

# Predictors of first-attempt puncture success in distal radial access for coronary procedures

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## ABSTRACT

**Objectives:** This study aimed to identify patient-based clinical and demographic factors affecting the success of the first puncture attempt in patients undergoing distal radial access (dTRA) for coronary angiography and interventional procedures.

**Patients and methods:** The study was designed as a retrospective, single-center observational study. Two hundred eighty-six consecutive patients who underwent dTRA procedures between January 2023 and March 2026 were included in the analysis. All puncture procedures were performed by a single experienced operator, with palpation guidance from the anatomical snuffbox region. Univariate and multivariate logistic regression analysis and receiver operating characteristic (ROC) curve analysis were used to identify independent variables predicting first-attempt success.

**Results:** Successful puncture was achieved on the first attempt in 70.6% (n=202) of the study population. Multivariate analysis showed that advanced age (odds ratio [OR]: 0.93, p<0.001) and female sex (OR: 0.50, p=0.015) were associated with a lower likelihood of first-attempt success, whereas higher body mass index (BMI) (OR: 1.17, p=0.001) was associated with a higher likelihood of success. The group with failure on the first attempt had significantly longer puncture time and a higher rate of access site complications (hematoma, spasm, etc.) (14.3% vs. 6.9%; p=0.049). The discriminatory power of the model was calculated as area under the curve: 0.721 (95% confidence interval: 0.658-0.785) in the ROC analysis.

**Conclusion:** The first-attempt success rate of dTRA was associated with patient age, sex, and BMI. Ultrasound-guided puncture strategies are recommended to increase procedural success and reduce vascular complications, especially in high-risk patient groups such as the elderly, women, and those with low BMI.

**Keywords:** Distal radial access, first-attempt success, coronary angiography, body mass index, sex differences.

Since its initial description by Kiemeneij,<sup>[1]</sup> distal radial access (dTRA) has gradually gained a place in coronary diagnostic and interventional practice. It is performed at the level of the anatomical snuffbox. It is an alternative to classic transradial access. Compared with conventional radial access, dTRA may offer practical advantages, including easier hemostasis, earlier mobilization, and a lower risk of radial artery occlusion.<sup>[1]</sup> However, the artery diameter is smaller, and anatomical variations may be observed. Therefore, it is technically more challenging and requires a significant learning curve.<sup>[2]</sup>

Recent studies have shown that dTRA is safe and feasible for both diagnostic and interventional procedures. However, the success of distal radial puncture depends not only on operator experience but also on patient-related factors. First-attempt puncture success in dTRA is critically important in terms of reducing puncture time, increasing patient comfort, and reducing the risk of vascular complications.<sup>[3]</sup> In contrast, multiple puncture attempts may lead to vascular spasm, hematoma formation, and prolonged puncture time.



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Several factors that can affect the success of distal radial puncture have been identified in the literature. Variables such as advanced age, female sex, small vessel diameter, and body mass index (BMI) have been reported to affect puncture success.<sup>[3,4]</sup> It has been shown that female patients have a smaller distal radial artery diameter, which can negatively affect puncture success.<sup>[4]</sup> In addition, female sex has been reported to be associated with a lower success rate and higher access site complications in dTRA.<sup>[4,5]</sup> According to Korean Prospective Registry for Evaluating the Safety and Efficacy of Distal Radial Approach (KODRA) data, female sex is an independent risk factor. This is particularly evident in terms of minor bleeding.<sup>[5]</sup>

The effect of BMI on dTRA is more complex. Some studies have shown that obesity has no significant effect on overall cannulation success or complication rates.<sup>[5]</sup> However, increased subcutaneous fat tissue can prolong puncture time by making palpation of arterial pulsation more difficult.<sup>[5]</sup> On the other hand, low BMI and small artery diameter can be important determinants in terms of technical difficulties due to increased vascular mobility.<sup>[3]</sup>

However, comprehensive studies evaluating the combined effect of age, sex, and BMI on first-attempt puncture success in dTRA are limited in the current literature. This study aims to evaluate patient-related factors affecting first-attempt puncture success in dTRA and to contribute to the determination of appropriate patient selection and procedure strategy in clinical practice.

## PATIENTS AND METHODS

### Patient Selection and Research Design

This research was structured as a retrospective observational study at a specialized tertiary heart center. The study population comprised individuals scheduled for coronary procedures where the dTRA approach was utilized as the primary access site.

