Catheterization and Cardiovascular Interventions 89:393–398 (2017)

*Case Report*

# New Technique for Treatment of Postcatheterization Radial Artery Pseudoaneurysm

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**We report a new technique for treatment of radial artery pseudoaneurysm (RAP) caused by transradial access (TRA) for coronary angiography. Traditional extrinsic compression with radial flow cessation leads to a local milieu likely associated with an increase in probability of radial artery occlusion (RAO). Our technique involves obtaining ipsilateral radial artery access distal to the neck of the RAP followed by a prolonged sheath dwell time covering the neck of the RAP which allows the RAP sac to thrombose and maintains radial artery lumen patency.** 

**Key words: transradial coronary intervention; radial artery pseudoaneurysm**

## INTRODUCTION

RAP is a rare complication of transradial access (TRA) and can occur as a sequela of arterial wall trauma and inadequate hemostasis after TRI. According Lemaitre J et al only 22 cases of RAP have been reported in world literature until 2006 [1]. In a recent publication only five cases of RAP were detected after 16,808 TRA (3 out of 10,000 catheterizations, 0,03%) [2], which is significantly lower compared to frequency of femoral pseudoaneurysm (0.6%) complicating femoral access [3]. The prevalence of RAP may increase in the future due to growing popularity of TRI.

Treatment of RAPs has evolved through the years. Initially surgical treatment was the dominant form of management for RAP. Subsequently, many cases have been treated with ultrasound-guided mechanical compression. Recently, thrombin injection under ultrasound guidance has become the preferred treatment method.

We describe a novel technique for treatment of RAP using ipsilateral radial artery catheterization with long introducer sheath placement and gentle mechanical compression isolating the pseudoaneurysm with resultant cessation of flow in the sac, thrombosis and subsequent closure.

## CASE PRESENTATION

A 68-year-old man with previous posterior MI, persistent atrial fibrillation, hypertension, and moderately depressed left ventricular function (EF = 0,44) was admitted with life-style limiting CCS class III angina. Diagnostic coronary angiography and possible PCI was planned using radial access. He underwent cardiac

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Conflict of interest: Nothing to report.

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Received 15 March 2016; Revision accepted 21 July 2016

DOI: 10.1002/ccd.26717
Published online 16 August 2016 in Wiley Online Library (wileyonlinelibrary.com)

