Received: September 2, 2026
Accepted: October 27, 2026
Published: November 27, 2026

Acad Med J 2026;6(3):38-47
UDC: 616.132.2-073.916
Original article

DISTAL TRANSRADIAL ACCESS IN INTERVENTIONAL CARDIOLOGY: CLINICAL EFFICACY, PROCEDURAL ASPECTS, AND SAFETY PROFILE

Ristovski Vladimir

Department of Cardiology, City General Hospital "8th September",
Skopje, Republic of North Macedonia
e-mail: vlatko_ristovski@yahoo.com

Abstract

Introduction: Transradial access (TRA) is the standard vascular approach for coronary angiography and percutaneous coronary intervention (PCI) because it reduces bleeding complications and improves clinical outcomes compared with transfemoral access. However, radial artery occlusion (RAO) remains an important limitation. Distal transradial access (dTRA) has been introduced as an alternative approach that may better preserve radial artery patency.

Aim: To compare the safety, efficacy, and clinical feasibility of dTRA with conventional TRA for coronary angiography and PCI.

Materials and methods: In this prospective randomized study, 238 patients were allocated in a 1:1 ratio to undergo coronary angiography and/or PCI via conventional TRA (n=124) or dTRA (n=114). Outcomes included RAO, vascular and bleeding complications, hemostasis time, puncture and cannulation time, procedural success, and postprocedural motor and sensory hand function.

Results: Among 238 patients (34.9% women; mean age 66.8±11.3 years), RAO occurred in 7 patients (5.65%) in the TRA group and in none in the dTRA group (p=0.015). No significant differences were observed in hematoma, pseudoaneurysm, or other local vascular complications. Hemostasis time was significantly shorter with dTRA than TRA (7.15±2.96 *vs*. 186.29±30.03 minutes; p<0.001). Cannulation time was longer with dTRA (1.99±1.14 *vs*. 1.56±1.29 minutes). Motor and sensory hand function did not differ between groups.

Conclusion: Distal transradial access is a safe and effective alternative to conventional TRA. It significantly reduces RAO and shortens hemostasis time without increasing vascular complications, although it requires greater technical expertise.

Keywords: distal transradial access; radial artery occlusion; coronary angiography; percutaneous coronary intervention; vascular complications; hemostasis

Introduction

Cardiovascular diseases remain the leading cause of morbidity and mortality worldwide and continue to represent one of the greatest public health challenges in modern medicine. According to the World Health Organization, more than 17.9 million people die annually as a consequence of cardiovascular diseases, with the majority of deaths resulting from acute myocardial infarction and cerebrovascular disease. More than 80% of cardiovascular deaths are caused by myocardial infarction and stroke, while a substantial proportion occur in patients younger than 70 years of age, highlighting the enormous clinical and socioeconomic burden of these conditions[1-4].

Coronary angiography remains the gold standard for the diagnosis and evaluation of coronary artery disease and serves as the foundation for planning and performing percutaneous coronary interventions. The procedure may be performed through different vascular access routes, including femoral, brachial, and radial access[5].

The first coronary angiography performed via transradial access was described by Campeau in 1989, while the first successful percutaneous coronary intervention through radial access was performed by Kiemeneij *et al.,* in 1993[6,7]. Over the past decades, transradial access (TRA) has gradually become the dominant and preferred vascular approach in interventional cardiology due to its lower incidence of local and bleeding complications, improved patient comfort and satisfaction, earlier postprocedural mobilization, and shorter hospitalization and recovery time[5]. These advantages have been demonstrated both in patients undergoing elective coronary angiography and in patients presenting with acute coronary syndromes.

The anatomical characteristic of dual blood supply to the hand through the radial and ulnar arteries significantly reduces the risk of critical distal ischemia in the event of thrombosis or occlusion of one of the arteries. In comaprison with transfemoral access, TRA demonstrates a similar procedural success rate but is associated with a significantly lower risk of major bleeding complications, all-cause mortality, and major adverse cardiovascular events (MACE)[8]. Owing to these advantages, the European Society of Cardiology (ESC/EACTS) guidelines in 2018 recommended transradial access as the preferred vascular approach for myocardial revascularization procedures.

