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ORIGINAL ARTICLE

Prevalence and clinical, procedural, and nutritional-status-related risk factors of puncture-site hematoma after cardiac catheterization in Northern Iraq: a cross-sectional study

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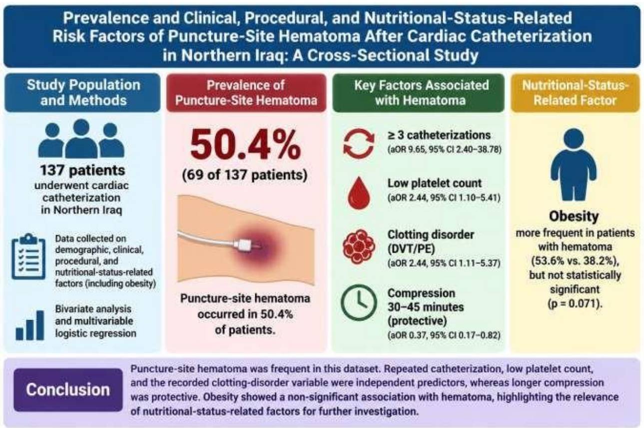
Abstract

Introduction: Puncture-site hematoma is a clinically relevant vascular-access complication after invasive catheter-based procedures. **Objective:** This study aimed to determine the prevalence of puncture-site hematoma and identify its associated risk factors including nutritional-status-related factors among patients following cardiac catheterization in Northern Iraq. **Methods:** Data from 137 patients were analyzed using a structured data-collection form covering demographic and clinical characteristics, catheterization-related variables, 16 potential risk factors, including obesity as a nutritional-status-related factor, and clinical signs and symptoms. Categorical data were summarized as frequencies and percentages. Pearson chi-square tests were used for bivariate associations, and variables significantly associated with hematoma were entered into a multivariable binary logistic regression model. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. **Results:** Puncture-site hematoma occurred in 69 of 137 patients (50.4%). Obesity was more frequent among patients with hematoma than those without hematoma (53.6% vs. 38.2%), although the association was not statistically significant (p=0.071). In bivariate analysis, hematoma was associated with three or more cardiac catheterizations (p=0.001), femoral versus radial access (p=0.033), shorter compression time (15–30 minutes; p=0.013), a history of inherited/acquired clotting disorder recorded as DVT/PE (p=0.002), and low platelet count (p=0.012). In the adjusted model, clotting disorder (aOR 2.44, 95% CI 1.11–5.37), low platelet count (aOR 2.44, 95% CI 1.10–5.41), and three or more catheterizations (aOR 9.65, 95% CI 2.40–38.78) were associated with greater odds of hematoma. Compression for 30–45 minutes was associated with lower odds (aOR 0.37, 95% CI 0.17–0.82). Radial access showed a protective direction but did not remain statistically significant after adjustment (aOR 0.48, p=0.079). **Conclusion:** Puncture-site hematoma was frequent in this dataset. Repeated catheterization, low platelet count, and the recorded clotting-disorder variable were independent predictors, whereas longer compression was protective. Obesity showed a non-significant association with hematoma, highlighting the relevance of nutritional-status-related factors for further investigation. Risk stratification and careful post-procedural hemostasis and monitoring should be emphasized in cardiac catheterization care.

Keywords: Cardiac catheterization. Puncture site. Hematoma. Risk factors. Nursing care. Vascular complications. Obesity. Nutritional status.

Graphical Abstract



Source: Own authorship.

Introduction

Cardiac catheterization is an invasive diagnostic and therapeutic procedure that provides direct information about cardiac anatomy, pressures, coronary circulation, and ventricular function. Although generally performed safely, vascular-access complications remain clinically important, and post-procedural assessment of the puncture site is a core component of patient care **[1]**. Bleeding and hematoma can occur when hemostasis at the access site is incomplete or when patient- or procedure-related factors increase bleeding risk. Related literature has identified antithrombotic therapy, procedural characteristics, prior procedures, and coagulation-related factors as relevant to hematoma or arterial puncture-site hemorrhage, although findings vary across clinical populations and procedures **[2,3]**. Obesity, as a nutritional-status-related factor, may also be relevant when considering vascular-access complications after cardiac catheterization.

