

Vascular access complications in patients undergoing percutaneous procedures in hemodynamics: a scoping review

Complicações do acesso vascular em pacientes submetidos a procedimentos percutâneos em hemodinâmica: revisão de escopo

Las complicaciones del acceso vascular en pacientes sometidos a procedimientos percutâneos en hemodinámica: revisión de escopo

Rejane Reich^{a,b}

Eneida Rejane Rabelo-Silva^{a,b,c}

Simone Marques dos Santos^{a,b}

Miriam de Abreu Almeida^{a,b,c}

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ABSTRACT

Objective: To map the production of knowledge on vascular access complications in patients undergoing percutaneous procedures in hemodynamic laboratories.

Methods: Scoping review study. The search strategy was developed in three stages, considering the period from July 2005 to July 2015 in the PubMed, CINAHL, Scopus, and LILACS databases. The collected data were analyzed and summarized in a narrative form.

Results: One-hundred twenty-eight publications that made it possible to map the contexts of study of complications, occurrence according to access routes, as well as an understanding of diagnosis and clinical management, were included. Three theme categories were identified: complications; predictive factors; and diagnosis/treatment.

Conclusion: Vascular access site complications range according to the access route used. Knowledge of factors that permeate the occurrence of these events may contribute to early detection, planning, and monitoring of the care implemented.

Keywords: Endovascular procedures. Hematoma. Hemorrhage. Patient care.

RESUMO

Objetivo: Mapear a produção de conhecimento acerca das complicações do acesso vascular em pacientes submetidos a procedimentos percutâneos em Laboratório de Hemodinâmica.

Métodos: Estudo do tipo revisão de escopo. Elaborou-se estratégia de busca em três etapas, considerando o período entre julho de 2005 e 2015, nas bases de dados PubMed, CINAHL, Scopus e LILACS. Os dados extraídos foram analisados e sintetizados de forma narrativa.

Resultados: Foram incluídas 128 publicações que permitiram mapear os contextos de estudo das complicações, a ocorrência de acordo com as vias, bem como a compreensão do diagnóstico e manejo clínico. Como síntese da análise identificou-se três categorias temáticas: Complicações; Fatores preditores; e Diagnóstico/tratamento.

Conclusão: As complicações no local do acesso vascular são de ocorrência variável conforme a via de acesso utilizada. O conhecimento dos fatores que permeiam a ocorrência destes eventos podem auxiliar no reconhecimento precoce, planejamento e monitorização dos cuidados implementados.

Palavras-chave: Procedimentos endovasculares. Hematoma. Hemorragia. Assistência ao paciente.

RESUMEN

Objetivo: Mapear la producción de conocimiento acerca de las complicaciones del acceso vascular en pacientes sometidos a procedimientos percutâneos en el Laboratorio de Hemodinámica.

Métodos: Estudio de tipo revisión de escopo. Se elaboró la estrategia de búsqueda en tres etapas, considerando el período comprendido entre julio 2005 y 2015, en las bases PubMed, CINAHL, Scopus y LILACS. Los datos extraídos fueron analizados y sintetizados de forma narrativa.

Resultados: Fueron incluidas 128 publicaciones que permitieron mapear los contextos de estudio de las complicaciones, la ocurrencia de acuerdo con las vias, así como la comprensión del diagnóstico y manejo clínico. Como síntesis del análisis se identificó tres categorías temáticas: Complicaciones, Factores predictores y Diagnóstico/tratamiento.

Conclusión: Las complicaciones en el sitio del acceso vascular son de ocurrencia variable de acuerdo con la vía de acceso utilizada. El conocimiento de los factores que están presentes en la ocurrencia de estos eventos puede auxiliar en el reconocimiento temprano, planeamiento y control de la atención implementados.

Palabras clave: Procedimientos endovasculares. Hematoma. Hemorragia. Atención al paciente.