Despite its important advantages, radial access is not completely free of complications. The most common vascular complications include local hematomas, arterial spasm, dissection, and radial artery occlusion (RAO), as well as pseudoaneurysm formation, arteriovenous fistulas, regional pain syndrome, and neurological injury[9]. Radial artery occlusion is considered one of the most significant complications, with an incidence ranging from 1% to 33% across different studies. Although RAO is frequently clinically asymptomatic due to collateral circulation through the ulnar artery, it has important clinical implications because it may prevent future use of the radial artery for repeated coronary interventions, as a conduit for coronary artery bypass grafting (CABG), or for arteriovenous fistula creation in hemodialysis patients[10,11].

Transulnar access has also been proposed as an alternative vascular approach; however, its broader use remains limited due to the deeper anatomical location of the ulnar artery, more difficult puncture, increased pain during cannulation, and the uncomfortable hand positioning requiring significant wrist rotation.

In an effort to minimize complications associated with conventional transradial access, increasing attention has recently been directed toward distal transradial access (dTRA), which is performed through the distal segment of the radial artery within the anatomical snuffbox. This approach represents a modern and innovative technique that enables better preservation of the proximal radial artery, reduced risk of radial artery occlusion, shorter hemostasis time, and improved patient comfort. Furthermore, dTRA has demonstrated potential for safe application both in elective procedures and in patients presenting with acute coronary syndromes[12,13].

Although distal transradial access is technically more demanding and requires greater operator expertise, its potential clinical and safety advantages position it as one of the most promising contemporary vascular access strategies in interventional cardiology.

Aims

The primary aim of this study was to evaluate the feasibility, safety, and efficacy of distal transradial access (dTRA) as a standard vascular approach for coronary angiography (CAG) and percutaneous coronary intervention (PCI).

Within the scope of the study, the association between the type of vascular access and the occurrence of radial artery occlusion (RAO) was analyzed, as well as the relationship between vascular access and local bleeding complications at the puncture site. Furthermore, the study evaluated whether statistically significant differences existed regarding hemostasis time, cannulation time, and sheath insertion success between distal and conventional transradial access. In addition, the impact of the different vascular approaches on postprocedural motor and sensory hand function was assessed.

Materials and methods

The study population consisted of patients with clinical and diagnostic evidence of coronary artery disease, including stable angina pectoris, unstable angina pectoris, and non-ST-segment elevation myocardial infarction (NSTEMI), aged over 18 years.

Patients were initially evaluated and recruited on an outpatient basis and subsequently hospitalized at the Department of Cardiology and the Intensive Care Unit of City General Hospital "8th September" in Skopje, Republic of North Macedonia.

Exclusion criteria included:

- age below 18 years,
- ST-segment elevation myocardial infarction (STEMI),
- hemodynamic instability,
- known intolerance or allergic reaction to iodinated contrast media,
- pregnancy and lactation,
- non-palpable right radial artery or previous use of the radial artery as a coronary bypass graft,
- the presence of anatomical restrictions (arteriovenous fistula, orthopedic deformities, or upper limb abnormalities),
- inability or refusal to provide written informed consent.

Patients scheduled for coronary angiography or percutaneous coronary intervention were randomly assigned into two groups: a conventional transradial access (TRA) group and a distal transradial access (dTRA) group. Randomization was performed according to even and odd sequential numbers, with patients assigned an odd number allocated to the dTRA group.

Before the procedure, all patients were prepared for both radial and femoral vascular access in order to ensure an alternative access route in the event of unsuccessful cannulation.

Baseline patient evaluation and follow-up included:

- Detailed medical history and clinical interview, including collection of sociodemographic data, disease history, comorbidities, previous surgical interventions, and prior vascular procedures;
- Physical examination and assessment of vital signs, including body temperature, heart rate, and arterial blood pressure;
- Standard 12-lead electrocardiogram (ECG);
- Laboratory and biochemical analyses, including complete blood count, blood glucose, urea, creatinine, liver enzymes, and cardiac-specific biomarkers;
- Imaging evaluation using Doppler ultrasonography of the radial artery one month after the procedure in patients with non-palpable radial pulse, in order to assess radial artery patency and detect radial artery occlusion.

After fulfilling the inclusion criteria, each patient was thoroughly informed about the aims and protocol of the study, and written informed consent for participation was obtained. The study was approved by the Ethics Committee of City General Hospital "8th September", Skopje, and all procedures were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments.

All collected data were entered into a previously designed structured data collection form and analyzed using appropriate statistical methods. The results are presented in tables, with statistical analysis performed to assess the significance of the obtained findings. Continuous variables are expressed as mean ± standard deviation (SD), median, and range, with 95% confidence intervals (CI) where appropriate. Categorical variables are presented as frequencies and percentages (n, %).