A hematoma usually manifests as pain and its accompanying symptoms, such as nausea and vomiting. The pain frequently starts suddenly, is severe, and does not radiate. Rarely, the hematoma may be substantial and exhibit tachypnea, tachycardia, and hypovolemia. A palpable, non-pulsating localized mass is typically found during a physical examination. A bulge in the abdominal wall that does not cross the midline and does not alter when the rectus muscles are flexed is known as the Fothergill sign. This indicates a rectus sheath hematoma and helps identify whether the abdominal mass is inside the abdominal cavity or the abdominal wall. It is not a very sensitive indicator and is frequently ambiguous in obese people. In order to identify any risk factors, such as surgery, coughing, constipation, asthma, bronchitis, anticoagulation therapy, and the use of oral anticoagulants and corticosteroids, the doctor should get a complete medical history **[4]**.

Nurses have a major role after cardiac catheterization through surveillance of the vascular access site, monitoring distal circulation and vital signs, maintaining hemostasis, and educating patients about post-procedural care. Studies of nursing care after cardiac catheterization have emphasized the need for adequate knowledge and adherence to post-catheterization safety practices **[5,6]**. Evidence describing puncture-site hematoma and associated factors in Northern Iraq is limited in the supplied literature. Therefore, this study aimed to determine the observed occurrence of puncture-site hematoma after cardiac catheterization and to identify patient- and procedure-related and nutritional-status-related factors associated with hematoma formation.

Materials and Methods

Study design and setting

This cross-sectional study, according to STROBE guidelines, was conducted in cardiac catheterization units at selected hospitals across three governorates in Northern Iraq: Kirkuk, Erbil, and Sulaymaniyah. A total of 137 patients who underwent cardiac catheterization were included in the study. Data were collected through Researcher- administered structured questionnaire during the patients' admission to the cardiac catheterization units. The questionnaire collected demographic and clinical information, including the presence or absence of puncture-site hematoma following cardiac catheterization and potential associated risk factors.

Ethical Consideration

Before starting of the study, an ethical clearance was obtained from the research ethics committee of the college of nursing under approval number (4) dated (28/6/2026). All participants were informed of the study's purpose, procedures, expected duration, and their right to withdraw at any stage without affecting their professional standing.

Participants and sampling

A convenience sampling technique was used to recruit eligible patients who had undergone cardiac catheterization during the data collection period. A total of 137 patients were included in the study. Data were collected from May 10, 2025, to April 18, 2026. Patients were eligible for inclusion if they were aged 18 years or older, had undergone cardiac catheterization, were admitted to the selected cardiac catheterization units during the data collection period, were able to communicate effectively, and agreed to participate in the study. Patients who were critically ill or clinically unstable at the time of data collection, or who were unable to complete the interview or provide the required information, were excluded.

Data collection tool and variables

A structured data-collection form was used. It contained four sections: (1) demographic data; (2) medical and catheterization-related information; (3) 16 potential risk-factor items; and (4) 11 signs and symptoms. The primary outcome was puncture-site hematoma (yes/no). The 16 risk-factor items were obesity as a nutritional-status-related factor; inherited/acquired clotting disorder (DVT/PE); increased blood pressure; renal dysfunction; use of anticoagulants; heparin dose; steroid use; low platelet count; sheath time; large sheath size; position change during compression; previous surgery in the same area; previous catheterization at the same site; compression-time factor; bleeding/tissue damage during puncture; and early ambulation. Because several questionnaire items (for example, heparin dose, sheath time, low platelet count, and large sheath size) were recorded as binary items without quantitative thresholds in the supplied instrument, they were analyzed according to the original yes/no coding and interpreted cautiously.

Statistical analysis

Categorical variables were summarized using frequencies and percentages. Pearson chi-square tests were used to evaluate bivariate associations with hematoma. The number of cardiac catheterizations was grouped as 1–2 versus ≥3 for inferential analysis because the third- and fourth-procedure categories contained small cell counts when analyzed separately. The five variables that were statistically significant in bivariate analysis—clotting disorder (DVT/PE), low platelet count, ≥3 catheterizations, puncture site, and compression time—were entered simultaneously into a binary logistic regression model. Adjusted odds ratios (aORs), 95% confidence intervals (CIs), and two-sided p values are reported. Statistical significance was set at $p<0.05$. The 16 risk-factor tests were exploratory and were not adjusted for multiple comparisons; therefore, these p values should be interpreted cautiously.