Patients underwent coronary angiography or percutaneous coronary intervention (PCI) via dTRA. All procedures were performed at the Cardiology Clinic of Mardin Training and Research Hospital. The study period was between January 2023 and March 2026.

All consecutive patients who underwent dTRA procedures within the specified time period were screened. Only patients with complete clinical and procedural records were included in the analysis. Individuals aged 18 years and older were included in the study.

### Inclusion and Exclusion Criteria

Adult individuals who underwent coronary angiography or PCI via dTRA were eligible for inclusion. The exclusion criteria were defined as follows:

1. Lack of clinical or procedural data,
2. Use of a vascular access route other than dTRA,
3. Inability to confirm the accuracy of the records.

### Procedure Description

Distal radial puncture was performed under palpation guidance from the anatomical snuffbox area. Standard interventional cardiology protocols were applied throughout the procedure. Necessary anticoagulation

therapy was provided during the procedure in accordance with standard practices. All procedures were performed by a single interventional cardiologist with experience in over 200 cases of dTRA.

### Study Endpoints and Operational Definitions

Success on the first attempt was defined as achieving cannulation after a single-needle puncture. Failure was considered to be the need for multiple needle punctures. The outcome variables evaluated in the study included total number of punctures, puncture time, and site-related complications. Puncture time was defined as the time from skin puncture to successful cannulation.<sup>[3]</sup> Since the standard approach in our clinic is left radial access, left dTRA was most frequently used according to operator preference. Access site complications were evaluated based on hospital records and defined as a composite endpoint including complications such as hematoma, radial artery occlusion, radial artery spasm, ecchymosis, and local numbness. For analytical comparisons, patients were stratified into two distinct groups:

- Successful puncture on the first attempt,
- Failed puncture on the first attempt.

### Data Collection

Patient demographic and clinical characteristics were extracted from the institutional electronic medical record system. Procedural data were obtained from catheterization laboratory records. The number of punctures and the success rate on the first attempt were recorded by the operator as part of routine post-procedure records. Data were reviewed retrospectively. Recorded variables included age, sex, BMI, diabetes mellitus, hypertension, hyperlipidemia, smoking, and a known history of coronary artery disease. Procedure-related data included procedure type (diagnostic angiography or PCI), number of punctures, puncture time, first-attempt success and site complications.

### Sample Size

A minimum of 197 patients was calculated as required based on G\*Power 3.1 analysis. During the study period, 286 patients who fulfilled the inclusion criteria were enrolled in the analysis.

### Statistical Analysis

Data processing and statistical assessments were executed via IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was verified before analysis; based on the distribution, these data were reported as mean  $\pm$  standard deviation or median (interquartile range). Inter-group comparisons were conducted using either parametric or non-parametric methods, depending on the data's distributional characteristics. For categorical data, frequencies and percentages were utilized, with differences evaluated through Fisher's exact test or the chi-square test where applicable.

To determine the predictors of successful first-attempt puncture, a logistic regression framework was employed. Factors exhibiting a p-value  $<0.10$  in the univariable screen, alongside clinically significant variables, were incorporated into the multivariable regression model. To maintain model parsimony and prevent overfitting, the total number of predictors was strictly limited. The diagnostic accuracy of the resulting model was quantified using the area under the curve (AUC) derived from receiver operating characteristic (ROC) analysis, including

95% confidence intervals. The Youden index was utilized to identify the optimal cut-off point. Furthermore, model calibration was validated using the Hosmer-Lemeshow test. Statistical significance was defined as a two-tailed p-value <0.05.

### Ethical Approval

Ethical clearance for this investigation was granted by the Mardin Training and Research Hospital Medical Ethics Committee (approval number: 2026/04-10, dated: 24.04.2026). The research protocols complied with the standards set forth in the Declaration of Helsinki. Due to the study's retrospective design, individual consent was not required; however, all datasets were completely de-identified prior to analysis to maintain confidentiality.