Normality testing was performed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The Pearson Chi-square test was used for comparing categorical variables, with Fisher's Exact Test applied when expected frequencies were less than 5. The Mann-Whitney U test was used for comparing non-normally distributed continuous variables (age, hemostasis time, cannulation time). The Fisher-Freeman-Halton Exact Test with Monte Carlo simulation (10,000 samples) was used for pain perception (VAS scores) due to the ordinal data and small expected cell counts. All tests were two-sided, and $p<0.05$ was considered statistically significant.

Results

A total of 238 patients were included in the analysis, of whom 83 (34.87%) were female and 155(65.13%) were male. The mean age of the study population was 66.84±11.26 years (95% CI 64.65-69.03), with a median age of 67 years and an age range from 39 to 85 years.

Gender Distribution Between the Study Groups

Among the 114 patients included in the dTRA group, 46 (40.35%) were female and 68 (59.65%) were male. In the TRA group, consisting of 124 patients, 37(29.84%) were female and 87(70.16%) were male (Table 1). Statistical analysis using the Chi-square test demonstrated no significant difference in gender distribution between the two groups (Pearson Chi-Square=2.890; p=0.089; Fisher's Exact Test p=0.103), indicating comparable baseline demographic characteristics regarding sex distribution.

Age Distribution Between the Study Groups

In the dTRA group, the mean patient age was 67.79±10.63 years (95% CI 65.82-69.76), with a median age of 68.5 years and an age range from 39 to 85 years. In the TRA group, the mean age was 62.43±10.30 years (95% CI 60.60-64.26), with a median age of 62 years and an age range from 39 to 85 years (Table 1). Normality testing using the Kolmogorov–Smirnov and Shapiro-Wilk tests demonstrated deviation from normal distribution, particularly within the dTRA group. Therefore, a nonparametric Mann-Whitney U test was applied for comparison between the groups. The Mann-Whitney U analysis demonstrated a statistically significant difference in age distribution between the two groups (U=4942.50; Z=-4.009; $p<0.001$), indicating that patients in the dTRA group were significantly older compared with those in the TRA group.

Association Between Type of Vascular Access and Radial Artery Occlusion (RAO)

Among the 114 patients in the dTRA group, no cases of RAO were observed, with all patients (100.0%) maintaining radial artery patency. In contrast, among the 124 patients in the TRA group, 117 patients (94.35%) had no evidence of RAO, while 7 patients (5.65%) developed radial artery occlusion (Table 1). Statistical analysis demonstrated a significant association between the type of vascular access and the occurrence of RAO. Fisher's Exact Test showed a statistically significant difference between the groups (p=0.015), indicating that dTRA was associated with a significantly lower incidence of radial artery occlusion compared with conventional TRA.

Association Between Type of Vascular Access and Hemorrhagic Complications at the Puncture Site

Hematoma Formation

Among the 114 patients in the dTRA group, 111 patients (97.36%) did not develop hematoma, whereas 3 patients (2.63%) developed a local hematoma at the puncture site. In the TRA group, 117 patients (94.35%) had no hematoma formation, while 7 patients (5.64%) developed a hematoma (Table 1). According to Fisher's Exact Test, there was no statistically significant association between the type of vascular access and the occurrence of hematoma (p=0.338).

Pseudoaneurysm Formation

No pseudoaneurysm was observed among patients in the dTRA group, with all 114 patients (100.0%) free from this complication. In the TRA group, pseudoaneurysm formation was observed in 1 patient (0.73%), while 123 patients (99.27%) had no evidence of pseudoaneurysm (Table 1). According to Fisher's Exact Test, there was no statistically significant association between the type of vascular access and the occurrence of pseudoaneurysm (p=1.000).

Table 1. Baseline demographic characteristics and vascular complications

Parameter	dTRA (n=114)	TRA (n=124)	p value
Sex			
Female, n (%)	46(40.35)	37(29.84)	0.089*
Male, n (%)	68(59.65)	87(70.16)	
Age (years)			
Mean ± SD	67.79±10.63	62.43±10.30	<0.001**
Median (range)	68.50(39-85)	62.00(39-85)	
95% CI	65.82-69.76	60.60-64.26	
Radial artery occlusion (RAO)			
Yes, n (%)	0(0.0)	7(5.65)	0.015***
No, n (%)	114(100.0)	117(94.35)	
Hematoma			
Yes, n (%)	3(2.63)	7(5.64)	0.338***
No, n (%)	111(97.36)	117(94.35)	
Pseudoaneurysm			
Yes, n (%)	0(0.0)	1(0.73)	1.000***
No, n (%)	114(100.0)	123(99.27)	

*Pearson Chi-Square test; **Mann-Whitney U test; ***Fisher's Exact Test Normality testing using the Kolmogorov–Smirnov and Shapiro–Wilk tests demonstrated deviation from normal distribution for age. Therefore, nonparametric tests were applied.