Results

A total of 137 patients were included. Puncture-site hematoma was documented in 69 patients (50.4%), while 68 (49.6%) did not develop hematoma. Table 1 summarizes demographic, clinical, and procedure-related characteristics.

Table 1. Demographic, clinical, and procedure-related characteristics of participants (N=137).

Variable	Category	n (%)
Age (years)	30–40	21 (15.3)
	41–50	33 (24.1)
	51–60	34 (24.8)
	61–70	31 (22.6)
	≥71	18 (13.1)
Gender	Male	81 (59.1)
	Female	56 (40.9)
Marital status	Single	15 (10.9)
	Married	116 (84.7)
	Divorced	6 (4.4)
Educational level	Illiterate	40 (29.2)
	Read and write	23 (16.8)
	Primary	25 (18.2)
	Secondary	30 (21.9)
	Higher education	18 (13.1)
	Unclassified code	1 (0.7)
Occupation	Employed	31 (22.6)
	Retired	23 (16.8)
	Student	4 (2.9)
	Jobless	3 (2.2)
	Free work	43 (31.4)
	Housewife	33 (24.1)
Residence	Kirkuk	57 (41.6)
	Erbil	34 (24.8)
	Sulaymaniyah	45 (32.8)
	Missing	1 (0.7)
Chronic-disease status	One chronic disease	52 (38.0)
	Multiple chronic diseases	74 (54.0)
	None	11 (8.0)
Personal habits	Smoking	89 (65.0)
	Alcohol	2 (1.5)
	None	34 (24.8)
	Smoking and alcohol	12 (8.8)
Purpose of catheterization	Diagnostic	68 (49.6)
	Therapeutic	69 (50.4)
Number of catheterizations	First	85 (62.0)
	Second	33 (24.1)
	Third	13 (9.5)
	Fourth	6 (4.4)
Puncture site	Femoral	73 (53.3)
	Radial	64 (46.7)
Variable	Category	n (%)
Compression time	15–30 min	67 (48.9)
	30–45 min	70 (51.1)

Note. One educational-level value was coded outside the five categories defined in the supplied questionnaire and is therefore shown as unclassified. Source: Own authorship.

Bivariate analysis showed no statistically significant association between hematoma and age, gender, chronic-disease status, or diagnostic versus therapeutic purpose. In contrast, hematoma was more frequent among patients with ≥3 catheterizations (84.2% vs 44.9% among those with 1–2 procedures), femoral access (58.9% vs 40.6% with radial access), and compression for 15–30 minutes (61.2% vs 40.0% with 30–45 minutes) (Table 2).

Table 2. Association of selected participant and procedure characteristics with puncture-site hematoma.

Variable / category	No hematoma n (%)	Hematoma n (%)	p value
Age 30–40	9 (42.9)	12 (57.1)	0.709
Age 41–50	17 (51.5)	16 (48.5)	
Age 51–60	17 (50.0)	17 (50.0)	
Age 61–70	18 (58.1)	13 (41.9)	
Age ≥71	7 (38.9)	11 (61.1)	
Male	39 (48.1)	42 (51.9)	0.675
Female	29 (51.8)	27 (48.2)	
One chronic disease	24 (46.2)	28 (53.8)	0.800
Multiple chronic diseases	38 (51.4)	36 (48.6)	
No chronic disease	6 (54.5)	5 (45.5)	
Diagnostic catheterization	39 (57.4)	29 (42.6)	0.073
Therapeutic catheterization	29 (42.0)	40 (58.0)	
1–2 catheterizations	65 (55.1)	53 (44.9)	0.001
≥3 catheterizations	3 (15.8)	16 (84.2)	
Femoral access	30 (41.1)	43 (58.9)	0.033
Radial access	38 (59.4)	26 (40.6)	
Compression 15–30 min	26 (38.8)	41 (61.2)	0.013
Compression 30–45 min	42 (60.0)	28 (40.0)	

Note. Percentages are within each category. p values are from Pearson chi-square tests. Source: Own authorship.