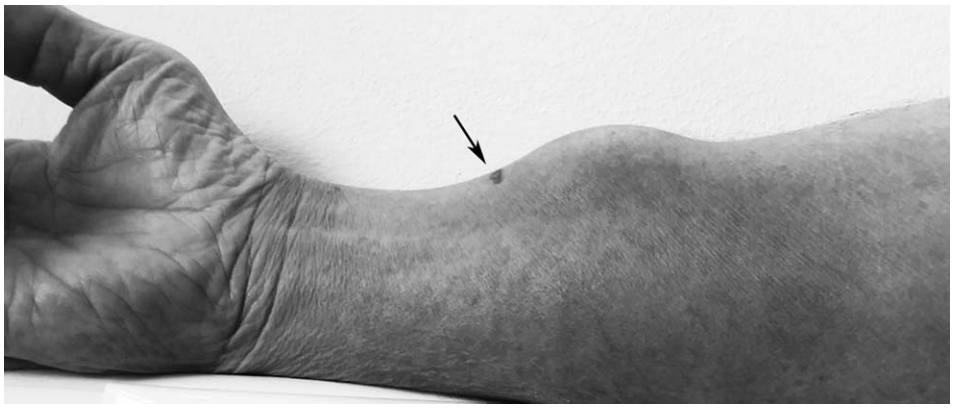

**Fig. 1. Pulsatile swelling at the right wrist just proximal to the previous puncture point of radial artery (arrow).**

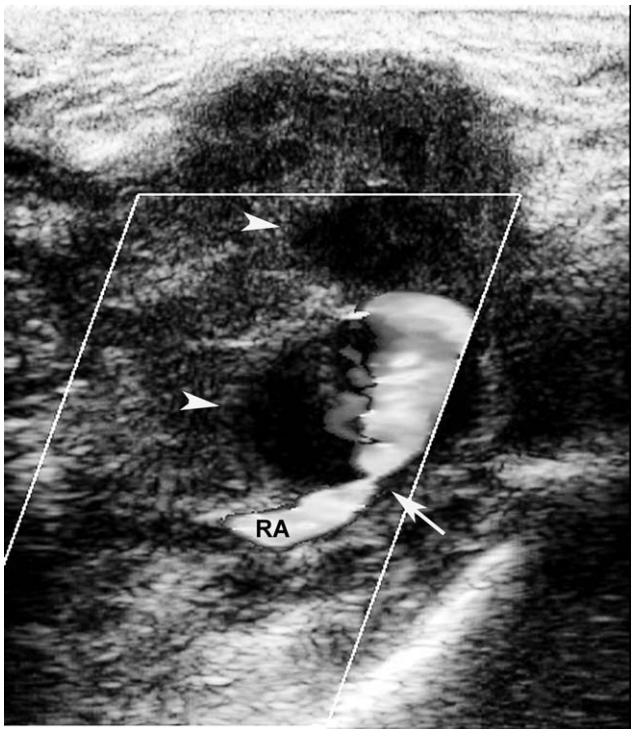


**Fig. 2. Duplex ultrasonography demonstrated dual chamber (arrowheads) pseudoaneurysm of radial artery (RA) with turbulent blood flow and narrow neck connection (arrow) with RA lumen. Pseudoaneurysm sac was partially filled with thrombotic mass.**

catheterization from the right radial using a 16 cm 6F hydrophilic introducer sheath (Terumo Interventional Systems, Japan). The radial artery had an anomalous origin from the mid-segment of brachial artery. Coronary stenoses were identified in the right coronary artery (RCA) and PCI was planned as a second stage in 2–3 weeks. At the time of diagnostic examination patient was on warfarin therapy and additional clopidogrel was prescribed for the forthcoming PCI procedure. The International Normalized Ratio (INR) at the time of angiography was 1.09. The sheath was removed and hemostasis was achieved using TR band (Terumo Interventional Systems, Japan). Patient was discharged 6 hr after diagnostic procedure and a small hematoma was noted after removal of hemostatic device without any signs of bleeding.

The patient was readmitted 1 month later with painful 6 X 4 cm pulsatile mass over the volar aspect of the right wrist just proximal to the previous radial puncture site (Fig. 1). This swelling appeared 48 hr following discharge after lifting a heavy object with the right hand. A systolic bruit was audible over the mass and duplex ultrasonography demonstrated an oval-shape dual chamber pseudoaneurysm measuring 49 X 38 mm, partially filled with thrombus. Pseudoaneurysm sac was connected to the radial artery lumen through a long (6 mm) and narrow (2 mm in diameter) neck (Fig. 2). Radial artery was patent and INR at the time of repeat hospitalization was 1.57.

At this point we contemplated a combined strategy of PCI of RCA and repair of RAP.

We decided to use the affected radial artery as the access site for PCI, because ultrasonography indicated presence of sufficient length and diameter of intact artery distal to RAP for puncture and catheterization. After successful puncture of radial artery distal to RAP, a small vessel dilator (5F) was inserted into RA lumen and retrograde radial artery angiography was performed using low pressure manual contrast injection. Radial artery angiography confirmed RA patency and significant deviation of its anatomic course at the site of RAP was seen with the signs of RA lumen narrowing as a result of extrinsic RA compression (Fig. 3a). Pseudoaneurysm was visualized with turbulent blood flow into aneurysm sac with QCA measured dimensions of 38.7 X 36.8 mm. After advancing a 0.014" Prowater guidewire (Asahi Intecc, Japan), a 21cm 6F hydrophilic