Hemostasis Time According to Vascular Access Approach

In the dTRA group, hemostasis time achieved by manual compression was significantly shorter, with a mean duration of 7.15 ± 2.96 minutes (95% CI 6.20–7.90), a median of 7.10 minutes, a minimum value of 3.25 minutes, and a maximum value of 18.00 minutes.

In contrast, patients in the TRA group, in whom hemostasis was achieved using a TR band, demonstrated a substantially longer hemostasis time, with a mean duration of 186.29 ± 30.03 minutes (95% CI 181.70–197.94), a median of 180 minutes, a minimum value of 180 minutes, and a maximum value of 300 minutes (Table 2). Patients in the TRA group had a significantly longer hemostasis time compared with patients in the dTRA group ($Z = -14.144$, $p < 0.001$).

Cannulation Time According to Vascular Access Approach

In the dTRA group, cannulation time ranged within a mean interval of 1.99±1.14 minutes (95% CI 1.80-2.18), with a median of 2.00 minutes, a minimum value of 0.35 minutes, and a maximum value of 6.10 minutes.

In the TRA group, the mean cannulation time was 1.56±1.29 minutes (95% CI 1.36-1.75), with a median of 1.25 minutes, a minimum value of 0.20 minutes, and a maximum value of 7.30 minutes (Table 2). Patients in the dTRA group had a significantly longer cannulation time compared with patients in the TRA group (Z=4.45, p=0.001).

Cannulation Success According to Vascular Access Approach

Among the 114 patients in the dTRA group, cannulation was successful in 111 patients (97.3%), while unsuccessful cannulation occurred in 3 patients (2.6%). In the TRA group, successful cannulation was achieved in 123 patients (99.2%), whereas unsuccessful cannulation occurred in 1 patient (0.8%) (Table 2). According to Fisher's Exact Test, there was no statistically significant difference in cannulation success depending on the vascular access approach (p=0.352).

Puncture Success According to Vascular Access Approach

In the dTRA group, puncture was successful in 111 patients (97.4%), while unsuccessful puncture occurred in 3 patients (2.6%). In the TRA group, puncture was successful in 123 patients (99.2%), whereas unsuccessful puncture occurred in 1 patient (0.8%) (Table 2). Fisher's Exact Test demonstrated no statistically significant difference in puncture success between the two groups (p=0.352).

Table 2. Procedural characteristics

Parameter	dTRA (n=114)	TRA (n=124)	p value
Hemostasis time (minutes)			
Mean ± SD	7.15±2.96	186.29±30.03	<0.001*
Median (range)	7.10(3.25-18.00)	180.00(180.00-300.00)	
95% CI	6.20-7.90	181.70-197.94	
Cannulation time (minutes)			
Mean ± SD	1.99±1.14	1.56±1.29	0.001*
Median (range)	2.00(0.35-6.10)	1.25(0.20-7.30)	
95% CI	1.80-2.18	1.36-1.75	
Cannulation success			
Successful, n (%)	111(97.3)	123(99.2)	0.352**
Unsuccessful, n (%)	3(2.6)	1(0.8)	
Puncture success			
Successful, n (%)	111(97.4)	123(99.2)	0.352**
Unsuccessful, n (%)	3(2.6)	1(0.8)	

*Mann-Whitney U test; **Fisher's Exact Test, Normality testing using the Kolmogorov-Smirnov and Shapiro-Wilk tests demonstrated deviation from normal distribution for both hemostasis and cannulation times. Therefore, nonparametric tests were applied.

Table 3. Thumb numbness and pain perception

Parameter	dTRA (n=114)	TRA (n=124)	p value
Thumb numbness			
Yes, n (%)	7(6.15)	2(1.6)	0.091*
No, n (%)	107(93.85)	122(98.4)	
Pain perception (VAS score)			
Median (range)	0(0-7)	1(0-9)	0.001**
Mean ± SD	1.07±1.66	1.90±2.18	

*Fisher's Exact Test; **Monte Carlo Fisher-Freeman-Halton Test, VAS-Visual Analog Scale (0=no pain, 10=worst possible pain).