Among the 16 prespecified risk-factor items, inherited/acquired clotting disorder (DVT/PE) and low platelet count were significantly associated with hematoma in unadjusted analysis. Obesity, considered a nutritional-status-related factor, was more frequent in the hematoma group (53.6%) than in the no-hematoma group (38.2%), although the association was not statistically significant (p=0.071). The remaining risk-factor items did not reach the conventional p<0.05 threshold (Table 3).

Table 3. Association between potential risk-factor items and puncture-site hematoma.

Risk factor present	No hematoma n (%)	Hematoma n (%)	p value
Obesity	26 (38.2)	37 (53.6)	0.071
Inherited/acquired clotting disorder (DVT/PE)	24 (35.3)	43 (62.3)	0.002
Increased blood pressure	40 (58.8)	49 (71.0)	0.135
Renal dysfunction	28 (41.2)	36 (52.2)	0.197
Use of anticoagulants	45 (66.2)	50 (72.5)	0.425
Heparin dose (binary item)	43 (63.2)	50 (72.5)	0.247
Steroid use	34 (50.0)	39 (56.5)	0.444
Low platelet count	23 (33.8)	38 (55.1)	0.012
Sheath time (binary item)	48 (70.6)	44 (63.8)	0.395
Large sheath size	45 (66.2)	51 (73.9)	0.323
Position change during compression	37 (54.4)	44 (63.8)	0.265
Previous surgery in the same area	31 (45.6)	33 (47.8)	0.793
Previous catheterization at same site	32 (47.1)	38 (55.1)	0.348
Compression-time risk item	45 (66.2)	40 (58.0)	0.322
Bleeding/tissue damage during puncture	31 (45.6)	36 (52.2)	0.441
Early ambulation	29 (42.6)	39 (56.5)	0.104

Note. Percentages are the prevalence of each risk-factor item within the no-hematoma (n=68) and hematoma (n=69) groups. p values are unadjusted Pearson chi-square tests. Source: Own authorship.

In multivariable analysis, clotting disorder, low platelet count, and ≥3 catheterizations remained independently associated with greater odds of hematoma. Compression for 30–45 minutes was independently associated with lower odds. Radial access showed lower adjusted odds than femoral access, but the confidence interval included 1 and the association did not reach statistical significance (Table 4).

Table 4. Multivariable binary logistic regression for puncture-site hematoma (N=137).

Predictor	Adjusted OR	95% CI	p value
Clotting disorder (DVT/PE): yes vs no	2.44	1.11–5.37	0.027
Low platelet count: yes vs no	2.44	1.10–5.41	0.028
≥3 vs 1–2 catheterizations	9.65	2.40–38.78	0.001

Radial vs femoral access	0.48	0.22–1.09	0.079
Compression 30–45 vs 15–30 min	0.37	0.17–0.82	0.014

Note. OR = odds ratio; CI = confidence interval. All five predictors were entered simultaneously. Source: Own authorship.

Among the 69 patients who developed hematoma, pain was the most frequently recorded symptom (95.7%), followed by tenderness (82.6%), difficulty moving/decreased range of motion (81.2%), numbness (79.7%), and muscle weakness (76.8%). Because signs and symptoms were not part of the primary study objective, they are presented descriptively in Figure 1 rather than as a main analytical table.

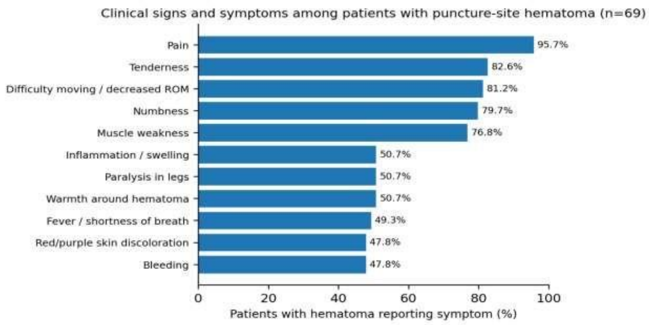


Figure 1. Clinical signs and symptoms among patients who developed puncture-site hematoma (n=69). Source: Own authorship.