^a Hospital de Clínicas de Porto Alegre (HCPA). Porto Alegre, Rio Grande do Sul, Brasil.

^b Universidade Federal do Rio Grande do Sul (UFRGS), Escola de Enfermagem, Programa de Pós-graduação em Enfermagem. Porto Alegre, Rio Grande do Sul, Brasil.

^c Universidade Federal do Rio Grande do Sul (UFRGS), Escola de Enfermagem. Departamento de Enfermagem Médico-Cirúrgica. Porto Alegre, Rio Grande do Sul, Brasil.

INTRODUCTION

Despite technological evolution and interventionist techniques, complications resulting from vascular access still occur in patients undergoing percutaneous procedures in hemodynamic laboratories. Therefore, studies to evaluate clinical outcomes associated with puncture sites in the different diagnostic and therapeutic options follow advances in the area⁽¹⁻⁴⁾.

Femoral vessels are still used as the most common access site for the different specialties performed in hemodynamic laboratories, especially in percutaneous procedures that require the use of large-caliber introducers such as in endovascular correction of aneurysms and valvuloplasties, which further increases the potential for access site complications⁽⁵⁾. Among femoral approach complications, the most frequently described are bleeding, hematoma, and pseudo-aneurysm⁽⁶⁻⁷⁾.

The trans-radial approach is gaining popularity, especially in diagnostic and therapeutic cardiac procedures, as data regarding the safety and effectiveness of the technique emerge, associating it with lower rates of vascular complications and bleeding⁽⁸⁻⁹⁾. A well-known complication is radial artery occlusion, with incidence ranging from <1% 33%⁽²⁾, but this rarely leads to clinical events, due to collateral perfusion of the hand and because it is often asymptomatic.

Another access route that stands out as an alternative for cardiac catheterization and percutaneous coronary intervention (PCI) in selected cases is the ulnar artery approach, when the radial technique may not be viable or when the trans-femoral technique is not an option⁽¹⁰⁾. With regard to the risk of complications associated with this access, similar results were found when comparing ulnar access with radial access⁽¹¹⁾.

However, brachial artery access, although little used by some specialties, is an option in peripheral vascular procedures and an alternative access in case of failure of other routes. Although the risk of complications is low for experienced interventionists, patients must be carefully evaluated regarding signs and symptoms of bleeding and nerve compression⁽¹²⁾.

Access site complications lead to longer periods of hospitalization, additional treatments, and higher costs, in addition to being associated with increased morbidity and mortality⁽⁶⁾. In the face of these repercussions, complications must be identified and monitored to prevent, minimize, or resolve potential harm to patients. Review studies have corroborated by reporting main vascular access site complications, their diagnosis, and treatment⁽¹³⁻¹⁴⁾, thus enabling the planning of actions in clinical practice.

Scoping review studies⁽¹⁵⁾ that enable a broad mapping of knowledge on this theme were not found in the literature. Therefore, with the purpose of increasing knowledge on

the available evidence, the objective of the present study was to map the production of knowledge on vascular access complications in patients undergoing percutaneous procedures in hemodynamic laboratories.

METHODS

The study was outlined as a scoping review that originated from a dissertation⁽¹⁶⁾. The objective of a scoping study is to map the main concepts of a specific area of knowledge, as well as to evaluate the extension, reach, and nature of the research, summarize and report the research data, and also make it possible to identify gaps in existing studies⁽¹⁵⁾. The study followed the methodology proposed by the Joanna Briggs Institute⁽¹⁷⁾ in the following stages: identification of the research question; identification of relevant studies; selection of studies; mapping of data; and grouping, synthesis, and report of results. It is recommended that at least two researchers work independently for the selection of the studies⁽¹⁸⁾.

The following guiding questions were identified: Which vascular access site complications have been reported after percutaneous procedures in hemodynamic laboratories? What are the risk factors and predictors of vascular access site complications? How are vascular access site complications clinically evaluated and treated?

