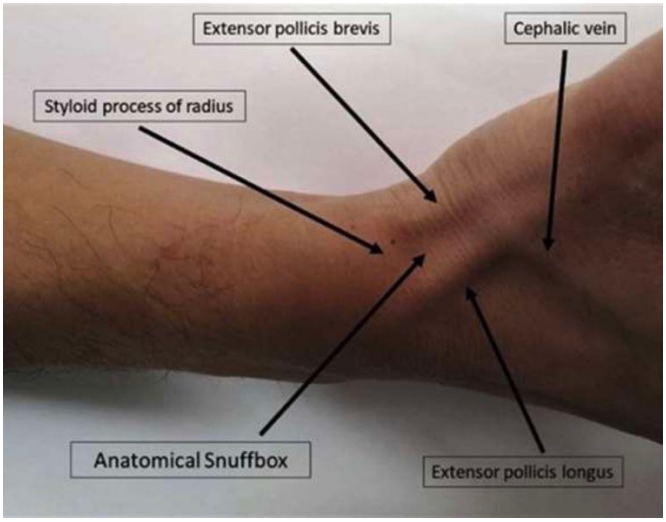

Figure 1: Illustration showing the anatomical landmarks and structures relevant for puncture at the anatomical snuff box.

If resistance was encountered, fluoroscopic guidance and dye injection were used to verify the cause of the resistance. In cases where the 0.018-inch guide wire failed, a 0.014-inch coronary guide wire was used. To prevent damage to the artery and introducer sheath tip, a small skin incision was made before introducing a 4, 5, or 6 Fr sheath, as needed. Unfractionated heparin (2500-5000 IU) was administered as an anticoagulant. For arterial hemostasis, the sheath was removed immediately, and local compression was applied using the contralateral thumb over the puncture site, while the other four fingers were placed under the patient's wrist for 10-15 minutes. Additional pressure was applied using bandage packs to complete hemostasis within 1-2 hours [3,5,7,8].

Statistical Analysis

Data was analyzed with SPSS 23 software. Descriptive statistics were used to summarize the dat and the chi-square test was employed for comparisons of categorical variables. Odds ratios (OR) and confidence intervals (CI) were calculated. Continuous variables were analyzed using

the student's t- test and Analysis of Variance (ANOVA). A p-value <0.05 was considered statistically significant.

Results:

A total of 100 patients participated in the study, with 48 undergoing distal trans-radial access (dTRA, snuffbox approach) and 52 receiving traditional radial access (TRA). The mean age was 57.44 ± 9.8 years in the dTRA group and 56.36 ± 10.54 years in the TRA group. Most patients were male: 41 (85.4%) in the dTRA group and 43 (82.7%) in the TRA group. Hypertension was the most common coronary artery disease (CAD) risk factor in both groups: 30 62.5%) in dTRA and 29 (55.8%) in TRA. Diabetes was present in 19 (39.6%) of dTRA patients and 22 (42.3%) of TRA patients. Smoking was reported by 14 (29.2%) in the dTRA group and 12 (23.1%) in the TRA group (p > 0.05). A family history of CAD was noted in 6 (12.5%) dTRA patients and 5 (9.6%) TRA patients. The most common clinical presentations in both groups were ST-elevation myocardial infarction (STEMI) and chronic stable angina (CSA). Patients were categorized based on their presentation as either acute coronary syndrome (ACS) or chronic coronary artery disease (CAD). STEMI was observed in 23 patients (47.9%) in the distal trans-radial access (dTRA) group and 23 patients (44.2%) in the traditional radial access (TRA) group (Figure 02).

