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Case Report

Complications Related to Radial Artery Cannulation from 2004 to 2013

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Summary

Radial artery cannulation facilitates the monitoring of arterial pressure, enables the introduction of gas-sampling lines, and provides routes for cardiac diagnostic and interventional catheterization. However, detailed information is needed to prevent complications associated with radial arterial cannulations.

Through an extensive literature search for case reports in PubMed and other databases from 2004 to 2013, 27 cases (from 24 articles) of complications related to radial artery cannulation for pressure monitoring and cardiac catheterization were identified. These cases included 7 cases of pseudoaneurysms, 6 cases of hand or finger ischemia, 5 cases of foreign bodies, 1 case of spasm, 2 cases of arteriovenous fistula, and 6 cases of perforation. In 13 cases, surgical intervention was required and completed successfully. Most cases of pseudoaneurysms and ischemia were associated with co-existing diseases, such as ischemic heart disease with an assumption of atherosclerosis. Radial artery perforations were successfully treated with catheter interventions.

Radial artery cannulation with longer catheters (≥5 cm) was associated with a decreased incidence of thrombosis. Although both 22-G and 20-G catheters are <5 cm long, 22-G catheters appear to have a favorable safety profile compared to 20-G catheters in atherosclerotic patients. Moreover, 5-Fr sheaths appear to have a favorable safety profile compared to 6-Fr sheaths. Care should be taken in choosing the size of catheters for cannulation according to the co-existing diseases.

Keywords

Radial artery; Cannulation; Complication; Catheter

Introduction

Radial artery cannulation facilitates the monitoring of arterial pressure, enables the introduction of gas-sampling lines, and provides routes for cardiac diagnostic and interventional catheterization. However, it can result in several types of complications. Review articles have included discussions of these complications, but these articles almost always refer to complications occurring before 2004 [1-7].

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This review article discusses case reports published from 2004 to 2013 describing complications related to radial arterial cannulation. Articles published during this same time frame that describe strategies to deal with complications in order to ensure safe cannulation are also discussed.

Data Collection

In an extensive literature search, we searched case reports, review articles, and original articles published from 2004 to 2013 related to complications of radial artery cannulation. We identified those articles in PubMed, Google Scholar, and science journals by using keywords such as radial artery, transradial, complication, pseudoaneurysm, occlusion, perforation, and spasm.

Results

We initially searched PubMed and found 447 documents with the keyword "radial artery complication" and 134 with the keyword "transradial complication." We then found 197 articles in a search for "radial artery pseudoaneurysm," 956 articles in a search for "radial artery occlusion," 46 articles in a search for "radial artery perforation," and 286 articles in a search for "radial artery spasms." Thereafter, we searched for articles using Google Scholar, and also identified the science journals related to the searched articles through PubMed.

After reviewing titles and abstracts, we identified 27 cases of complications in 24 papers published from 2004 to 2013.

Table 1 shows a summary of the 27 case reports related to radial arterial cannulation [8-31]. These cases included 7 cases of pseudoaneurysm [8-14], 6 cases of ischemia [15-20], 5 cases of foreign bodies [8,21-24], 1 case of spasm [25], 2 cases of arteriovenous fistulas [26,27], and 6 cases of perforations [28-31]. In 2 of the 27 cases, the patients were children [17,25].

Surgical repair was required in 13 of the 27 cases. Pseudoaneurysms were resected [9-12,14], a hand or fingers were amputated for ischemia [15,16,19], foreign bodies were removed [22-25], and an arteriovenous fistula was ligated [26].

Pseudoaneurysms and foreign bodies were frequent and were successfully resected or removed surgically. Risk factors for the development of pseudoaneurysm were abnormal vessel wall (atherosclerosis), age of >70 years, indwelling duration, and other miscellaneous factors [9,11,13]. All 7 cases of pseudoaneurysms and 5 of the 6 cases of hand ischemia were associated with co-existing diseases, such as ischemic heart disease with an assumption of atherosclerosis. In 5 of the 7 pseudoaneurysm cases, the patients were aged >70 years [10–14]. In 4 of the 7 cases, the indwelling duration was >9 days [8,9,11,14].