The studies were eligible for inclusion if published in English, Portuguese, or Spanish, in the period between July 2005 and July 2015, and available in full for online access. Studies that did not approach the relevant concept for the achievement of the objective; duplicate studies; letters to the publisher, editorials, and abstracts published in annals were excluded. The scoping review did not anticipate the exclusion of articles according to methodological quality criteria⁽¹⁷⁾.

For identification of relevant studies, an initial electronic search was carried out in the following databases: the U.S. National Library of Medicine (PubMed) and the Cumulative Index to Nursing and Allied Health Literature (CINAHL with full text). Descriptors chosen were: endovascular procedures; percutaneous coronary intervention; and cardiac catheterization, according to Health Sciences Descriptors (DeCS) and the keywords vascular complications and vascular access site. The Boolean operators (OR and AND) were used to carry out the cross-checking of descriptors and keywords.

This initial search was followed by analysis of the words contained in the title, abstract, and descriptors or keywords of the recovered articles. Then, a second search was carried out in all of the databases included for the research of relevant studies. In this stage, the following terms were considered for PubMed and CINAHL databases: endovascular procedures; vascular complications; femoral access; radial access; manual compression; vascular closure devices; and access

site complications, with the Boolean operators OR and AND. For the search in the Latin American and Caribbean Health Sciences Literature (LILACS), the following terms were used: “*complicações vasculares*” (*acesso femoral* OR *acesso radial*); “*cateterismo cardíaco*”; “*complicações vasculares*,” and “*intervenção coronária percutânea*” and “*complicações vasculares*.” To search the Scopus data base, the following terms were used: endovascular procedures; percutaneous coronary intervention; cardiac catheterization; and access site complications, with the Boolean operator OR.

For the third search strategy, the list of references of each article selected was evaluated. The articles considered relevant in the context studied were researched as additional studies and accessed through PubMed and the Coordination for the Improvement of Higher Education Personnel (CAPES) publication portals.

The references selected were then entered into the EndNote bibliography management software. Access to full articles was carried out through the PubMed search page, through the CAPES publications portal, and through free search in journals.

In the three search strategies, the records were selected by title using a single evaluator. Subsequently, a selection by analysis of title and abstract was independently carried

out by two evaluators. Then, consensus on the records with potential relevance and evaluation of full articles for eligibility were carried out by one of the researchers.

Relevant data were identified and extracted from each publication, such as: authors; year of publication; country of origin; type of study; sample; access route; type of procedure; context in study (vascular access site complications, risk factors, predictors, evaluation, and treatment); main result; and considerations of the study. In the analysis of the data originated from the articles, the access route used and the main interest focus of each publication were considered. The findings were organized in categories and subcategories, and were summarized in a narrative form.

■ RESULTS

The search strategies enabled recovery of 3,713 records. The reading with analysis of titles and abstracts by two evaluators resulted in the selection of 180 publications for full reading. After the reading of the full text, 128 publications responded to at least one of the guiding questions of the scoping review and characterized the sample of this theoretical search. Figure 1 represents the process of selection of articles based on PRISMA guidelines⁽¹⁹⁾.

