RESEARCH ARTICLE / *Araştırma Makalesi*

Evaluation of Demographic Characteristics and Treatment of Upper Extremity Iatrogenic Pseudoaneurysm Patients: A Single Center Experience

Üst Ekstremitede İyatrojenik Psödoanevrizma Gelişen Hastaların Demografik Özelliklerinin ve Tedavilerinin Değerlendirilmesi: Tek Merkez Deneyimi

Yusuf Can[1], Fahrettin Turna[2], Ahmet Can Çakmak[2]

[1] Department of Cardiology, Sakarya University School of Medicine, Sakarya, Türkiye
[2] Department of Cardiology, Sakarya University Education And Research Hospital, Sakarya, Türkiye

Yazışma Adresi / *Correspondence:*
Yusuf Can

Department of Cardiology, Sakarya University School of Medicine, Sakarya, Türkiye
T: **+90 541 251 41 49** E-mail **: yusufcan@sakarya.edu.tr**

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Orcid ve Mail Adresleri
Yusuf Can https://orcid.org/0000-0002-4535-7367, yusufcan@sakarya.edu.tr
Fahrettin Turna https://orcid.org/0000-0003-3483-9456, fturna_53@hotmail.com
Ahmet Can Çakmak https://orcid.org/0000-0001-5168-8907, a.can.c@hotmail.com

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Abstract

Introduction	Pseudoaneurysm is rarely seen after percutaneous interventions from the upper extremity arteries. In this study, we aimed to evaluate the demographic characteristics of patients with iatrogenic pseudoaneurysms in the upper extremities and the treatment methods for pseudoaneurysms.
Materials and Methods	We retrospectively reviewed the cases of 17 patients who were followed up with in our clinic for pseudoaneurysm between 2012 and 2022. The endpoint was determined as nerve damage, compartment syndrome, thromboembolic event, fistula and the need for surgery. Nerve damage was determined to be axonal degeneration, as seen by electromyography and symptoms.
Results	Of the 17 patients included in the study, 8 developed radial artery pseudoaneurysms, 5 developed ulnar artery pseudoaneurysms and 4 developed brachial artery pseudoaneurysms. While 15 were treated with conservative methods, 2 were treated surgically. One of the two underwent surgery due to a pseudoaneurysm with a diameter of 9 × 9 mm diagnosed in the late period, and the other underwent surgery due to pain and a pseudoaneurysm with a diameter of 36 × 26 mm. Ulnar nerve damage was detected in one patient. Another patient was diagnosed with a fistula. Ulnar nerve injury and brachial arteriovenous fistulas were treated with conservative methods without surgery.
Conclusion	Most pseudoaneurysms that develop after percutaneous intervention in the upper extremity arteries can be treated with conservative methods. Interventional cardiologists should know that different treatment methods are available for pseudoaneurysms and should be able to treat them successfully in light of the current data. Early diagnosis and treatment are of vital importance since late diagnosis leads to worse complications and the need for surgical intervention.
Keywords	Pseudoaneurysm, Percutaneous intervention, Treatment method

Öz

Amaç	*Üst ekstremite arterlerinden perkütan girişimler sonrası psödoanevrizma nadiren görülür. Bu çalışmada üst ekstremitede iatrojenik psödoanevrizması olan hastaların demografik özelliklerini ve psödoanevrizma tedavi yöntemlerini değerlendirmeyi amaçladık.*
Yöntem ve Gereçler	*2012-2022 yılları arasında kliniğimizde psödoanevrizma nedeniyle takip edilen 17 hasta retrospektif olarak incelendi. Son nokta sinir hasarı, kompartman sendromu, tromboembolik olay, fistül ve cerrahi ihtiyacı olarak belirlendi. Sinir hasarı, elektromiyografi ve semptomlarla görüldüğü gibi aksonal dejenerasyon olarak belirlendi.*
Bulgular	*Çalışmaya alınan 17 hastanın 8'inde radial arter psödoanevrizması, 5'inde ulnar arter psödoanevrizması ve 4'ünde brakiyal arter psödoanevrizması gelişti. 15'i konservatif yöntemlerle tedavi edilirken, 2'si cerrahi olarak tedavi edildi. İkisinden biri geç dönemde teşhis edilen 9X9 mm çapındaki psödoanevrizma nedeniyle, diğeri ise ağrı ve 36x26 mm çapındaki psödoanevrizma nedeniyle ameliyat edildi. Bir hastada ulnar sinir hasarı tespit edildi. Bir hastaya fistül teşhisi konuldu. Ulnar sinir yaralanması ve brakial arterovenöz fistül konservatif yöntemlerle ameliyatsız tedavi edildi.*
Sonuç	*Üst ekstremite arterlerinde perkütan girişim sonrası gelişen psödoanevrizmaların çoğu konservatif yöntemler ile tedavi edilebilmektedir. Girişimsel kardiyologlar psödoanevrizmalar için farklı tedavi yöntemlerinin olduğunu bilmeli ve güncel veriler ışığında başarılı bir şekilde tedavi edebilmelidir. Erken tanı ve tedavi, geç tanı daha kötü komplikasyonlara ve cerrahi müdahale gereksinimine yol açtığı için hayati önem taşımaktadır.*
Anahtar Kelimeler	*Psödoanevrizma, Perkütan girişim, Tedavi yöntemi*