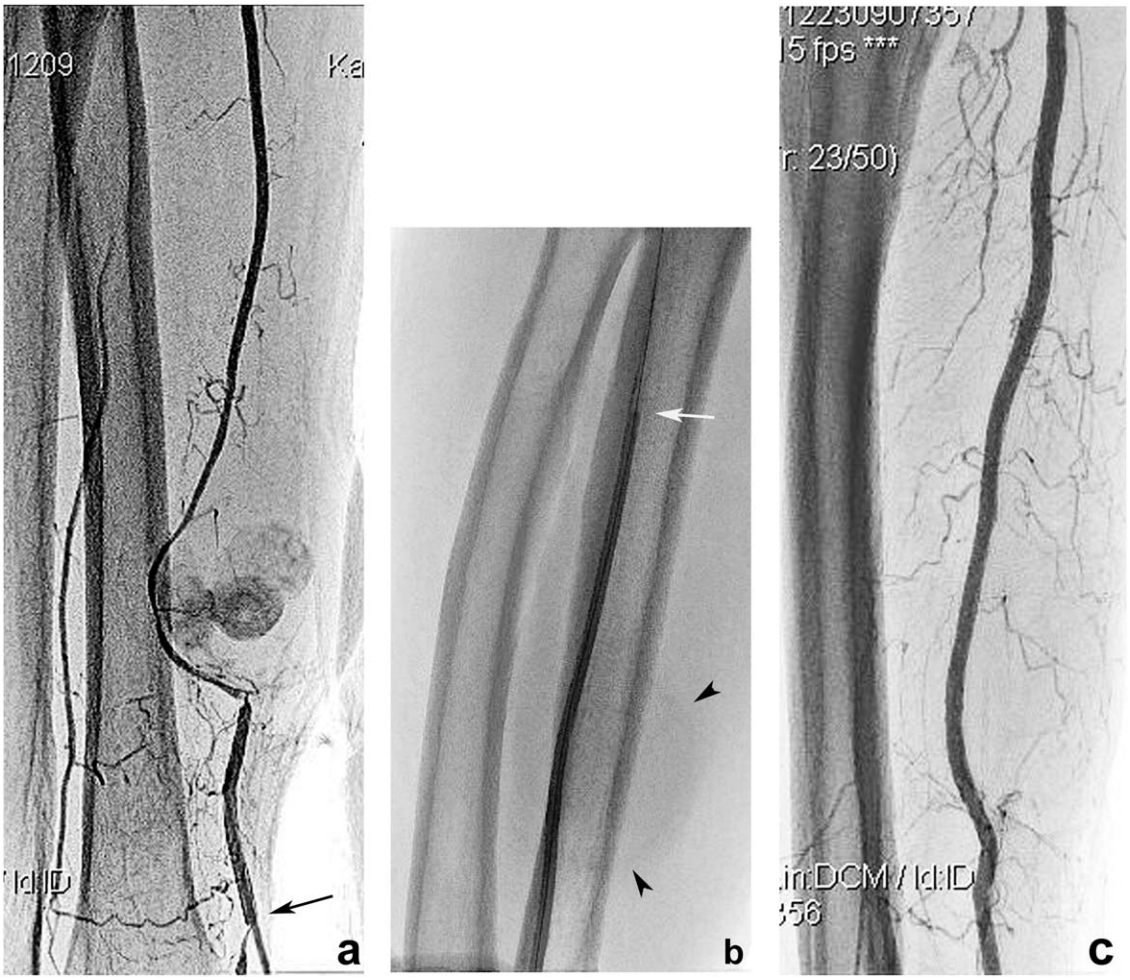


**Fig. 3. Radial artery angiography before and after second stage PCI: a—Retrograde angiography after distal punction (puncture point indicated by arrow) and catheterization of radial artery with 5F dilator confirmed duplex ultrasonography findings. Note significant deviation of anatomic course and stenosis of radial artery at the site of RAP compression. b—Location of long 6F sheath (tip is shown by arrow) in radial artery until its ostium. Connection point between RAP sac and main artery covered by Sheath body. Faint opacification of RAP sac indicated by arrowheads. c—Before sheath removal control retrograde radial arteriography revealed restoration of arterial lumen and absence of pseudoaneurysm sac filling.**

introducer sheath (Terumo Interventional Systems, Japan) was placed covering the neck of RAP therefore isolating the aneurysm sac from the blood circulation (Fig. 3b). PCI of RCA was performed through the 6F sheath (procedure duration 34 min) using a 6 French JR4 guide catheter, 0.014" Prowater guidewire (Asahi Intecc, Japan) and 3.5–15 mm Xience drug-eluting stent. 70 Units/Kg of unfractionated heparin was administered intravenously at the beginning of the procedure. The sheath was left in RA lumen after completion of PCI for 8 hr. The sheath was attached to a pressurized heparinized saline flush using a standard arterial line setup, with 500 units/hour of heparin administered via the sheath in a monitored post-procedure unit. Additional light mechanical compression was applied at the RAP site using an external compression bandage dressing.

Radial artery angiography before sheath removal demonstrated RA patency with clean contours, straightening of the anatomic course of RA and complete closure of RAP without any signs of leakage into the RAP sac (Fig. 3c). Vascular sheath was removed and patent hemostasis technique was used with TR band (Terumo Interventional Systems, Japan). After removal of the band the patient was discharged from the hospital following 2-hr monitoring.