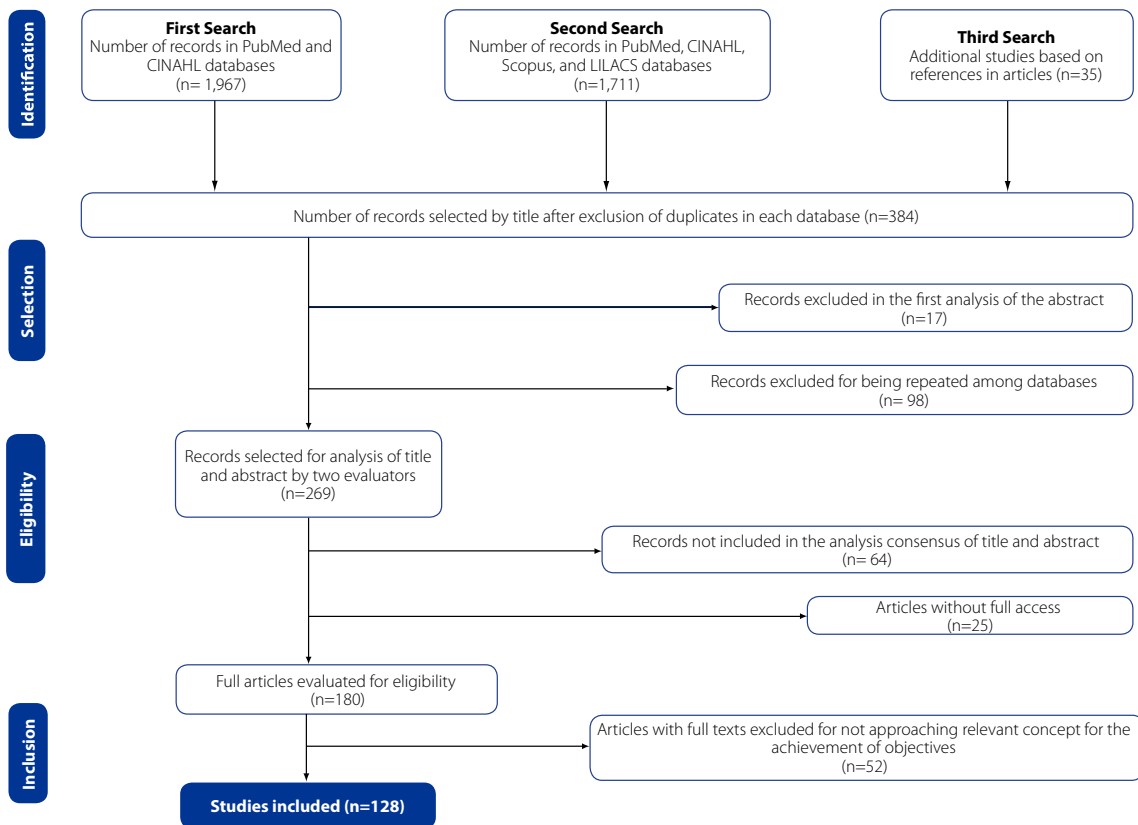


Figure 1 - Flowchart of the process of selection of articles with the different search strategies, developed on the basis of PRISMA guidelines

With regard to the search period, it was observed that the highest number of the studies selected was concentrated in 2014 (17%), 52 (41%) were carried out by researchers from the United States, and the remaining studies by teams from 26 countries. The prospective studies represent about 28% of the sample and, regarding the access route, more than half of the publications included were associated with femoral access. Cardiac procedures (84%) stand out compared with other procedures and are mostly represented

by studies associated with coronary diagnostic and therapeutic procedures. Most publications were developed by the medical area, with a less extensive proportion by the nursing area. Table 1 shows data regarding general characteristics of the publications included.

The grouping of data also enabled mapping the different contexts of study of vascular complications associated with the access site regarding types of procedures and access routes used, as shown in Figure 2.

Table 1 - Distribution of the studies included according to year of publication, country, type of study, access route, and type of procedure, search period from 2005 to 2015

Variable	Total (n=128)
Year of publication	n (%)
2014	22 (17.2)
2012	20 (15.6)
2011	16 (12.5)
2013	15 (11.7)
2008	14 (10.9)
Others	41 (32)
Country	n (%)
United States	52(4.6)
Brazil	11(8.6)
Germany	9 (7.0)
Canada	8 (6.2)
Italy	6 (4.6)
Others	42(32.8)
Type of study	n (%)
Prospective	36 (28.1)
Retrospective	31 (24.2)
Review	14 (10.9)
Randomized	13 (10.1)
Systematic review/Meta-analysis	8 (6.2)
Others	26 (20.3)
Access route	n (%)
Femoral	65 (50.7)
Radial	25 (19.5)
Radial/Femoral	24 (18.7)
Ulnar	2 (1.5)
Brachial	1 (0.8)
Others*	11 (8.6)
Type of procedure	n (%)
Cardiac	107 (83.6)
Extra cardiac	8 (6.2)
Others	13 (10.1)

Source: Research data, 2015.