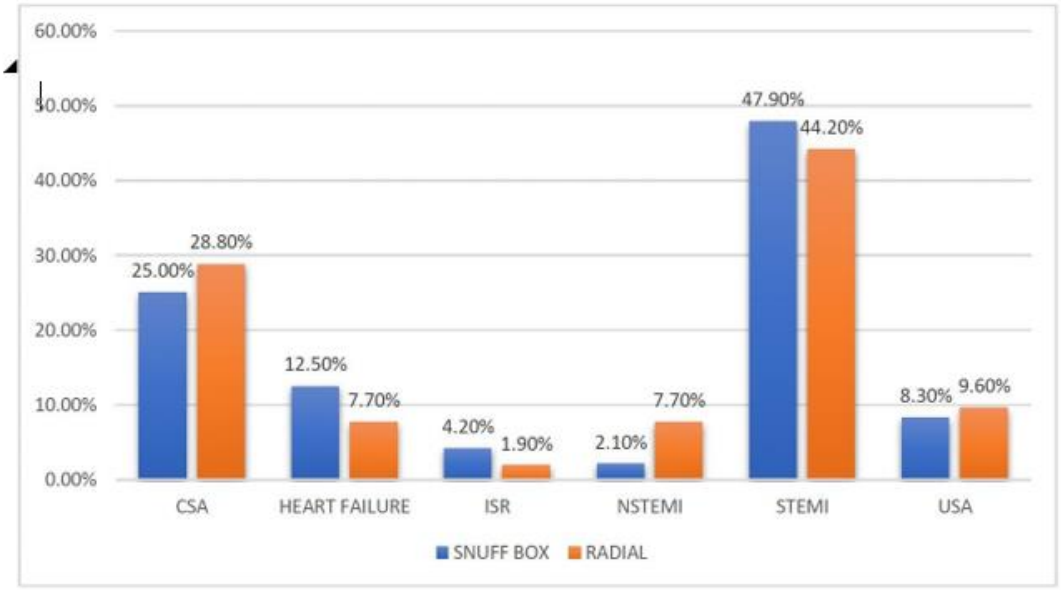

Figure 2: Chart showing clinical presentation of patients in distal trans-radial access (snuff box) and traditional radial (radial) access route

A history of CAD was reported in 21 patients (43.8%) in the dTRA group and 21 (40.4%) in the TRA group. Previous myocardial infarction (MI) was present in 14 patients (29.2%) in dTRA and 14(26.9%) in TRA. Prior PCI was noted in 12 (25.0%) and 9 (17.3%) patients in the dTRA and TRA groups, respectively. A history of coronary artery bypass grafting (CABG) was recorded in 2 patients (4.2%) in dTRA and 2 (3.8%) in TRA. No statistically significant differences were found between the groups regarding baseline characteristics, cardiovascular risk factors, or overall clinical presentation. Baseline characteristics are summarized in Table 1.

Characteristics	Distal trans radial Access	Traditional radial Access	P Value
Age (In years) (Mean ± SD)	57.44 ± 9.800	56.36 ±10.54	0.600
Gender n (%)			
1. Male	41(85.4%)	43(82.7%)	0.710
2. Female	7 (14.6%)	9 (17.3%)	
CAD risk factors n (%)			
1. Hypertension	30 (62.5%)	29 (55.8%)	0.49
2. Diabetes mellitus	19 (39.6%)	22 (42.3%)	0.78
3. Smoking	14 (29.2%)	12 (23.1%)	0.48
4. Family history of CAD	06 (12.5%)	05 (9.6%)	0.64
Clinical diagnosis n (%)			
STEMI	23(47.9%)	23(44.2%)	0.866
NSTEMI	1 (2.1%)	4 (7.7%)	0.41
USA	4 (8.3%)	5 (9.6%)	0.90
CSA	12 (25%)	15 (28.8%)	0.83
ISR	2 (4.2%)	1 (1.9%)	0.94
Heart Failure after stabilization	6 (12.5%)	4 (7.7%)	0.64

Table 1: Baseline Characteristics of the study population

However, some clinical features varied between groups. The dTRA group had a higher incidence of post-heart failure recovery (6 patients, 12.5% vs. 4 patients, 7.7%) and in-stent restenosis (ISR) (2 patients, 4.2% vs. 1 patient, 1.9%). In contrast, non-ST-elevation myocardial infarction (NSTEMI) was more common in the TRA group (1 patient, 2.1% in