Discussion

This study found a high observed proportion of puncture-site hematoma (50.4%) in the analyzed dataset. This value should be interpreted according to the study's broad yes/no clinical recording of hematoma rather than compared directly with studies restricted to major hemorrhage or device-pocket hematoma. For example, Tamari et al. reported puncture-site hemorrhage in 5.9% of patients undergoing neuroendovascular treatment, while Tarakji et al. reported a 2.2% hematoma rate after cardiac implantable electronic device procedures **[2,3]**. The procedures, populations, outcome definitions, and surveillance methods differ substantially, so these figures are not directly equivalent.

Hematoma was shown to be independently correlated with the questionnaire item identifying an inherited/acquired clotting condition (DVT/PE). Because DVT and PE are thrombotic problems rather than bleeding disorders and because the provided data does not differentiate between diagnosis, treatment intensity, or current anticoagulation status, this result must be interpreted carefully. However, relevant procedural literature indicates that antithrombotic treatment can significantly affect the likelihood of hematomas or bleeding at the puncture site. In a femoral neuroendovascular cohort, Tamari et al. found that triple antiplatelet therapy and postoperative heparin use were risk factors for puncture-site hemorrhage **[2]**, while Tarakji et al. discovered that anticoagulant/antiplatelet strategies were significant predictors of hematoma following cardiac device procedures **[3]**. The anticoagulant use distinct binary item in the current investigation was not significant, indicating that the relationship with the DVT/PE item should not be taken as evidence of a drug impact because the separate binary item for anticoagulant use in the current study was not significant.

Low platelet count was also an independent predictor of hematoma. This finding is biologically plausible because platelets are central to primary hemostasis and clot formation after vascular injury **[4]**. Importantly, the present instrument recorded low platelet count as a binary item without a numeric threshold; therefore, the magnitude of thrombocytopenia and its clinical context could not be examined. Future studies should record actual platelet counts and relevant coagulation measurements. A particularly strong association was observed for repeated catheterization: patients with three or more catheterizations had markedly higher adjusted odds of hematoma than those with one or two procedures. The wide confidence interval indicates limited precision because only 19 participants were in the ≥3-procedure group, but the direction is clinically important. Tarakji et al. similarly identified the number of previous cardiac device procedures among factors associated with hematoma risk in a different invasive cardiac setting **[3]**. Repeated vascular manipulation may be relevant, but a prospective study documenting access-site history and technical characteristics would be required to clarify the mechanism.

Femoral access was associated with a higher hematoma proportion in unadjusted analysis, whereas radial access showed a protective direction after adjustment but did not remain statistically significant. This attenuation suggests that the crude access-site association may partly reflect other procedural or patient factors. These results are generally in line with recent research showing that radial access has a lower frequency of access-site problems than femoral access. Radial access was linked to a significantly reduced risk of access-site hematoma than femoral access, according to a 2024 network meta-analysis of 47 randomized studies including 38,924 participants (OR 0.34, 95% CI 0.24–0.48) **[7]**. Similarly, radial access significantly reduced severe bleeding and vascular problems, according to an updated comprehensive review and meta-analysis of 31 randomized studies **[8]**.

Additionally, recent research highlights that the advantages of radial access are especially linked to decreases in vascular problems and access-site bleeding, however procedural skill and patient or procedural variables may affect the observed effect **[9]**. The reduction of the link in the current study upon adjustment indicates that variations in baseline patient characteristics and procedural parameters, rather than access site alone, may contribute to the crude relationship between access site and hematoma. Therefore, it is important to evaluate the lack of statistical significance following correction with caution. This could be an indication of residual confounding, low statistical power, or a small number of hematoma occurrences.