*Combinations among femoral, radial, ulnar, and brachial access routes.

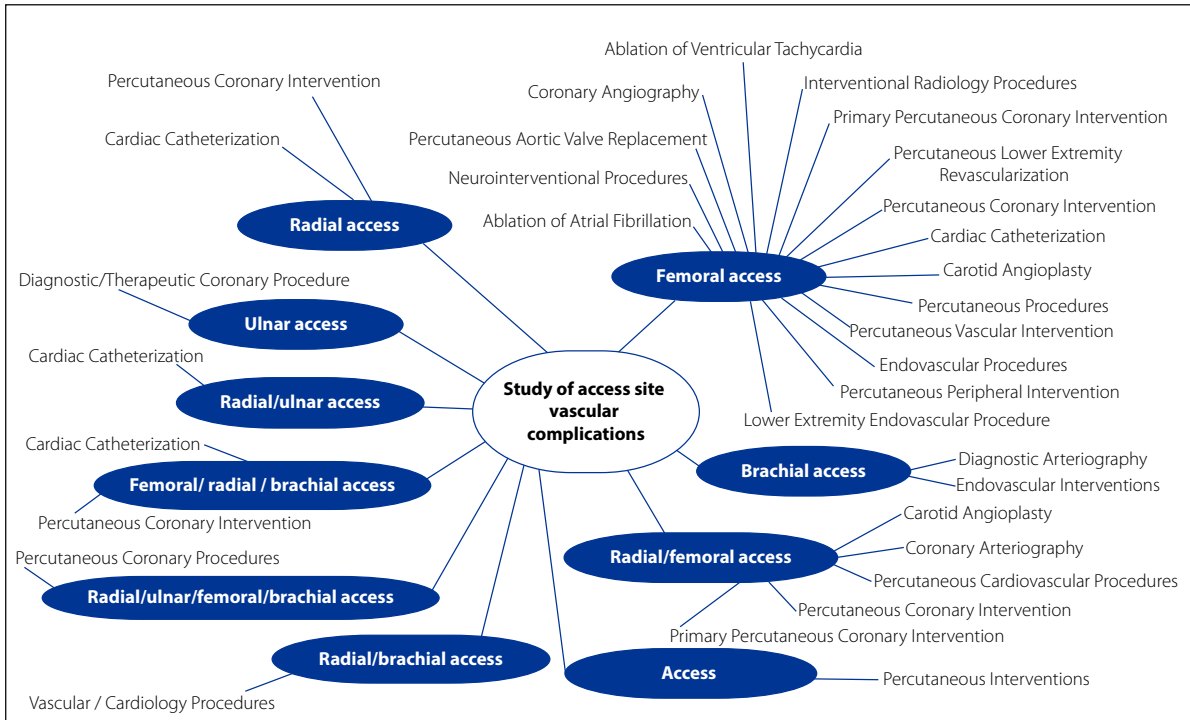


Figure 2 – Evidence map of access sites and types of procedures of the studies included in the scoping review, period from 2005 to 2015

Source: Research data, 2015.

As synthesis of the knowledge on the occurrence of post-procedure access site complications that were evaluated in the studies, data regarding the most reported types of complications are presented, with data regarding their frequency according to the access site used (Chart 1).