Discussion

We identified 27 cases of complications related to radial arterial cannulation. These cases included 7 cases of pseudoaneurysms, 6 cases of hand or finger ischemia, 5 cases of foreign bodies, 1 case of spasm, 2 cases of arteriovenous fistula, and 6 cases of perforations.

The most common complications associated with peripheral

Table 1: Summary of case reports related to radial arterial cannulation.

Reference no.	Year	Compli -cations	Age	Co-existing condition(s) before cannulation	Catheter size	Purpose	Duration	Treatment
Blasco et al. [8]	2005	Pseudo -aneurysm	55 y	AMI	6Fr Sh	Diagnostic CC	14 d	Mechanical compression
Afshar and Nasiri [9]	2009		48 y	MVM	?	Pressure monitoring	1 m	Surgical resection
Nazeri et al. [10]	2011		82 y	IHD, HT	–	Pressure monitoring	5 d	Surgical resection
Ranganath and Hanumanthaiah [11]	2011		75 y	HD Lacunar infarction Post-CABG Af	–	Pressure monitoring	20 d	Surgery
Truong and Thakar [12]	2013		73 y	IHD	20G		2 d	Surgical resection
Suchoń [13]	2013		84 y	HT	6Fr Sh	Diagnostic CC	1 d	Compression
Bhat et al. [14]	2013		80 y	IHD	5Fr Sh	CC intervention	10 d	Surgical resection
Wallach [15]	2004	Ischemia	61 y	DM PAD IHD	–	Pressure monitoring	12 h	Surgical amputation
Lemaitre et al. [16]	2006		58 y	COPD DM HT HL HHCys	–	Pressure monitoring	21 d	Surgical ligation
Stephenson et al. [17]	2009		3 m	–	24G	Pressure monitoring	5 h	Bacitracin ointment
Rhyne and Mann [18]	2010		72 y	HT HL Smoking	6Fr Sh	Diagnostic CC	14 d	Angioplasty
Chaparro [19]	2012		31 y	DM	20G	Pressure monitoring	3 d	Surgical amputation
Rademakers and Laarman [20]	2012		44 y	Smoking	6Fr Sh	Diagnostic CC	5 d	Medication
Blasco et al. [8]	2005	Foreign body	57 y	AMI	6Fr Sh	Cardiac angioplasty	14 d	Biopsy
Luo et al. [21]	2010		73 y	–	20G	Pressure monitoring	–	Surgical removal
Moon et al. [22]	2012		69 y	–	22G	–	0 d	Surgical removal
Aslam et al. [23]	2012		63 y	–	20G	Pressure monitoring	0 d	Surgical removal
Olechowski et al. [24]	2013		42 y	IHD	6Fr Sh	CC intervention	0 d	Surgical removal
Latham et al. [25]	2013	Spasm	8 m	–	–	–	0 d	
Na et al. [26]	2012	Fistula	61 y	IHD	–	CC intervention	11 m	Surgical ligation
Dehghani et al. [27]	2013		62 y	IHD	6Fr 23 cm Sh	CC intervention	30 d	Observation
Patel et al. [28]	2009	Perforation	60 y	IHD	5Fr	Diagnostic CC	0 d	Observation
			54 y	IHD	6Fr	CC intervention	0 d	Catheter maneuvering
			70 y	IHD DM	5Fr	Diagnostic CC	0 d	Observation
Mamarelis et al. [29]	2010		75 y	IHD HT HL Obestiy	6Fr 10 cm Sh	Diagnostic CC	0 d	Baloon occlusion
Narayan et al. [30]	2012		69 y	IHD HT DM HL	6Fr Sh	Diagnostic CC	0 d	Stent graft
Buturak et al. [31]	2013		73 y	IHD HT HL	5Fr Sh	CC intervention	0 d	Catheter sealing

y; year, m; month, –; not mentioned, Fr; French size, G; gauge, Sh; sheath, AMI; acute myocardial infarction, MVM; mitral valve malfunction, IHD; ischemic heart disease, HT; hypertension, HD; haemodialysis, CABG; coronay artery bypass graft, Af; atrial fibrillation, DM; diabetis mellitus, PAD; peripherally arterial disease, COPD; chronic obstructive pulmonary disease, HL; hyperlipidemia, HHCys; hyper homocysteinemia, CC; cardiac catheterization

arterial catheters used for hemodynamic monitoring from 1978 to 2001 were temporary radial artery occlusion (19.7%) and hematoma (14.4%), followed by infection at the arterial site (0.7%), hemorrhage (0.5%) or bacteremia (0.1%), and permanent ischemic damage or pseudoaneurysm (0.1% each) [2].