Compression for 30-45 minutes was independently associated with lower odds of hematoma compared with 15-30 minutes. According to this study, a longer duration of regulated compression may improve hemostasis and lessen early access-site hemorrhage after cardiac catheterization. A 2023 meta-analysis of randomized trials revealed that shorter hemostatic compression durations were linked to a higher risk of access-site hematoma, especially when compression was maintained for less than 90 minutes. This finding supports the significance of optimizing compression duration following transradial procedures **[10]**. On the other hand, more recent research shows that compression protocols can be safely shortened once sufficient hemostasis is attained. It emphasizes that the ideal duration should strike a balance between the avoidance of bleeding and hematomas and the risks of prolonged compression, such as radial artery occlusion **[11]**. Consequently, the protective correlation identified in our research may indicate the advantage of attaining more stable hemostasis in the early post-procedural phase, while the ideal duration of compression should be tailored based on access site, anticoagulation status, sheath dimensions, and indications of persistent bleeding.

Most of the other 16 risk-factor items were not statistically significant. Obesity was more common among patients with hematoma, although the association was not statistically significant. Recent studies have also examined the relationship between body mass index and bleeding after cardiac interventions **[12]**. Absence of statistical significance should not be interpreted as evidence that these factors are clinically irrelevant. Some items were measured only as yes/no variables without defined thresholds, and 16 separate exploratory comparisons increase the possibility of chance findings. In related contexts, Tarakji et al. identified anticoagulation, antiplatelet therapy, procedure history, and other clinical characteristics as hematoma predictors **[3]**, while Tamari et al. reported associations with activated clotting time and antithrombotic therapy **[2]**. Differences in outcome definitions, patient populations, and measurement methods may explain variation between studies.

Strengths and Limitations

Strength of this study is the simultaneous assessment of demographic, clinical, procedural, and prespecified risk-factor information in a patient dataset from Northern Iraq. The analysis also moved beyond simple frequencies by evaluating bivariate associations and an adjusted multivariable model. There are a few important limitations. The specific study design, sampling strategy, participating centers, data collection period, and ethics information were not included in the provided manuscript; these aspects need to be confirmed prior to publishing. Due to the small size of the (≥3)-catheterization subgroup and the small sample size, the confidence interval was wide. Some risk-factor items were binary with unclear clinical thresholds, including the "clotting disorder **[DVT/PE]**" box mixes thrombotic diseases under language that may be confused for a bleeding disorder. The risk-factor analysis contained many exploratory comparisons without multiplicity adjustment. It is also challenging to compare the results with studies that only reported clinically significant bleeding or severe hematomas because the study recorded hematomas as a yes/no outcome without a specified severity assessment. Consequences for nursing practices.

Implications for Nursing Practice

The results support coordinated post-catheterization surveillance, particularly for patients with low platelet counts, complicated thrombotic/antithrombotic histories, or repeated procedures. A nursing assessment should be include monitoring the access site, keeping an eye out for change in distal circulation and bleeding, maintaining appropriate hemostasis, and teaching patients about post procedural safety precautions. The need of safe post-procedural practice, monitor and comprehension has also been emphasized in other studies on nursing care after cardiac catheterization **[5,6]**.

Conclusion

Puncture-site hematoma was recorded in approximately half of the patients in this dataset. After adjustment, a history recorded as clotting disorder (DVT/PE), low platelet count, and three or more cardiac catheterizations were associated with increased odds of hematoma, while compression for 30–45 minutes was associated with lower odds. Radial access showed a protective direction but was not statistically significant after adjustment. These findings support targeted risk assessment and careful hemostatic monitoring, while also highlighting the need for prospective multicenter studies using standardized definitions of hematoma and quantitatively defined risk factors. Nutritional-status-related factors, particularly obesity, should also be considered in future studies.

CRediT

Author contributions: **Conceptualization-** All authors; **Investigation-** All authors. **Methodology-** All authors; **Project administration-** All authors; **Supervision-**All authors; **Writing - original draft-** All authors; **Writing-review & editing-** All authors.

Acknowledgment

Not applicable.

Ethical Approval

Before starting of the study, an ethical clearance was obtained from the research ethics committee of the college of nursing under approval number (4) dated (28/6/2026). All participants were informed of the study's purpose, procedures, expected duration, and their right to withdraw at any stage without affecting their professional standing.

Informed Consent

It was applicable.

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Conflict of Interest

The authors declare no conflict of interest.

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Application of Artificial Intelligence (AI)

Not applicable.

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It was performed.

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