dTRA vs. 4 patients, 7.7% in TRA). Unstable angina (USA) was reported in 4 patients (8.3%) in the dTRA group and 5 (9.6%) in the TRA group. CSA was observed in 12 patients (25.0%) in dTRA and 15 (28.8%) in TRA. most frequently stented vessel in both groups was the left anterior descending artery (LAD). The left main coronary artery (LMCA) and obtuse marginal 1 (OM1) were exclusively stented via dTRA, while the ramus and OM2 were stented only through TRA. The left circumflex artery (LCX) was more often stented via TRA. In dTRA patients, multivessel stenting involving combinations such as RCA–PLVB, RCA–OM1, and LCX–OM2 was more common, whereas LAD–OM1 and LCX–PDA combinations were more frequent in the TRA group. These differences were not statistically significant. A significantly higher proportion of dTRA patients received two stents, whereas single- stent usage was more common in TRA. The mean haemostasis duration was significantly shorter in the dTRA group (154 minutes) compared to the TRA group (185 minutes).

Complications:

Arterial dissection occurred in 2.1% of patients in the distal trans-radial access (dTRA) group and 1.9% in the traditional radial access (TRA) group. Arterial perforation was reported in 2.1% of dTRA patients and none in the TRA group. Hematoma was observed in 2.1% of dTRA patients and 1.9% in TRA. Conversion to right femoral access due to radial artery spasm was required in 4.2% of dTRA cases, whereas 1.9% of TRA patients required femoral access due to dissection. These differences were not statistically significant ($p > 0.05$). A summary of vascular complications is provided in Table 2.

Characteristics	Distal trans radial Access	Traditional radial Access	P Value
Dissection n (%)	1 (2.1%)	1 (1.9%)	0.954
Perforation (Acute marginal branch of the right coronary artery)	1 (2.1%)	0 (0%)	0.296
Hematoma	1 (2.1%)	1 (1.9%)	0.954
Alternate access used due to Arterial spasm Arterial dissection	 2 (4.2%) 0 (0%)	 0 (0%) 1 (1.9%)	 0.511

Table 02: Complications between the distal and traditional radial access

Discussion:

Distal trans-radial access (dTRA) via the anatomical snuffbox has emerged as a viable alternative to conventional trans-radial access (TRA) for coronary angiography and percutaneous coronary intervention (PCI). Its growing adoption is primarily attributed to its potential to reduce radial artery occlusion (RAO), a key concern for patients requiring repeated vascular access. Despite promising early data, evidence remains limited to a few randomized and observational studies (Table 03).

Studyauthor (Year)	Study design	Sample size	Successful dTRA (Distal trans radial access) Cannulation (%)	dTRA Access site	Hematomas (%)	Radial artery occlusion
Kiemenej et al. 2017 (7)	Non-Randomised	70	89	Left	3.2	Left distal radial artery occlusion (2%)
Soydan et al. 2017 (11)	Prospective	54	96.3	Left	None	None
Ali Azizi Km et al. 2018 (08)	Prospective	22	100	Left	None	None
Azizi Km et al. 2018 (8)	Retrospective	61	98.4	Left	None	None
Kim et al. 201 (12)	Retrospective	150	88	Left	1.33	None
Coughlan et al. 2018 (13)	Prospective non-randomised	94	100	Left	None	None
Ziakas et al. 2018 (14)	Prospective	49	89.8	Right	15 (No Major)	None
Adel Aminian et al. 2022 (15)	Randomised controlled	1307	80.8	Right	None	Seen in 5.4% patients

Table 03: Summary of Studies on Distal Transradial Artery Access – Success Rates and Complications

The first randomized comparison by Koutouzis et al. [10] showed that while dTRA facilitated faster hemostasis, it required more puncture attempts and longer cannulation time. Importantly, rates of spasm, hematoma, and RAO were comparable between groups. In our study, dTRA showed a high procedural success rate (95.8%), even with exclusive use of right-sided access and 6 Fr sheaths. These results align with success rates reported by Kiemeneij (89%) and Zikas et al. (89.8%) [7, 14], possibly reflecting increasing operator proficiency and careful patient selection. The 6 Fr sheath, thoug technically challenging in smaller vessels, proved safe and effective—supporting its use in coronary interventions including FFR, imaging-guided, and multivessel PCI [8, 11, 15, 16]. RAO remains critical factor in access selection. The DISCO RADIAL trial [15], involving over 1,300 patients, reported no significant difference in RAO rates between dTRA and TRA (0.31% vs 0.91%, P = 0.29). However, dTRA was associated with shorter hemostasis time (153 vs 180 minutes), higher crossover (7.4% vs 3.5%), and increased spasm (5.4% vs 2.7%). Our findings mirror these outcomes: while procedural success was high, puncture difficulty and wire manipulation were more frequent, particularly with right-sided access.