In the reviewed cases, pseudoaneurysms and foreign bodies were successfully resected or removed surgically. Ultrasonography and three-dimensional computerized tomography proved useful for the detection of the presence of intra-arterial catheter remnants or foreign bodies [8,21,22].

Greenwood et al. [32] and Kohonen et al. [33] suggest that the Allen test is a good and valid screening test for the circulation of the hand. If the Allen test is negative it is safe to harvest the radial artery. If it is positive further examinations are needed to ensure safe harvesting of the radial artery. Conversely, Aglifoglio et al. [34,35] declare that the Allen test is not adequate enough for the screening of hand circulation. It is noted that the Modified Allen's test cannot predict ischemic complications in the setting of radial artery occlusion in review articles [4,6,7]. Ischemic events were reported in the present 6 cases. Allen's test was normal in one case [20], was not mentioned in other 4 cases including one child [15-18], and a patent ulnar artery was confirmed in the other case [19].

Thrombosis can cause ischemia. Radial artery cannulation with a 15.2-cm catheter is associated with a lower incidence of post-decannulation radial artery thrombosis as compared to cannulation with a 4.45 cm catheter. Radial artery cannulation with longer catheters (≥5 cm) appears to have a favorable safety profile [36]. In patients with atherosclerosis, the radial arterial occlusion rate was 6% for a 25-mm-long 22-G catheter compared with 26% for a 33-mm-long 20-G catheter for radial arterial cannulation [37]. Moreover, radial artery occlusion was less frequent when a 5-Fr sheath was used (14.4%) compared to a 6-Fr sheath (33.1%) for coronary

catheterization (P<0.001) [38]. Radial artery occlusion was also less frequent when using a 5-Fr sheath than when using a 6-Fr sheath in another study [39]. Radial artery occlusion occurred in 0.6% of coronary angiographies and 1.4% of coronary interventions out of 1191 cases [40]. A 5-Fr sheath can be used for diagnostic angiography. In the present review, complications occurred in 1 case involving a 22-G catheter and 4 cases involving 20-G catheters. Complications occurred in 4 cases involving a 5-Fr sheath and 9 cases involving a 6-Fr sheath.

Advancement of the ultrasonographic apparatus with a 50-MHz probe clearly indicated the presence of a radial arterial spasm in an infant [25]. Intra-arterial vasodilators remain mandatory in prevention of radial arterial spasm. The combination of verapamil (1.25–5 mg) and nitroglycerin (100–200 μg) can reduce the incidence of radial arterial spasm by up to 3.8%, and the use of hydrophilic-coated sheaths and catheters can further reduce the incidence of radial arterial spasm to 1% [5]. Radial spasm was significantly reduced when using the long sheath, compared to the short sheath in (7 [4%] vs. 32 [18%]) of patients, P<0.001) [41]. It seems unclear whether or not such prevention is effective for children.

In cases of iatrogenic radial artery perforation, 9 patients were managed conservatively by inserting a long arterial sheath in the damaged radial artery up to the brachial artery [42]. In this review, 6 cases of perforations were managed successfully, with 4 catheter interventions and 2 observations without operation.

One article supports the superiority of radial access over femoral access in reducing complications [43]. However, severe complications related to radial artery cannulation were reported in papers published from 2004 to 2013. Therefore, we believe that care should be taken when choosing the size of the catheter for cannulation according to the co-existing diseases, especially in cases with atherosclerosis.

We could not retrieve all the data about the radial artery cannulation in case reports, although we attempted to obtain the data directly from the authors. However, we believe that this review covers most of the available information about radial artery cannulation from case reports, in addition to past reviews and original articles. However, further information on this topic would facilitate the reduction of complications related to radial artery cannulation.