## RESULTS

Demographic and clinical characteristics of the groups according to the success of the first puncture attempt are presented in Table 1. The first puncture attempt was successful in 202 patients (70.6%) and unsuccessful in 84 patients (29.4%). Patients with failed first-attempt puncture were older ( $p<0.001$ ). Female sex was more frequent in the unsuccessful group (47.6% vs. 31.3%,  $p=0.009$ ). BMI was higher in the successful group ( $p=0.002$ ). The groups were similar in terms of hypertension, diabetes, smoking, and hyperlipidemia (all  $p>0.05$ ). There was no difference in history of coronary artery disease and ipsilateral radial intervention history ( $p>0.05$ ). Systolic blood pressure and creatinine levels were similar ( $p>0.05$ ). The rate of presentation

with acute coronary syndrome was not different between the two groups ( $p=0.354$ ).

Table 2 summarizes the data related to the procedures. Patients in the unsuccessful first-attempt category required a substantially greater number of punctures compared to the successful group ( $p<0.001$ ). Similarly, the duration of the puncture process was notably extended in the failed group ( $p<0.001$ ). No significant disparity was observed in PCI rates between the cohorts ( $p=0.658$ ). Regarding safety, the incidence of access site complications was significantly higher among those with failed first attempts (14.3% vs. 6.9%,  $p=0.049$ ). However, the groups showed no statistical difference in the preference for left dTRA ( $p=0.362$ ) or the utilization of 6F sheaths ( $p=0.209$ ).

### Regression and ROC Analysis Results

Factors affecting first-attempt success are shown in Table 3. In univariable analysis, age, female sex, and BMI were found to be associated with first attempt success. As age increased, the probability of success decreased (odds ratio [OR]: 0.92, 95% confidence interval [CI]: 0.89-0.95,  $p<0.001$ ). Female sex was associated with lower success (OR: 0.50, 95% CI: 0.29-0.84,  $p=0.010$ ). As BMI increased, the probability of success increased (OR: 1.15, 95% CI: 1.05-1.27,  $p=0.003$ ). In multivariate analysis, age (OR: 0.93, 95% CI: 0.90-0.96,  $p<0.001$ ), female sex (OR: 0.50, 95% CI: 0.29-0.87,  $p=0.015$ ), and BMI (OR: 1.17, 95% CI: 1.06-1.30,  $p=0.001$ ) remained significant. No significant association was found with previous radial intervention, diabetes, and creatinine levels (all  $p>0.05$ ).

**Table 1.** Baseline characteristics according to first-attempt puncture success

Variable	Overall (n=286)	Successful first-attempt (n=202)	Failed first-attempt (n=84)	p-value
Age, years	64.15±8.57	62.61±7.77	67.84±9.29	<0.001
Female sex, n (%)	103 (36.1)	63 (31.3)	40 (47.6)	0.009
BMI, kg/m <sup>2</sup>	25.76±2.69	26.08±2.57	25.01±2.82	0.002
Hypertension, n (%)	152 (53.1)	102 (50.5)	50 (59.5)	0.163
Diabetes mellitus, n (%)	85 (29.7)	58 (28.7)	27 (32.1)	0.563
Current smoking, n (%)	84 (29.4)	61 (30.2)	23 (27.4)	0.634
Hyperlipidemia, n (%)	59 (20.6)	38 (18.8)	21 (25.0)	0.239
Previous CAD, n (%)	51 (17.8)	32 (15.8)	19 (22.6)	0.173
Previous ipsilateral radial access, n (%)	37 (12.9)	23 (11.4)	14 (16.7)	0.226
Systolic blood pressure, mmHg	130.38±8.23	129.94±8.08	131.45±8.52	0.158
Creatinine, mg/dL	1.04 (0.82-1.24)	1.10 (0.81-1.24)	0.92 (0.84-1.22)	0.253
ACS indication, n (%)	30 (10.5)	19 (9.4)	11 (13.1)	0.354

Data are presented as mean ± standard deviation, median (interquartile range), or n (%), as appropriate. BMI: Body mass index; CAD: Coronary artery disease; ACS: Acute coronary syndrome.

**Table 2.** Procedural characteristics according to first-attempt puncture outcome

Variable	Overall (n=286)	Successful first-attempt (n=202)	Failed first-attempt (n=84)	p-value
Puncture attempts, n	1 (1-2)	1 (1-1)	2 (2-3)	<0.001
Puncture time, s	65 (40-90)	55 (35-80)	93 (65-130)	<0.001
Procedure type, PCI, n (%)	142 (49.7)	102 (50.5)	40 (47.6)	0.658
Access-site complications, n (%)	26 (9.1)	14 (6.9)	12 (14.3)	0.049
Puncture side, left, n (%)	265 (92.7)	189 (93.6)	76 (90.5)	0.362
Sheath size, 6F, n (%)	199 (69.6)	145 (71.8)	54 (64.3)	0.209

Values are presented as median (interquartile range) or n (%), as appropriate. PCI: Percutaneous coronary intervention; F: French.