Analysis of the full text of the 128 publications included also made it possible to identify the interest theme of each publication. Themes were organized in three theme categories based on the review’s guiding questions. Each category will be presented separately as follows:

Access site complications	Frequency in femoral access	Frequency in radial access	Frequency in ulnar access
Ecchymosis	(35%) ⁽²⁰⁾ to (73%) ⁽²¹⁾	(52%) ⁽²²⁾ to (60%) ⁽²¹⁾	-
Arteriovenous fistula	(<0.1%) ⁽²³⁾ to (3.3%) ⁽²⁴⁾	(1.0%) ⁽²⁵⁾	-
Hematoma	(0.5%) ⁽²³⁾ to (25.7%) ⁽²⁶⁾	(0.6%) ⁽²⁷⁾ to (16.0%) ⁽²⁸⁾	(1.0%) ⁽²⁹⁾ to (7.7%) ⁽³⁰⁾
Retroperitoneal hematoma	(0.7%) ⁽³¹⁾ to (4.0%) ⁽²⁴⁾	-	-
Puncture infection	(<0.1%) ⁽³²⁾ to (1.7%) ⁽³³⁾	-	-
Arterial occlusion	(<0.1%) ⁽³⁴⁾ to (0.9%) ⁽³⁵⁾	(0.2%) ⁽³⁶⁾ to (30.5%) ⁽²⁵⁾	(0.8%) ⁽³⁷⁾ to (2.0%) ⁽²⁹⁾
Pseudo-aneurysm	(0.1%) ⁽³¹⁾ to (8.0%) ⁽³⁸⁾	(0.1%) ⁽³⁹⁾ to (4.3%) ⁽³⁵⁾	-
Bleeding	(0.1%) ⁽³²⁾ to (27%) ⁽⁴⁰⁾	(0.2%) ⁽³⁶⁾ to (14.0%) ⁽²²⁾	-

Chart 1- Access site complications and frequency of access route complications in the studies included in the review, period from 2005 to 2015

Source: Research data, 2015.

Category 1. Vascular access complications after percutaneous procedure

This theme category was prevalent with regard to frequency, with 97 publications. It consisted of studies that aimed to evaluate vascular access complications after percutaneous procedures in different contexts. This category is reported through three subcategories for a better understanding:

Elements associated with vascular access site complications

Studies of this subcategory report different factors that occur from the development of complications to their implications in later clinical outcomes. Seventy-one publications that evaluated different elements associated with access site complications were selected, such as: puncture strategies; result from different access routes in special situations; hemostasis strategies; rest time and early hospital discharge; and use of pre-procedure anticoagulant/fibrinolytic agents.

Vascular complications in different access routes

Fifteen studies were included in this subcategory. Most were associated with a comparison between radial and femoral access routes (14 publications) in patients with acute coronary syndrome, end-stage liver disease, advanced age, carotid artery stenting, using anticoagulants. Comparison was also between genders in records of patients undergoing PCI and in primary PCI. In addition, a publication compared the ulnar versus radial approaches in cardiac catheterization.

Vascular complications according to hemostatic/hemostasis methods

The use of different modalities of vascular closure devices has made progress over the years in interventionism. In many of the studies, these modalities were compared with the traditional hemostasis technique, that is, manual compression. Eleven publications were included in this subcategory.

Category 2. Risk factors/predictors of vascular access complications

The 12 studies in this category examined factors associated with the occurrence of access site complications, such as predictors of: complications between genders; complications after sheath removal; risk of retroperitoneal hematoma; and vascular complications in coronary procedures.

Category 3. Diagnosis and treatment of vascular access complications

Nineteen studies associated with the different access routes in percutaneous procedures were included in this category, with the following themes: identification of rare radial puncture complications and treatment options; treatment of pseudo-aneurysm and arteriovenous fistula; and evaluation and management of vascular access complications. There was a prevalence of review studies and case reports in this category.

DISCUSSION

Mapping the literature that deals with vascular complications associated with the access site in percutaneous procedures carried out in hemodynamic laboratories made it possible to outline the different contexts of study on this theme with regard to types of procedures, access routes used, and related complications.