INTRODUCTION

The transradial approach to coronary angiography and interventions has recently grown in popularity, thanks to fewer complications compared to transfemoral interventions. With percutaneous coronary intervention success rates similar to transfemoral access, transradial coronary angiography is associated with fewer vascular and bleeding complications, earlier ambulation, higher postprocedure comfort and better cost-effectiveness. Ferrante et al. showed a 77% reduction in major vascular complications using transradial access.[1] Further, transradial access reduces the risk of all-cause death and major haemorrhage in patients with acute coronary syndrome (ACS).[2] Therefore, a 'radial first' strategy was proposed in the 2015 guidelines for the management of ACS as a Class I indication.[3]

One of the complications of vascular intervention sites is pseudoaneurysms, which are observed in up to 8% of cases due to transfemoral interventions in the lower extremities.[4] Studies differ in their assertions regarding transradial interventions; the frequency is less than 0.5%.[5,6] The frequency of intervention through the ulnar and brachial arteries is also gradually increasing.[7,8] Pseudoaneurysm data of the percutaneous interventions performed through the upper extremity arteries were mostly obtained from transradial interventions. In this study, we aimed to assess the demographic characteristics of patients with iatrogenic pseudoaneurysms in the upper extremities and the treatment methods for pseudoaneurysms.

PATIENTS and METHODS

Study Design and Population

Approximately 40,000 patients underwent coronary angiography and intervention from the upper extremity arteries. Patients with iatrogenic upper extremity pseudoaneurysms that developed between March 2012 and September 2022 were included in the study. Twelve patients had iatrogenic aneurysms in the upper extremities. Patients with missing Doppler ultrasonography and clinical follow-up were excluded from the study. This study was approved by the clinical research ethics committee of the Sakarya University Faculty of Medicine (Date: 05.10.2022, number: 265).

Study Protocol

The diagnosis was confirmed by a systolic murmur and Doppler ultrasound, which showed a back-and-forth flow through the radial artery. Clinical signs of pseudoaneurysm include the development of pain, swelling and tenderness at the catheterisation site after the procedure, pulsatile hematoma and murmur detected on physical examination. In diagnostic ultrasonography (USG), pseudoaneurysms appear as a hollow pulsatile mass with an echolucent feature adjacent to the artery from which they originate. A forward-backward flow (to and from) spectrum on the aneurysm neck in Doppler ultrasonography, flow jet in the systole in the colour Doppler USG and blood filling into the aneurysm cavity, outflow of blood with low flow in the diastole, and two different colours (ying-yang) in the aneurysm cavity are among the characteristic Doppler USG findings.

Data Collection

The demographic, clinical, angiographic, ultrasonographic and procedural characteristics of the patients were collected retrospectively from hospital records.

Study Endpoints and Definitions

The endpoint was determined as death, compartment syndrome, thromboembolic event, nerve damage and the need for surgery. Nerve damage was determined to be axonal degeneration, as seen by electromyography and symptoms.