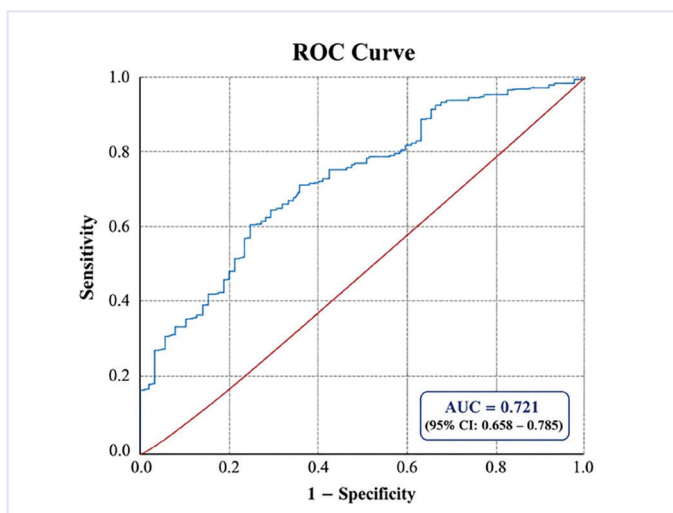
### Model Performance and Diagnostics

The multivariable model demonstrated a moderate-to-good predictive capacity, with an AUC of 0.721 (95% CI: 0.658-0.785,  $p < 0.001$ ) according to the ROC analysis. Assessment of the model's calibration via the Hosmer-Lemeshow test indicated an adequate fit ( $\chi^2=10.085$ ,  $df=8$ ,  $p=0.259$ ). Based on the Youden index, the optimal probability threshold was identified as 0.683. At this cut-off point, the model yielded a sensitivity of 67.2% and a specificity of 65.5%, as illustrated in Figure 1.

### DISCUSSION

The first-attempt success rate in dTRA was 70.6%. Advanced age, female sex, and low BMI were independent predictors of failed first-attempt puncture. Failed first-attempt puncture was also associated with longer puncture time and higher access-site complication rates.

dTRA has emerged as an alternative to the classic transradial approach in recent years. Data from different centers show that dTRA is a safe and feasible method.<sup>[6,7]</sup> Its significant advantages include lower radial artery occlusion and shorter hemostasis time.<sup>[1,7]</sup> Overall procedural success rates for dTRA have been reported in the literature to be between 88% and 95.5%.<sup>[6,7]</sup> However, these studies have mostly focused on overall cannulation success. Data on success on the first attempt are limited.



**Figure 1.** ROC curve of the multivariable prediction model. The AUC was 0.721 (95% CI: 0.658-0.785). The optimal cut-off value was 0.683 (sensitivity: 67.2%, specificity: 65.5%). AUC: Area under the curve; ROC: Receiver operating characteristic; CI: Confidence interval.

Achieving success on the first attempt shortens the puncture time. It reduces complications such as spasm and hematoma. It contributes positively to patient comfort.<sup>[3]</sup>

A negative correlation was found between female sex and puncture success. This is a key finding of the study. A possible explanation is the smaller diameter of the distal radial artery in women.<sup>[3,8]</sup> The more delicate vascular structure may also make the procedure more difficult.<sup>[3]</sup> KODRA data show that female sex is an independent risk factor for access site complications. This increase has been reported to be largely due to minor bleeding events.<sup>[4]</sup> Therefore, a more careful and controlled puncture approach should be preferred in female patients.

Our study showed that low BMI reduced puncture success. This finding is consistent with studies reporting that low body weight and small vessel diameter pose technical challenges.<sup>[3,5,8]</sup> In patients with low BMI, the arterial diameter is generally smaller, and the subcutaneous supporting tissue is also more limited. This can lead to increased arterial mobility, making vessel stabilization during puncture more difficult.<sup>[9]</sup> Consequently, cannulation becomes more challenging, and the probability of failure on the first attempt increases. Conversely, an increase in subcutaneous tissue with increasing BMI may have facilitate palpation of the artery.