Duplex ultrasonography at 2-month follow-up revealed persistent closure of RAP and good patency of radial artery. Swelling decreased markedly and was painless (Fig. 4).

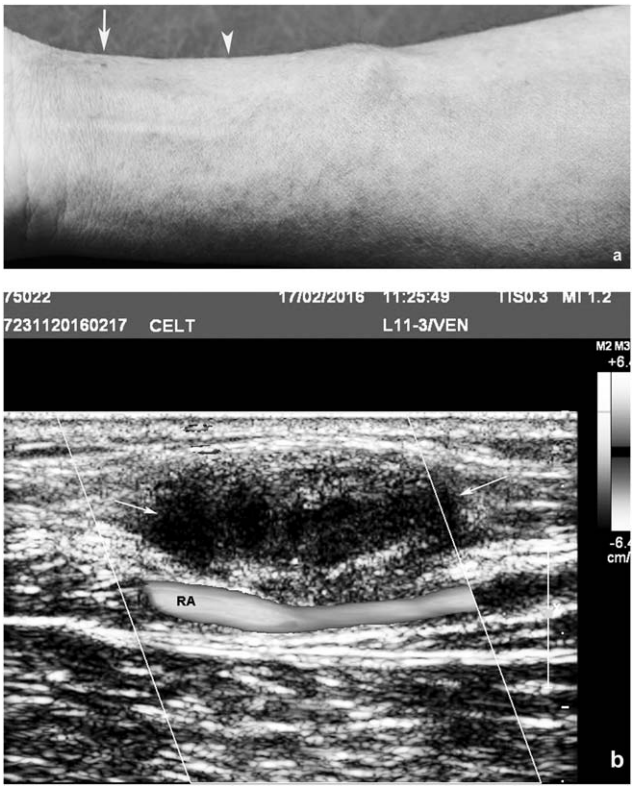


**Fig. 4. Follow up result 2 months after initial procedure of RAP treatment. a—Picture of forearm demonstrated markedly reduction of swelling. Initial and repeat puncture point of RA are indicated by arrowhead and arrow, respectively. b—Duplex Ultrasonography demonstrated patent radial artery (RA) without compromise of blood flow. Residual cavity of RAP was still detected filling with thrombotic mass and liquid, but without communication between RA and residual RAP sac.**

## DISCUSSION

Pseudoaneurysms are recognized as a complication of arterial catheterization and are usually caused by disruption of arterial wall with hematoma formation associated with persistence of blood flow between arterial adventitia and the hematoma. Over time, arterial blood flow under high pressure creates a cavity outlined by inflammatory cells and fibroblasts subsequently replaced by fibrous tissue and the inner surface covered by endothelium.

Development of femoral artery pseudoaneurysm (FAP) is described well in literature with a reported incidence of 0.2% for diagnostic and 0.8% for interventional transfemoral procedures [4,5]. In contrast, the real world incidence of radial artery pseudoaneurysm (RAP) is unknown, probably because of lower incidence and underreporting. During the period of 2003-2015 in our institution we detected only 4 RAP cases out of 17,204 diagnostic and interventional transradial catheterization procedures (0.02%).

Many small postcatheterization pseudoaneurysms tend to spontaneously thrombose over time [5]. However, large pseudoaneurysms which do not thrombose spontaneously, should be treated, because potential complications of RAP may be nearby venous compression, thromboembolism and rupture with significant bleeding requiring urgent surgery [6,7]. Until recently, the standard technique of treatment has been surgical repair including radial artery ligation, patch angioplasty using vein segment, RAP ligation and excision with end-to-end anastomosis [8–10]. During the past decade several minimally invasive methods have been introduced that have largely replaced surgical treatment. Most common techniques are ultrasound-guided compression [2,11,12] and percutaneous thrombin injection into RAP sac under ultrasound guidance [2,13,14].

Ultrasonographically guided compression is associated with a high success rate [11,12], but this technique also has significant limitations, including decreased success rate for patients taking long-term anticoagulation therapy [11,15] and prolonged compression time, often resulting in patient discomfort and pain. Sometimes there are recurrences after compression therapy subsequently requiring further compression attempts or surgery [16]. Moreover, pseudoaneurysm with relatively rigid fibrous wall require prolonged forceful compression that may cause occlusion of small caliber radial arteries, despite use ultrasound guidance, as cessation of radial artery flow during compression has been identified a risk factor for subsequent radial artery occlusion (RAO) [17], as well as prolonged compression of the artery [18].