References

1. Wilkins RG (1985) Radial artery cannulation and ischaemic damage: a review. Anaesthesia 40: 896-899.
2. Scheer B, Perel A, Pfeiffer UJ (2002) Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine. Crit Care 6: 199-204.
3. Bazemore E, Mann JT 3rd (2005) Problems and complications of the transradial approach for coronary interventions: a review. J Invasive Cardiol 17: 156-159.
4. Brzezinski M, Luisetti T, London MJ (2009) Radial artery cannulation: a comprehensive review of recent anatomic and physiologic investigations. Anesth Analg 109: 1763-1781.
5. Kristic I, Lukenda J (2011) Radial artery spasm during transradial coronary procedures. J Invasive Cardiol 23: 527-531.
6. Tiru B, Bloomstone JA, McGee WT (2012) Radial artery cannulation: A review article. J Anesth Clin Res 3: 5.
7. Ruzsa Z, Szolnoky J (2012) Radial artery cannulation: a systemic review. J Anesth Clin Res 4: 313.
8. Blasco A, Oteo JF, Fontanilla T, Salamanca J, Ocaranza R, et al. (2005) [Unusual complications of cardiac catheterization via the radial artery]. Rev Esp Cardiol 58: 1233-1235.
9. Afshar A, Nasiri B (2009) Radial artery pseudoaneurysm at the previous site of invasive monitoring. J Teh Univ Heart Ctr 3: 193-196.
10. Nazeri A, Sohawon S, Papadopoulou B, Georgala A, Dernier Y, et al. (2011) A late complication of percutaneous radial artery cannulation. Acta Clin Belg 66: 223-225.
11. Ranganath A, Hanumanthaiah D (2011) Radial artery pseudo aneurysm after percutaneous cannulation using Seldinger technique. Indian J Anaesth 55: 274-276.
12. Truong AT, Thakar DR (2013) Radial artery pseudoaneurysm: a rare complication with serious risk to life and limb. Anesthesiology 118: 188.
13. SuchoÅ„ E, JÄ…kaÅ‚a J, Dykla D, Depukat R, Krochin M, et al. (2013) Radial artery pseudoaneurysm as an extremely rare complication associated with transradial catheterisation. Kardiol Pol 71: 542.
14. Bhat T, Bhat H, Teli S, Rajiv B, Akhtar M, et al. (2013) Pseudoaneurysm a rare complication of transradial cardiac catheterization: a case report. Vascular.
15. Wallach SG (2004) Cannulation injury of the radial artery: diagnosis and treatment algorithm. Am J Crit Care 13: 315-319.
16. Lemaitre J, Goffin C, Bellens B (2006) Digital embolus arising from a pseudoaneurysm after radial artery catheterization: a case report. Acta Chir Belg 106: 246-248.
17. Stephenson LL, Gordon N, Seefelder C (2010) Regional skin necrosis from radial artery cannulation in infants. J Clin Anesth 22: 230-231.
18. Rhyne D, Mann T (2010) Hand ischemia resulting from a transradial intervention: successful management with radial artery angioplasty. Catheter Cardiovasc Interv 76: 383-386.
19. Chaparro Mendoza K (2012) Radial artery catheterism for invasive monitoring: Preventing complications, a challenge in anesthesia. Colum J Anesth 4: 262-265.
20. Rademakers LM, Laarman GJ (2012) Critical hand ischaemia after transradial cardiac catheterisation: an uncommon complication of a common procedure. Neth Heart J 20: 372-375.
21. Luo CF, Mao CC, Su BC, Yu HP (2010) An iatrogenic complication of radial artery cannulation. Acta Anaesthesiol Taiwan 48: 145-147.
22. Moon SK, Gong JC, Kim JH, Lee KC, Kim HY, et al. (2012) A retained catheter fragment in radial artery caused by accidental catheter transection during arterial catheter removal. J Anesth 26: 625-626.
23. Aslam MI, Sarker B, Bhattachary V (2012) A rare complication of radial artery cannulation. J Med Ultrasound 20: 183-185.
24. Olechowski B, Purkiss M, Strike P (2013) Radial artery damage due to sheath fracture: unpredicted complication. Heart 99: 353-354.
25. Latham GJ, Bosenberg AT, Low DK (2013) Radial Artery Spasm in an Infant as Documented by High-frequency Micro-ultrasound. Anesthesiology .
26. Na KJ, Kim MA, Moon HJ, Lee JS, Choi JS (2012) Radial arteriovenous fistula developed late after coronary angiography: a case report. Korean J Thorac Cardiovasc Surg 45: 421-423.
27. Dehghani P, Culig J, Patel D, Kraushaar G, Schulte P (2013) Arteriovenous fistula as a complication of transradial coronary angiography: a case report. J Med Case Rep 7: 21.
28. Patel T, Shah S, Sanghavi K, Pancholy S (2009) Management of radial and brachial artery perforations during transradial procedures--a practical approach. J Invasive Cardiol 21: 544-547.
29. Mamarelis I, Kantounakis I, Kotileas P, Takos P, Stefanopoulos T (2010) Radial artery angioplasty after perforation during diagnostic cardiac catheterisation. Hellenic J Cardiol 51: 467-471.
30. Narayan RL, Vaishnava P, Kim M (2012) Radial artery perforation during transradial catheterization managed with a coronary polytetrafluoroethylene-covered stent graft. J Invasive Cardiol 24: 185-187.
31. Buturak A, Demirci Y, Dagdelen S (2013) Management of an iatrogenic radial artery perforation: a case report. Turk Kardiyol Dern Ars 41: 332-335.
32. Greenwood MJ, Della-Siega AJ, Fretz EB, Kinloch D, Klinke P, et al. (2005) Vascular communications of the hand in patients being considered for transradial coronary angiography: is the Allen's test accurate? J Am Coll Cardiol 46: 2013-2017.