The relationship between BMI and puncture success is not clear. Results in the literature are heterogeneous. A large-scale analysis based on KODRA data showed that obesity did not affect the success rate. However, it was reported that the puncture time was prolonged.<sup>[4]</sup> These findings suggest that BMI may have different effects. In our study, the success rate increased as BMI increased. This may be related to the small vessel diameter seen in low BMI. Increased vessel mobility may also pose technical challenges. Therefore, low BMI can be considered a factor that increases the likelihood of failure on the first attempt.

A negative correlation was found between advanced age and puncture success. Advanced age may negatively affect puncture success because of vascular calcification, tortuosity, and reduced arterial elasticity.<sup>[10,11]</sup> Therefore, dTRA should be planned more carefully in the elderly age group.

When procedure-related variables were evaluated, the sheath size did not have an effect on success in the first attempt. This observation suggests that success is primarily determined in the initial stage of puncture. That is, the critical step is the first entry into the artery. It is known that dTRA has a significant learning curve. Success rates have been shown to stabilize after approximately 200 cases.<sup>[2]</sup> This highlights the importance of operator experience. In our study, all procedures

**Table 3.** Univariable and multivariable logistic regression analysis of predictors of first-attempt puncture success

Variable	Univariable OR (95% CI)	p-value	Multivariable OR (95% CI)	p-value
Age	0.92 (0.89-0.95)	<0.001	0.93 (0.90-0.96)	<0.001
Female sex	0.50 (0.29-0.84)	0.010	0.50 (0.29-0.87)	0.015
BMI	1.15 (1.05-1.27)	0.003	1.17 (1.06-1.30)	0.001
Previous ipsilateral radial access	0.64 (0.31-1.31)	0.228	-	-
Diabetes mellitus	0.85 (0.49-1.47)	0.563	-	-
Creatinine	1.34 (0.81-2.24)	0.248	-	-

Variables with  $p < 0.10$  in univariable analysis and clinically relevant factors were included in the multivariable logistic regression model. A  $p$ -value  $< 0.05$  was considered statistically significant. OR: Odds ratio; CI: Confidence interval; BMI: Body mass index.

were performed by an experienced operator. Therefore, it can be assumed that the results obtained reflect more patient-related factors.

Ultrasound-guided puncture has been reported to increase the success rate. This effect is particularly pronounced in patients with low BMI and women.<sup>[3,12]</sup> It has also been shown to reduce complication rates.<sup>[3,12]</sup> In our series, all interventions were performed with palpation. This may have increased technical difficulties in some patient groups. The use of ultrasound may be beneficial, especially in high-risk patients. Adding this approach to routine practice may increase success rates.

Our study has a single-center and retrospective design. All procedures were performed by a single operator with experience in more than 200 dTRA cases. While this increases technical standardization, it may limit the generalizability of the results. Furthermore, recording bias cannot be completely ruled out due to the operator recording the number of punctures. The lack of ultrasound-guided puncture may also have affected the results.

In conclusion, the success of puncture on the first attempt in dTRA is closely related to the patient's age, sex, and BMI. Technical challenges should be anticipated, especially in elderly, female, and low BMI patients, and auxiliary methods such as ultrasound guidance should be planned when necessary.

### Ethics

**Ethics Committee Approval:** Ethical clearance for this investigation was granted by the Mardin Training and Research Hospital Medical Ethics Committee (approval number: 2026/04-10, dated: 24.04.2026). The research protocols complied with the standards set forth in the Declaration of Helsinki.

**Informed Consent:** Due to the study's retrospective design, individual consent was not required; however, all datasets were completely de-identified prior to analysis to maintain confidentiality.

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### Footnotes

#### Authorship Contributions

Surgical and Medical Practices: A.A.; Concept: A.A., R.K., T.G., M.Z.K.; Design: A.A., R.K., T.G., B.A., A.E., A.Ar., M.S.C., M.R.T., M.Z.K.; Data Collection or Processing: A.A., R.K., T.G., B.A., A.E., A.Ar., M.S.C., M.R.T., M.Z.K.; Analysis or Interpretation: A.A., R.K., T.G., B.A.; Literature Search: A.A., R.K., T.G., B.A., M.S.C., M.Z.K.; Writing: A.A., R.K., T.G.

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