Thumb Numbness According to Vascular Access Approach

Among the 114 patients in the dTRA group, 7 patients (6.15%) reported thumb numbness, whereas 107 patients (93.85%) did not report this symptom. In the TRA group, thumb numbness was reported in 2 patients (1.6%), while 122 patients (98.4%) had no

symptoms of thumb numbness (Table 3). According to Fisher's Exact Test, there was no statistically significant difference in thumb numbness depending on the vascular access approach (p=0.091).

Pain Perception

Pain perception was assessed using the Visual Analogue Pain Scale (VAS 0-10). In the dTRA group, the majority of patients, 62(60.2%), reported no pain (VAS score 0), compared with 41 patients (39.8%) in the TRA group. The highest reported pain score in the dTRA group was 7, observed in one patient, whereas in the TRA group the highest pain score was 9, also reported by one patient (Table 4). The median VAS score was 0 (range 0-7) in the dTRA group and 1 (range 0-9) in the TRA group (Table 3). According to the Fisher-Freeman-Halton Exact Test (Monte Carlo Sig. 2-sided=0.001), pain perception was significantly more pronounced among patients in the TRA group compared with the dTRA group.

Table 4. Pain perception distribution according to Visual Analogue Scale (VAS 0-10)

VAS Score	dTRA (n=114) n (%)	TRA (n=124) n (%)	Total n (%)
0	62(60.2)	41(39.8)	103(100.0)
1	10(41.7)	14(58.3)	24(100.0)
2	19(46.3)	22(53.7)	41(100.0)
3	11(35.5)	20(64.5)	31(100.0)
4	5(38.5)	8(61.5)	13(100.0)
5	4(30.8)	9(69.2)	13(100.0)
6	2(25.0)	6(75.0)	8(100.0)
7	1(33.3)	2(66.7)	3(100.0)
8	0(0.0)	1(100.0)	1(100.0)
9	0(0.0)	1(100.0)	1(100.0)

Fisher-Freeman-Halton Exact Test (Monte Carlo Sig. 2-sided=0.001)

Comorbidities

The most frequently observed comorbid conditions among the study population were: angina pectoris and arterial hypertension in 73 patients (30.6%); angina pectoris and dyslipidemia in 56 patients (23.5%); angina pectoris, arterial hypertension, and dyslipidemia in 45 patients (18.9%); and angina pectoris, diabetes mellitus, and arterial hypertension in 35 patients (14.7%). Other comorbidities were present at lower frequencies within the study population (Table 5).

Table 5. Comorbidities distribution

Comorbidity	Patients n=238 (%)
Angina pectoris + Arterial hypertension	73(30.6)
Angina pectoris + Dyslipidemia	56(23.5)
Angina pectoris + Arterial hypertension + Dyslipidemia	45(18.9)
Angina pectoris + Diabetes mellitus + Arterial hypertension	35(14.7)
Other combinations	29(12.2)

Discussion

Distal transradial access (dTRA) has emerged in recent years as one of the most important innovations in contemporary interventional cardiology. Its increasing adoption is driven by ongoing efforts to reduce vascular and bleeding complications associated with

conventional transradial access (TRA), while simultaneously preserving the radial artery for future coronary procedures or surgical revascularization. The anatomical localization of the distal radial artery within the anatomical snuffbox enables improved hemostatic control, reduced risk of proximal radial artery occlusion (RAO), and greater postprocedural patient comfort[6-13].

In the present study, 238 randomized patients with clinical and diagnostic evidence of coronary artery disease were included and allocated into two groups: dTRA and TRA. Although procedural success rates were high and comparable between the two approaches, significant differences were observed regarding radial artery occlusion, hemostasis time, cannulation characteristics, and postprocedural patient comfort.

One of the most important findings of our study was the incidence of radial artery occlusion. No cases of RAO were observed in the dTRA group, whereas RAO occurred in 7 patients (5.65%) in the TRA group, demonstrating a statistically significant difference (p=0.015). This finding is of major clinical importance because, although RAO is frequently asymptomatic due to the dual arterial blood supply of the hand, it may preclude future use of the radial artery for repeat coronary procedures, coronary artery bypass grafting (CABG), or arteriovenous fistula creation in hemodialysis patients.