The femoral approach stands out as the access route that includes the greatest diversity of diagnostic and therapeutic procedures. It is considered the choice route for different procedures and specialties in hemodynamic laboratories, especially in procedures that require large-caliber introducers, such as transcatheter aortic valve implantation (TAVI), in which vascular access complications may be frequent. In a study of a Portuguese team that included 140 patients submitted to TAVI, 7.1% presented serious complications and 29.3% presented minor complications, of which a prevalence of inguinal hemorrhage/hematoma (11.4%), pseudo-aneurysm (7.9%), and closure device failure (5.0%)⁽¹⁾ was found. These findings reinforce the fact that risks of complications associated with the procedure go beyond a satisfactory result in hemodynamic laboratories, because complications associated with the access site may occur early or late. Therefore, a team attentive to potential complications represents a differential in the post-procedure period.

However, the radial access route stands out in coronary cardiac procedures as a choice when there are appropriate conditions for and benefits to its use. In this respect, in primary PCI, the radial approach must be the main choice for experienced radial hemodynamicists⁽⁸⁾. In addition, studies show that the radial access route is superior to the femoral access route in reducing access site complications and bleeding^(3,9).

Some publications examined in this theoretical review also evaluated different access options, both to recommend another feasible and safe option and to offer an approach option when there is impossibility of access or failure in the standard access used. From this perspective, the ulnar access route stands out in some centers as a viable

access route for coronary procedures, and brachial access is used as an alternative access route. Ulnar access proved to be a safe and effective option in case of failure of the ipsilateral radial route⁽³⁷⁾. A recent meta-analysis reported that similar results were found when comparing ulnar access with radial access, with regard to risk of complications associated with the access⁽¹¹⁾.

Regarding complications according to access routes, ecchymosis is characterized as the most frequent complication for both femoral and radial access routes. However, it is worth mentioning that this complication was evaluated in a low number of studies⁽²⁰⁻²²⁾, and is characterized as a complication of late presentation and with little impact on clinical evolution. It may present due to another complication, such as hematoma, or simultaneously with another serious complication.

With regard to complications that are associated with different levels of involvement and impact on clinical outcomes, bleeding, hematoma, and pseudo-aneurysm were the most frequent complications in femoral puncture. When comparing these findings with radial access, lower rates of frequency of these events was observed, which is similar to data from different studies that reported lower rates of complications for the radial approach. Publications with a meta-analysis approach are favorable to the use of radial vascular access due to reductions in bleeding and vascular access site complications, as well as better results for patients^(3,8-9).

Radial artery occlusion is characterized as the most frequent complication (30.5%) in the analysis of studies of the radial approach in the present scoping study. This datum corroborates a recent review that included 66 studies and found an occlusion incidence up to 33%⁽²⁾. This complication is often asymptomatic and there is a trend toward reduction in occlusion rates in evaluations carried out during longer periods of post-procedure follow-up.

Retroperitoneal hematoma, due to its direct association with femoral puncture, is not a complication evaluated in procedures using another access route. Although rare, when it occurs it usually requires blood transfusion, and surgical procedure in some cases. An American study that evaluated factors associated with the development of this complication showed that most cases of retroperitoneal hematoma occurred in the first hours after the procedure. Of these, 92% of patients received blood transfusion and 12% required surgical intervention⁽³¹⁾.

Other complications, such as artery laceration⁽⁴⁾, artery perforation⁽⁴¹⁾, granuloma⁽⁴²⁾, mycotic aneurysm, arterial dissection, compartment syndrome, and limb ischemia⁽⁴³⁾ were reported in the selected publications, but due to their rare presentation they were only mentioned in the definitions of the complications evaluated or were reported in review studies as rare occurrences.