Statistical Analysis

The data were analysed using SPSS 17.0 (SPSS Inc., Chicago, IL, USA). Compliance of the variables with non-normal distribution was determined using the Kolmogorov-Smirnov test. Normally distributed continuous variables were expressed as mean and standard deviation,

and non-normally distributed variables were expressed as median (smallest and largest values). Categorical data were expressed as percentages. Comparative analysis was not performed because there was no control group.

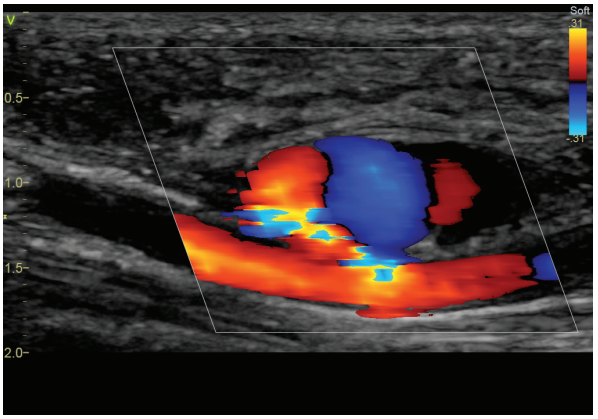
RESULTS

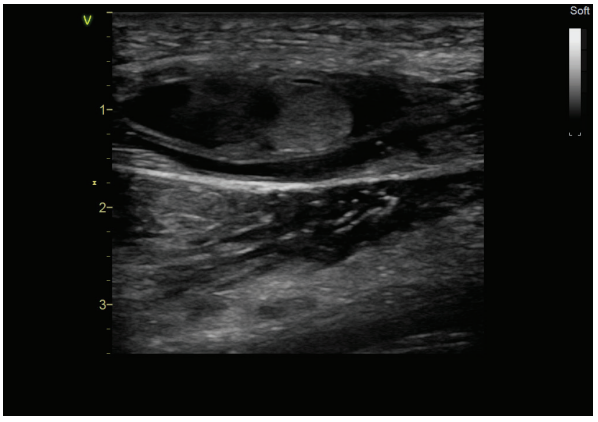
In the last 10 years, approximately 40,000 transradial, 1,000 transulnar and 1,000 transbrachial interventions have been performed in our clinic. The mean age of the 17 patients included in the study was 69.18 ± 8.26, and 9 (52.9%) of the patients were male. Three patients had diabetes mellitus, 14 patients had hypertension, 16 patients had coronary artery disease and 5 patients had peripheral artery disease. The demographic characteristics of the patients with pseudoaneurysms are shown in Table 1.

Ultrasonography images of one of our patients can be seen in Figures 1–2. A pseudoaneurysm was detected in the ulnar artery in a patient who developed pulsatile swelling after percutaneous coronary intervention. Since a small pseudoaneurysm neck (less than 5 mm) was present, the pseudoaneurysm was treated without surgery (Figure 1). In the same patient, a thrombosed pseudoaneurysm was observed on Doppler ultrasonography one day later (Figure 2).

Table 1. Baseline clinical characteristics of patient with pseudoaneurysm

Age (years)	69.18 ± 8.26
Gender (male), n (%)	9 (52.9)
Hypertension, n (%)	14 (82.4)
Diabetes mellitus, n (%)	3 (17.6)
Smoking, n (%)	6 (35.3)
Coronary artery disease, n (%)	16 (94.1)
Hyperlipidemia, n (%)	9 (52.9)
Peripheral artery disease, n (%)	3 (17.6)





Eight patients were admitted to the catheter laboratory with the diagnosis of unstable angina here pectoris and non-ST-elevation myocardial infarction (USAP and NON-STEMI); indications for intervention are shown in Table 2.

Table 2. Indication for percutaneous intervention

Stable angina, n (%)	4 (23.5)
USAP/Non-STEMI, n (%)	8 (47.1)
STEMI, n (%)	3 (17.6)
Claudicatio intermittens, n (%)	2 (11.8)

USAP/Non-STEMI: Unstable angina pectoris/Non-ST-segment elevation myocardial infarction, STEMI: ST-segment elevation myocardial infarction

Of the 17 patients included in the study, 8 developed radial artery pseudoaneurysms, 5 developed ulnar artery pseudoaneurysms and 4 developed brachial artery pseudoaneurysms. One of the brachial pseudoaneurysms occurred after transradial access and the others occurred after transbrachial access. Ulnar and radial pseudoaneurysms were found to develop in the artery where the intervention was performed. Nerve damage was observed in one patient. Ultrasonography images of one of our patients can be seen in Figures 1–2. Parameters related to access site and pseudoaneurysm characteristics in patients with upper extremity iatrogenic pseudoaneurysms are shown in Table 3.