Our findings are consistent with contemporary clinical trials. The CONDITION trial demonstrated a significantly lower incidence of long-term RAO in the dTRA group compared with the conventional TRA group (0.8% *vs*. 3.3%; p=0.02), accompanied by a lower rate of bleeding complications[14]. Similarly, the Distal Radial Artery Approach to Prevent Radial Artery Occlusion Trial showed that distal radial access prevented RAO in the proximal segment at 24 h and 30 days after the procedure compared with conventional radial access[15]. In contrast, the DISCO RADIAL trial did not demonstrate a statistically significant difference in RAO incidence between the two approaches, suggesting that the occurrence of RAO may be influenced by several additional factors, including puncture technique, operator experience, anticoagulation strategy, and hemostatic management[16].

Regarding procedural characteristics, our study demonstrated longer cannulation time in the dTRA group (1.99±1.14 minutes) compared with the TRA group (1.56±1.29 minutes). These findings are consistent with the results reported by Koutouzis *et al*., who also observed prolonged puncture time in patients undergoing dTRA (269±251 s *vs*. 140±161 s; p<0.001)[17]. The longer cannulation time associated with dTRA is most likely related to the smaller vessel diameter, anatomical variability of the distal radial artery, and the greater technical precision required during puncture. Nevertheless, despite these technical challenges, procedural success remained high, indicating that dTRA can be effectively integrated into routine clinical practice with increasing operator experience.

A particularly important finding of our study was the significantly shorter hemostasis time observed in the dTRA group. Hemostasis time in the dTRA group was 7.15±2.96 minutes, compared with 186.29±30.03 minutes in the TRA group. The shorter hemostasis duration associated with dTRA may be explained by the anatomical position of the distal radial artery over a bony surface, allowing more effective compression. These findings are in agreement with the study by Koutouzis *et al*., which also demonstrated faster hemostasis with dTRA[17]. From a clinical perspective, shorter hemostasis time enables earlier mobilization, improved patient comfort, and potentially shorter hospital stay, making dTRA particularly attractive for ambulatory and same-day discharge procedures.

No significant differences were observed between the groups regarding local bleeding complications, pseudoaneurysm formation, or arteriovenous fistula development. However, patients in the dTRA group reported significantly lower postprocedural pain and better hand functionality compared with patients in the TRA group (p=0.001). These results are consistent

with the findings of Sharma *et al*., and further support the potential advantages of dTRA in terms of patient comfort and quality of life following coronary procedures[18].

Additionally, previous studies have demonstrated particular benefits of dTRA in patients receiving anticoagulant therapy. The study "Radial Access for Coronary Angiography in Anticoagulated Patients" reported a significant reduction in bleeding complications with dTRA, highlighting its potential role in high bleeding-risk populations.

Despite the promising clinical and safety profile of dTRA, several limitations should be acknowledged. The technical complexity of the procedure, prolonged cannulation time, and the need for greater operator expertise may limit its widespread implementation during the initial learning phase. Furthermore, patients with ST-segment elevation myocardial infarction (STEMI) and hemodynamic instability were not included in our study, which limits the generalizability of our findings to higher-risk patient populations.

Conclusion

Overall, the results of our study, together with data from contemporary randomized clinical trials, suggest that dTRA represents a safe and effective alternative to conventional TRA. Its use is associated with a significant reduction in radial artery occlusion, shorter hemostasis time, and improved patient comfort, while preserving the radial artery for future procedures. Nevertheless, further multicenter studies with larger patient populations and longer follow-up periods are required to better define the long-term clinical outcomes and optimal indications for dTRA in modern interventional cardiology.

Conflict of interest statement. None declared.