33. Kohonen M, Teerenhovi O, Terho T, Laurikka J, Tarkka M (2007) Is the Allen test reliable enough? Eur J Cardiothorac Surg 32: 902-905.

34. Agrifoglio M, Dainese L, Pasotti S, Galanti A, Cannata A, et al. (2005) Preoperative assessment of the radial artery for coronary artery bypass grafting: is the clinical Allen test adequate? Ann Thorac Surg 79: 570-572.

35. Agrifoglio M, Barili F, Dainese L, Biglioli P (2008) The Allen test is not adequate enough for the screening of hand circulation. Eur J Cardiothorac Surg 33: 754.

36. Dahl MR, Smead WL, McSweeney TD (1992) Radial artery cannulation: a comparison of 15.2- and 4.45-cm catheters. J Clin Monit 8: 193-197.

37. Eker HE, Tuzuner A, Yilmaz AA, Alanoglu Z, Ates Y (2009) The impact of two arterial catheters, different in diameter and length, on postcannulation radial artery diameter, blood flow, and occlusion in atherosclerotic patients. J Anesth 23: 347-352.

38. Uhlemann M, Möbius-Winkler S, Mende M, Eitel I, Fuernau G, et al. (2012) The Leipzig prospective vascular ultrasound registry in radial artery catheterization: impact of sheath size on vascular complications. JACC Cardiovasc Interv 5: 36-43.

39. Kotowycz MA, Dzavík V (2012) Radial artery patency after transradial catheterization. Circ Cardiovasc Interv 5: 127-133.

40. Yoo BS, Yoon J, Ko JY, Kim JY, Lee SH, et al. (2005) Anatomical consideration of the radial artery for transradial coronary procedures: arterial diameter, branching anomaly and vessel tortuosity. Int J Cardiol 101: 421-427.

41. Caussin C, Gharbi M, Durier C, Ghostine S, Pesenti-Rossi D, et al. (2010) Reduction in spasm with a long hydrophylic transradial sheath. Catheter Cardiovasc Interv 76: 668-672.

42. Calvino-Santos RA, Vázquez-Rodriguez JM, Salgado-Fernández J, Vázquez-González N, Pérez-Fernández R, et al. (2004) Management of iatrogenic radial artery perforation. Catheter Cardiovasc Interv 61: 74-78.

43. Jolly SS, Yusuf S, Cairns J, Niemelä K, Xavier D, et al. (2011) Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet 377: 1409-1420.