Ultrasound-guided thrombin injection is a quick and more effective technique in almost all cases even in patients with anticoagulation therapy. However, direct thrombin injection into pseudoaneurysm sac is not without risk. The unattended escape of thrombin into adjacent main artery can result in thromboembolism to the distal arterial bed, resulting in necrosis [19]. In recent publication Zegri et al described a case of asymptomatic RAO after thrombin injection in RAP sac[2]. Teh et al described a case of thrombin injection into temporal artery pseudoaneurysm with unexpected outcome of seizure and scalp necrosis [6]. In another publication D'Achille et al presented a case where thrombin injection in RAP sac led to distal skin changes suggesting distal vessel embolization after possible thrombin entry in arterial circulation [20]. Other reported complications included anaphylaxis [21] or generalized urticaria after bovine thrombin injection and pseudoaneurysm rupture [19].

Taking into account all issues mentioned above, we decided to use of lumen-based flow interruption in the RAP sac using insertion of 6F arterial sheath into

radial artery covering the RAP neck and protected the radial artery against external compression related consequences, such as RAO. The stasis of blood in RAP sac facilitates thrombosis of the sac and resolution of pseudoaneurysm, without the need of external compression. Moreover, if needed we can safely inject thrombin into RAP sac after covering RAP neck by the sheath without the risk of thrombin entry into the arterial circulation.

Initial angiography demonstrated significant deviation and stenosis of RA at the site of RAP and solely mechanical compression even ultrasound guidance did not guarantee radial artery patency and sheath was protected arterial lumen against external mechanical compression. In general, arterial sheath acts as a temporary covered stent, which can be removed after successful closure of RAP. Permanent covered stents has been utilized with good results in treatment of pseudoaneurysms of large caliber arteries [22], but in radial artery with mean diameter less than 2.5 mm, use of permanent covered stents may be risky. For prevention of radial artery closure after long dwell time of the arterial sheath, patent hemostasis technique should be used after sheath removal to prevent RAO [23].

Possible contributing cause of RAP formation in our case was inadequate index hemostasis with an adverse influence of long-term systemic anticoagulation therapy, which likely facilitated persistent communication between main artery and pseudoaneurysm sac. Earlier, Collins et al. noted that full anticoagulation therapy, rather than inadequate compression, was a potential contributing factor for development of RAP [8]. While radial artery access is favored in such high risk patients to avoid bleeding complications, ongoing anticoagulation therapy may predispose to RAP formation. Prolonged non-occlusive hemostatic compression, as well as other measures such as, use of smaller diameter introducer sheath, temporary interruption of anticoagulation therapy and surveillance for RAP (palpation of radial puncture site, ultrasound examination) during follow-up after TRI procedure, may lower the incidence and aid in early detection of RAP.

Despite the success of temporary radial artery occluding technique with arterial sheath for nonsurgical RAP treatment some questions remain and require further investigation, such as optimal sheath/radial artery diameter ratio, appropriate sheath dwell time in the artery for reliable RAP closure and monitoring after successful RAP closure.

## CONCLUSION

We propose the use of our new technique of radial pseudoaneurysm closure by insertion of arterial sheath into radial artery combined with mechanical compression or thrombin injection may improve safety and efficacy of RAP treatment. Patients receiving continuous anticoagulation therapy after the transradial invasive procedures may warrant more careful monitoring after sheath removal and hemostasis.

## ACKNOWLEDGMENT

The authors thank all the nurses and technicians of our cath lab for their professional contribution and help in the introduction this new technique in our practice.