Table 3. Parameters related to access site and pseudoaneurysm characteristics in patients with upper extremity iatrogenic pseudoaneurysm.

Arterial access	
Transradial access, n (%)	9 (52.9)
Transulnar access, n (%)	5 (29.4)
Transbrachial access, n (%)	3 (17.6)
Pseudoaneurysm location	
Radial artery, n (%)	8 (47.1)
Ulnar artery, (%)	5 (29.4)
Brachial artery, (%)	4 (23.5)
Accompanying Complications	
Hematoma, n (%)	17 (100)
Fistula, n (%)	1 (5.9)
Nerve damage, n (%)	1 (5.9)
Sheat size (6Fr), n (%)	17 (100)
Pseudoaneurysm size, mm	19.65 ± 12.05

While 15 patients were treated with conservative methods, 2 were treated surgically. One of them underwent surgery due to a pseudoaneurysm with a diameter of 9 × 9 mm diagnosed in the late period, and the other underwent surgery due to pain and a pseudoaneurysm with a diameter of 36 × 26 mm. Nerve damage was observed in one patient. No mortality, compartment syndrome or thromboembolic events were observed within 30 days. The management and prognosis of the patients are shown in Table 4.

Table 4. Management and prognosis of patients with upper extremity iatrogenic pseudoaneurysm

Clinical management	
Conservative management, n (%)	15 (88.2)
Surgery, n(%)	2 (11.8)
In-hospital prognosis and 30 days mortality	
Death, n (%)	0 (0.0)
Compartment syndrome, n (%)	0 (0.0)
Thromboembolic event, n (%)	0 (0.0)
Nerve damage, n (%)	1 (5.9)
Fistula, n (%)	1 (5.9)

DISCUSSION

In our study, pseudoaneurysms observed in interventions from different arteries of the upper extremities were evaluated. Since the most commonly used artery is the radial artery, a pseudoaneurysm was observed most often in the radial artery. It is possible for the pseudoaneurysm to develop outside the puncture area of the treated artery, that is, in the proximal area. Although ulnar and brachial access is lower, the incidence of pseudoaneurysms in the ulnar and brachial arteries tends to be higher. Pseudoaneurysms developing after upper extremity interventions are rarely accompanied by vascular pathologies or nerve damage. In Turkey, there is limited data on pseudoaneurysms of upper extremity interventions, and the present study is valuable in this regard since it investigated the highest number of cases thus far.

Upper extremity pseudoaneurysms are generally reported to be traumatic or iatrogenic.[5,6,9,10] Pseudoaneurysms were frequently observed in the radial artery, since most of the interventions were performed from the radial artery.[5,6] However, pseudoaneurysms were also observed after intervention from different arteries in the upper extremities and have mostly been treated with conservative methods.[5,6,11–13] Risk factors for pseudoaneurysms include multiple puncture interventions, catheter infection, anticoagulation use, antiaggregant use, insufficient haemostasis and the use of a larger sheath.[14] When left untreated, a pseudoaneurysm can cause mass effect,[10,11] haemorrhage

as a result of rupture[15] and infection.[16]

Although very few ulnar and brachial interventions were performed in our clinic, the reasons for the pseudoaneurysms at these sites may be due to insufficient compression because of lack of experience, multiple punctures or deeper vessels. Of the 17 patients included in the study, 5 developed ulnar artery pseudoaneurysms, and 4 developed brachial artery pseudoaneurysms.

The literature on radial artery pseudoaneurysm management is limited. There is no standard treatment approach for pseudoaneurysm; treatment may vary depending on the location of the pseudoaneurysm, the experience of the interventional cardiologist and surgical support. Basically, treatment options can be listed as conservative, endovascular and surgical methods. Most of the patients were treated with conservative methods.