References

1. World Health Organization. Cardiovascular diseases (CVDs) [Internet]. Geneva: WHO; 2021 [cited 2026 Jul 16]. Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds).
2. Centers for Disease Control and Prevention. Heart Disease Facts [Internet]. Atlanta: CDC; 2022 [cited 2026 Jul 16]. Available from: https://www.cdc.gov/heartdisease/facts.htm.
3. Jha P, Ramasundarahettige C, Landsman V, Rostron B, Thun M, Anderson RN, *et al*. 21st-century hazards of smoking and benefits of cessation in the United States. *N Engl J Med* 2013; 368(4): 341-350. doi: 10.1056/NEJMsa121112.
4. Centers for Disease Control and Prevention. Ten great public health achievements--United States, 1900-1999. *MMWR Morb Mortal Wkly Rep* 1999; 48(12): 241-243. PMID: 10220250.
5. Ghanem I, Mesbah M, Refaat H. Safety and efficacy of brachial approach for coronary angiography and percutaneous coronary intervention. *Egypt Heart J* 2024; 76(1): 36. doi: 10.1186/s43044-024-00466-6.
6. Campeau L. Percutaneous radial artery approach for coronary angiography. *Cathet Cardiovasc Diagn* 1989; 16(1): 3-7. doi: 10.1002/ccd.1810160103.
7. Kiemeneij F, Laarman GJ. Percutaneous transradial artery approach for coronary stent implantation. *Cathet Cardiovasc Diagn* 1993; 30(2): 173-178. doi: 10.1002/ccd.1810300220.
8. Agostoni P, Biondi-Zoccai GG, de Benedictis ML, Rigattieri S, Turri M, Anselmi M, *et al*. Radial versus femoral approach for percutaneous coronary diagnostic and interventional procedures: systematic overview and meta-analysis of randomized trials. *J Am Coll Cardiol* 2004; 44(2): 349-356. doi: 10.1016/j.jacc.2004.04.034.
9. Riangwiwat T, Blankenship JC. Vascular complications of transradial access for cardiac catheterization. *US Cardiol* 2021; 15: e04. doi: 10.15420/usc.2020.23.

10. Bernat I, Aminian A, Pancholy S, Mamas M, Gaudino M, Nolan J, *et al*. Best Practices for the Prevention of Radial Artery Occlusion After Transradial Diagnostic Angiography and Intervention: An International Consensus Paper. *JACC Cardiovasc Interv* 2019; 12(22): 2235-2246. doi: 10.1016/j.jcin.2019.07.043.
11. Rashid M, Kwok CS, Pancholy S, Chugh S, Kedev SA, Bernat I, *et al*. Radial artery occlusion after transradial interventions: a systematic review and meta-analysis. *J Am Heart Assoc* 2016; 5(1): e002686. doi: 10.1161/JAHA.115.002686.
12. Kiemeneij F. Left distal transradial access in the anatomical snuffbox for coronary angiography (ldTRA) and interventions (ldTRI). *EuroIntervention* 2017; 13(7): 851-857. doi: 10.4244/EIJ-D-17-00079.
13. Liu M, Du Y, Cui C, Zhai J, Yu W, Zhang H, *et al*. Distal transradial access for percutaneous coronary intervention: a single-center randomized controlled study (DRAGON study). *BMC Cardiovasc Disord* 2025; 26(1): 77. doi: 10.1186/s12872-025-05456-3.
14. Chen T, Li L, Li F, Lu W, Shi G, Li W, et al. Comparison of long-term radial artery occlusion via distal vs. conventional transradial access (CONDITION): a randomized controlled trial. *BMC Med* 2024; 22(1): 62. doi: 10.1186/s12916-024-03281-7.
15. Eid-Lidt G, Rivera Rodríguez A, Jimenez Castellanos J, Farjat Pasos JI, Estrada López KE, Gaspar J. Distal Radial Artery Approach to Prevent Radial Artery Occlusion Trial. *JACC Cardiovasc Interv* 2021; 14(4): 378-385. doi: 10.1016/j.jcin.2020.10.013.
16. Aminian A, Sgueglia G, Wiemer M, Kefer J, Ruzsa Z, Van Der Heyden J, *et al*. Distal Versus Conventional Radial Access for Coronary Angiography and Intervention: The DISCO RADIAL Trial. *J Am Coll Cardiol Intv* 2022; 15(12): 1191-1201. doi: 10.1016/j.jcin.2022.04.032.
17. Koutouzis M, Kontopodis E, Tassopoulos A, Tsiafoutis I, Katsanou K, Rigatou A, *et al*. Distal versus traditional radial approach for coronary angiography. *Cardiovasc Revasc Med* 2019; 20(8): 678-680. doi: 10.1016/j.carrev.2018.09.018.
18. Sharma AK, Razi MM, Prakash N, Sharma A, Sarraf S, Sinha S, *et al*. A comparative assessment of dorsal radial artery access versus classical radial artery access for percutaneous coronary angiography: a randomized control trial (DORA trial). *Indian Heart J* 2020; 72(5): 435-441. doi: 10.1016/j.ihj.2020.06.002.