Feasibility and Safety

In our cohort, dTRA was performed without major complications requiring surgical intervention o transfusion. Complex interventions were completed successfully, with only two cases requiring crossover (4.17%), a rate lower than that reported by Tsigkas et al. (9%) [17]. Minor complications included two cases of radial spasm (2.1%) and one forearm hematoma, consistent with prior literature [7, 11]. The smaller vessel caliber—especially in female patients—remains a limitation, though anatomical landmarks generally suffice for successful puncture, even in hypotensive patients. The distal radial artery's location beyond the superficial palmar arch also preserves hand perfusion in the event of

RAO, reducing ischemic risk. Since its introduction by Kiemeneij in 1993 [7], TRA has become the preferred access site due to its favorable safety profile over femoral access. However, TRA is still prone to RAO (2.8%–11.7%), which, while often asymptomatic, can preclude future procedures such as CABG or AV fistula creation [18–21]. Anatomic variations, prior surgeries, and vessel occlusions may further limit TRA applicability. Transulnar access offers an alternative but has not demonstrated clear advantages [21– 25]. dTRA—first described by Roghani et al. in 2016 [25–29]—has been increasingly recognized for its advantages: lower RAO risk, quicker hemostasis, and reduced risk of hand ischemia. Accessing the artery distal to the superficial palmar branch enhances safety and preserves future access sites.

Key Advantages of dTRA

Faster Hemostasis: The anatomical snuffbox offers stable bony support, allowing quicker compression and reduced bleeding risk. Lower RAO Risk: Distal puncture preserves forearm radial nflow and reduces long-term access loss. Improved Ergonomics: Natural hand positioning improves comfort for both patient and operator, and may reduce radiation exposure. Minimal Ischemic Risk: Dual hand perfusion via the ulnar artery minimizes complications in case of distal RAO. Enhanced

Workflow: Faster hemostasis enables earlier ambulation and potential same-day discharge. Challenges and Limitations Despite its benefits, dTRA poses technical challenges. Smaller vessel diameter increases cannulation difficulty and may limit the use of larger sheaths or guide catheters in complex interventions (e.g., CTO). The puncture site—

located in the snuffbox or first intermetacarpal space—can be harder to access, particularly in patients with small or tortuous vessels. Ultrasound guidance may enhance accuracy and safety but were not used in this study. Standard catheters designed for wrist access may be insufficient for dTRA, necessitating longer equipment. Additionally, a learning curve exists, requiring dedicated training and experience.

Future Directions

Further large-scale, multicenter randomized trials are needed to validate the safety, procedural outcomes, and long-term efficacy of dTRA compared to TRA. Future research should also focus on optimizing sheath/catheter design, puncture techniques, and hemostasis protocols. As operator experience grows and device technology evolves, dTRA may become a standard access strategy— particularly in patients at high risk of RAO or those requiring repeated vascular access.

Conclusion

Distal trans-radial access using a 6 Fr sheath is a safe, effective, and increasingly viable alternative for coronary interventions. While procedural complexity may be higher, the benefits—including shorter hemostasis, lower RAO risk, and long-term vascular preservation—support its broader adoption. Our findings, consistent with those of the DISCO RADIAL trial, underscore its potential role in contemporary interventional cardiology.

Study Limitations

This was a single-center, observational feasibility study with a modest sample size and short follow- up. Ultrasound guidance was not used for arterial puncture, possibly affecting success rates. All dTRA cases were performed by a single experienced operator. Vascular complications were only assessed during hospitalization, and no post-procedural ultrasound was conducted to evaluate RAO. Pain at the access site was not formally recorded. The study period coincided with the COVID-19 pandemic, limiting evaluation of early discharge feasibility.

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DOI:10.31579/2641-0419/512