Non-surgical methods of treatment include occlusive compression by applying a pneumatic radial artery compression band to the radial artery proximal to the pseudoaneurysm for 3–4 hours, followed by semi-occlusive compression using an elastic bandage for 24 hours. There are also treatment options, such as external compression with bandages, ultrasound-guided compression,[17] ultrasound-guided thrombin injections,[18] coils[19] and graft stents.[20] We treated the majority of our patients with manual external compression and compression accompanied by ultrasonography. The surgical methods used were resection of the pseudoaneurysm and radial artery ligation. Surgical methods are usually applied for persistent pain, failure of conservative treatment methods and if the pseudoaneurysm is larger than 3 cm.[21,22] Two of our patients were treated surgically, one of whom had a pseudoaneurysm larger than 3 cm. The other was treated surgically due to ongoing pain and late admission, although the pseudoaneurysms were small.

Pseudoaneurysms are usually seen in punctured vessels and are rarely seen in the proximal vessels of punctured vessels.[23] In one of our patients, a pseudoaneurysm developed in the brachial artery after radial intervention.

Neuropathy or ulnar nerve damage after a transulnar intervention has been reported in several cases.[24,25] Data on ulnar nerve damage are limited, and there is no agreement on the best treatment approach. Conservative approaches and surgical treatments are applied for ulnar nerve damage. To the best of our knowledge, this report presents the first case of coexisting ulnar nerve injury and pseudoaneurysm after transulnar intervention. Orthopaedic surgeons recommended conservative follow-up for our patient rather than surgery.

Limitations

The main limitations of this study were its single-centred nature and the limited number of patients. Furthermore, since there were few patients, the lack of comparison between different intervention methods was another limitation.

CONCLUSIONS

Pseudoaneurysms occur more frequently in the radial artery. Transradial interventions are very frequently used today, and invasive cardiologists and cardiac catheterisation team members should be familiar with pseudoaneurysms. Interventional cardiologists should know that there are different treatment methods for pseudoaneurysms and should be able to treat them successfully in light of current data. Early diagnosis and treatment are of vital importance since late diagnosis leads to worse complications and the need for surgical intervention.

Ethics Committee Approval

This study was approved by the clinical research ethics committee of the Sakarya University Faculty of Medicine. Date: 05.10.2022, number:265

Informed Consent

This is retrospective study, we could not obtain written in-

formed consent from the participants.

Peer-review

Externally peer-reviewed.

Conflict of Interest

The authors declared that there was no conflict of interest during the preparation and publication of this article.