## REFERENCES

1. Lemaitre J, Goffin C, Bellens B. Digital embolus arising from a pseudoaneurysm after radial artery ccatheterization: A case report. Acta Chir Belg 2006;106:246–248.
2. Zegrí I, García-Touchard A, Cuenca S, Oteo JF, Fernández-Díaz JA, Goicolea J. Radial artery pseudoaneurysm following cardiac catheterization: Clinical features and nonsurgical treatment results. Rev Esp Cardiol (Engl Ed) 2015;68:349–351.
3. Popovic B, Freysz L, Chometon F, Lemoine J, Elfarra M, Angioi M, Selton-Suty C, de Chillou C, Aliot E. Femoral pseudoaneurysms and current cardiac catheterization: Evaluation of risk factors and treatment. Int J Cardiol 2010;14;141:75–80.
4. Katzenschlager R, Ugurluoglu A, Ahmadi A, Hülsmann M, Koppensteiner R, Larch E, Maca T, Minar E, Stümpflen A, Ehringer H. Incidence of pseudoaneurysm after diagnostic and therapeutic angiography. Radiology 1995;195:463–466.
5. Morgan R, Belli AM. Current treatment methods for postcatheterization pseudoaneurysms. J Vasc Interv Radiol 2003;14:697–710.
6. Teh LG, Sieunarine K. Thrombin injection for repair of pseudoaneurysms: A case for caution. Australas Radiol 2003;47: 64–66.
7. Harkin DW, Connolly D, Chandrasekar R, Anderson M, Blair PH, Hood JM, Barros D'Sa AA. Radial artery mycotic pseudoaneurysm in a haemophiliac: A potentially fatal complication of arterial catheterization. Haemophilia 2002;8:721–724.
8. Collins N, Wainstein R, Ward M, Bhagwandeen R, Dzavik V. Pseudoaneurysm after transradial cardiac catheterization: case series and review of the literature. Catheter Cardiovasc Interv 2012;80:283–287.
9. Leone Vincenzo, Misuri D, Console N. Radial artery pseudoaneurysm after a single puncture for blood-gas analysis: A case report. Cases J 2009;2:6890
10. Ganchi PA, Wilhelmi BJ, Fujita K, Lee WP, Less A. Ruptured pseudoaneurysm complicating an infected radial artery catheter: Case report and review of the literature. Ann Plast Surg 2001; 46:647–650.
11. Eisenberg L, Paulson EK, Kliewer MA, Hudson MP, DeLong DM, Carroll BA. Sonographically guided compression repair of pseudoaneurysms: Further experience from a single institution. AJR Am J Roentgenol 1999;173:1567–1573.
12. Beer M, Beissert M, Sandstede J, Wittenberg G, Tschammler A, Hahn D. Compression repair of ruptured pseudoaneurysms guided by color Doppler ultrasonography: Report of two cases. J Ultrasound Med 2001;20:409–412.
13. Pozniak MA, Mitchell C, Ledwidge M. Radial artery pseudoaneurysm:A maneuver to decrease the risk of thrombin therapy. J Ultrasound Med 2005;224:119–122.
14. Herold J, Brucks S, Boenigk H, Said SM, Braun-Dullaeus RC. Ultrasound guided thrombin injection of pseudoaneurysm of the

radial artery after percutaneous coronary intervention. Vasa 2011;40:78–81.
15. Dean SM, Olin JW, Piedmonte M, Grubb M, Young JR. Ultrasound-guided compression closure of postcatheterization pseudoaneurysms during concurrent anticoagulation: A review of seventy-seven patients. J Vasc Surg 1996;23:28–34.
16. Webber GW, Jang J, Gustavson S, Olin JW. Contemporary management of postcatheterization pseudoaneurysms. Circulation 2007;115:2666–2674.
17. Sanmartin M, Gomez M, Rumoroso JR, Sadaba M, Martinez M, Baz JA, Iniguez A. Interruption of blood flow during compression and radial artery occlusion after transradial catheterization. Catheter Cardiovasc Interv 2007;70:185–189.
18. Pancholy SB, Patel TM. Effect of duration of hemostatic compression on radial artery occlusion after transradial access. Catheter Cardiovasc Interv 2012;79:78–81.
19. Khoury M, Rebecca A, Greene K, Rama K, Colaiuta E, Flynn L, Berg R. Duplex scanning-guided thrombin injection for the treatment of iatrogenic pseudoaneurysms. J Vasc Surg 2002;35: 517–521.
20. D'Achille A, Sebben R, Davies R. Percutaneous ultrasound-guided thrombin injection for coagulation of post-traumatic pseudoaneurysms. Australian Radiol 2001;45:218–221.
21. Pope M, Johnston KW. Anaphylaxis after thrombin injection of a femoral pseudoaneurysm: Recommendations for prevention. J Vasc Surg 2000;32:190–191.
22. Thalhammer C, Kirchherr AS, Uhlich F, Waigand J, Gross CM. Postcatheterization pseudoaneurysms and arteriovenous fistulas: Repair with percutaneous implantation of endovascular covered stents. Radiology 2000;214:127–31.
23. Pancholy SB. Strategies to prevent radial artery occlusion after transradial PCI. Curr Cardiol Rep 2014;16:505.