Female gender⁽⁴⁴⁻⁴⁵⁾ and age older than 75 years^(4,44) were identified as the main predictors of complications. The following risk factors for complications were also reported: pre-procedure use of anticoagulants; kidney disease; peripheral vascular disease; congestive heart failure; high blood pressure; use of sheaths larger than 6-French (large-caliber sheaths); lower body mass index; lower body weight or lower skin-fold thickness; multiple punctures; use of glycoprotein IIb/IIIa inhibitors; length of time of the procedure; and high femoral artery puncture.

Regarding evaluation of the complications, this is initially clinical, through signs and symptoms, and may require imaging examinations⁽⁴⁶⁾ for diagnosis confirmation. Most complications, after identification, may be carried out with clinical monitoring; conservative measures such as manual compression or use of compression devices; compression guided by ultrasound; or percutaneous/endovascular treatments. When more serious, they may require surgical treatment or blood transfusion.

The knowledge of teams on the recognition and clinical management of complications, especially in units that admit patients from hemodynamic laboratories, helps to promote continuity of care, with interventions to minimize or prevent these complications so that better results may be achieved.

Main highlights of this scoping review for clinical practice

- Different factors are associated with the results of patients, such as factors inherent to the each patient, therapy, and questions regarding to the procedure and team.
- Among predictors of vascular complications, female gender and advanced age are those more often identified, and healthcare teams must also consider these aspects in post-procedure care.
- There is a trend toward better results with the use of vascular closure devices compared with other hemostatic methods but, when complications occur, they must be carefully monitored.
- Early mobilization proved to be a safe practice after PCI when compared with longer standard periods of rest.
- Programs for hospital discharge on the same day after PCI may be feasible for carefully selected patients.
- The use of a specific technique by interventionists as a standard puncture may influence the results if another puncture technique is adopted.
- Lower time of hemostatic compression and hemostasis in radial puncture were associated with lower incidence of radial artery occlusion.
- Femoral puncture guided by ultrasound as routine proved to bring benefits regarding lower rates of access complications.

- The radial approach must be prioritized whenever possible, because it enables better results regarding bleeding and vascular access complications.
- The radial approach is recommended as the first choice in acute coronary syndrome and primary PCI, when carried out by experienced radial hemodynamicists.
- Vascular access complications from procedures may be conservatively managed with non-invasive therapies, percutaneous or endovascular treatment; when more serious, surgical procedure may be required.

Study limitations

- The delimitation of the search period to 10 years may have failed to consider articles, theses, or dissertations that would contribute to add results to the research questions.
- Analysis of the publications by two evaluators occurred only in the selection stage, by title and abstract, and was not possible in the full reading of the articles.
- In the categorization regarding the type of study, the description found in the article was considered, and not the impression of the evaluator after full content analysis.

CONCLUSION

The total number of publications included in the scoping review shows that the theme has been widely studied. In the context of percutaneous procedures, the femoral access route was identified as the most used approach in hemodynamic laboratory procedures. The most highlighted complications associated with the access site in post-procedures were ecchymosis, arteriovenous fistula, hematoma, retroperitoneal hematoma, puncture infection, arterial occlusion, pseudo-aneurysm, and bleeding. These complications ranged according to the access route used.

Vascular access complication diagnoses are based on findings in history and physical examinations, and they may usually be confirmed through imaging. With regard to clinical management, they may be carried out with conservative measures and care, with constant monitoring, percutaneous/endovascular treatments and, when more serious, with surgical treatment.

Implications for teaching, research, and care

The methodological path taken may be useful for the teaching and development of new studies, because scoping reviews are still an incipient methodology in the nursing knowledge area. This type of review, although its me-

thod does not anticipate the exclusion of articles according to methodological quality criteria, enables researchers to specify the type of literature that will not be included in its protocol. In clinical practice, this study contributes to the body of knowledge on percutaneous procedure complications, providing substitutes for actions in patient care.

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■ **Corresponding author:**

Miriam de Abreu Almeida

E-mail: miriam.abreu2@gmail.com

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