Financial Disclosure

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References

1. *Ferrante G, Rao SV, Jüni P, Da Costa BR, Reimers B, Condorelli G, et al. Radial Versus Femoral Access for Coronary Interventions Across the Entire Spectrum of Patients With Coronary Artery Disease: A Meta-Analysis of Randomized Trials. JACC Cardiovasc Interv. 2016;9:1419-1434.*
2. *Valgimigli M, Gagnor A, Calabró P, Frigoli E, Leonardi S, Zaro T, et al. Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: a randomised multicentre trial. Lancet. 2015;385:2465-2476.*
3. *Roffi M, Patrono C, Collet JP, Mueller C, Valgimigli M, Andreotti F, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). Eur Heart J. 2016;37:267-315.*
4. *Wixon CL, Philpott JM, Bogey WM Jr, Powell CS. Duplex-directed thrombin injection as a method to treat femoral artery pseudoaneurysms. J Am Coll Surg. 1998;187:464-466.*
5. *Jolly SS, Yusuf S, Cairns J, Niemelä K, Xavier D, Widimsky P, et al. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet. 2011;377:1409-1920.*
6. *Hahalis GN, Leopoulou M, Tsigkas G, Xanthopoulou I, Patsilinakos S, Patsourakos NG, et al. Multicenter Randomized Evaluation of High Versus Standard Heparin Dose on Incident Radial Arterial Occlusion After Transradial Coronary Angiography: The SPIRIT OF ARTEMIS Study. JACC Cardiovasc Interv. 2018;11:2241-2250.*
7. *Gokhroo R, Kishor K, Ranwa B, Bisht D, Gupta S, Padmanabhan D, et al. Ulnar Artery Interventions Non-Inferior to Radial Approach: AJmer Ulnar ARtery (AJULAR) Intervention Working Group Study Results. J Invasive Cardiol. 2016;28:1-8.*
8. *Lam UP, Lopes Lao EP, Lam KC, Evora M, Wu NQ. Trans-brachial artery access for coronary artery procedures is feasible and safe: data from a single-center in Macau. Chin Med J (Engl). 2019;132:1478-1481.*
9. *Ratschiller T, Müller H, Schachner T, Zierer A. Pseudoaneurysm of the Radial Artery After a Bicycle Fall. Vasc Endovascular Surg. 2018;52:395-397.*
10. *Maertens A, Tchoungui Ritz FJ, Poumellec MA, Camuzard O, Balaguer T. Posttraumatic pseudoaneurysm of a superficial branch of the ulnar artery: A case report. Int J Surg Case Rep. 2020;75:317-321.*
11. *Polytarchou K, Triantafyllou K, Antypa E, Kappos K. Ulnar pseudoaneurysm after transulnar coronary angiogram treated with percutaneous ultrasound-guided thrombin injection. Int J Cardiol. 2016;222:404-406.*
12. *Deşer SB. Management of iatrogenic brachial artery pseudoaneurysm: surgical treatment of iatrogenic brachial artery pseudoaneurysm. International Journal of the Cardiovascular Academy. 2017;3:9-10*
13. *Sarkadi H, Csőre J, Veres DS, Szegedi N, Molnár L, Gellér L, et al. Incidence of and predisposing factors for pseudoaneurysm formation in a high-volume cardiovascular center. PLoS One. 2021;16:e0256317.*
14. *Kanei Y, Kwan T, Nakra NC, Liou M, Huang Y, Vales LL, et al. Transradial cardiac catheterization: a review of access site complications. Catheter Cardiovasc Interv. 2011;78:840-846.*
15. *Hachem K, Kfoury J, Tohmé J, Chalhoub V. Rupture of an infected radial artery false aneurysm. Can J Anaesth. 2017;64:92-93.*
16. *Siddiqui S, Weedle R, Vainorius A, Kelly R, Da Costa M. Infected radial artery pseudoaneurysm: a rare entity. Chirurgia. 2020;33:325-7.*
17. *Kongunattan V, Ganesh N. Radial Artery Pseudoaneurysm following Cardiac Catheterization: A Nonsurgical Conservative Management Approach. Heart Views. 2018;19:67-70.*
18. *Moussa Pacha H, Alraies MC, Soud M, Bernardo NL. Minimally invasive intervention of radial artery pseudoaneurysm using percutaneous thrombin injection. Eur Heart J. 2018;39:257.*
19. *Washimi S, Yamada T, Takahashi A. Successful coil embolization with distal radial access for a ruptured radial artery pseudoaneurysm in a patient with SARS-CoV-2 infection. Clin Case Rep. 2022;10:e05509.*
20. *Tsiafoutis I, Zografos T, Koutouzis M, Katsivas A. Percutaneous Endovascular Repair of a Radial Artery Pseudoaneurysm Using a Covered Stent. JACC Cardiovasc Interv. 2018;11:e91-e92.*
21. *Mahanta D, Mahapatra R, Barik R, Singh J, Sathia S, Mohanty S. Surgical repair of postcatheterization radial artery pseudoaneurysm. Clin Case Rep. 2020;8:355-358.*
22. *Tosti R, Özkan S, Schainfeld RM, Eberlin KR. Radial Artery Pseudoaneurysm. J Hand Surg Am. 2017;42:295.e1-295.e6.*
23. *Villanueva-Benito I, Solla-Ruiz I, Rodriguez-Calveiro R, Maciñeiras-Montero JL, Rodriguez-Paz CM, Ortiz-Saez A. Iatrogenic subclavian artery pseudoaneurysm complicating a transradial percutaneous coronary intervention. JACC Cardiovasc Interv. 2012;5:360-361.*
24. *Hahalis G, Tsigkas G, Kakkos S, Panagopoulos A, Tsota I, Davlouros P, et al. Vascular complications following transradial and transulnar coronary angiography in 1600 consecutive patients. Angiology. 2016;67:438-43.*
25. *Geng W, Fu X, Gu X, Jiang Y, Fan W, Wang Y, et al. Safety and feasibility of transulnar versus transradial artery approach for coronary catheterization in non-selective patients. Chin Med J. 2014;127:1222-1228.*