

# Liability Related to Peripheral Venous and Arterial Catheterization: A Closed Claims Analysis

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**BACKGROUND:** Serious complications after peripheral IV and arterial vascular cannulations have been reported. To assess liability associated with these peripheral vascular catheters for anesthesiologists, we reviewed claims in the American Society of Anesthesiologists Closed Claims database.

**METHODS:** Claims related to peripheral vascular catheterization were categorized as related to IV or arterial catheters. Complications related to IV catheters were categorized as to type of complication. Patient and case characteristics, severity of injury, and payments were compared between claims related to IV catheters and all other (nonperipheral catheter) claims in the database. Payment amounts were adjusted to 2007-dollar amounts using the consumer price index.

**RESULTS:** Claims related to peripheral vascular catheterization accounted for 2% of claims in the database ( $n = 140$  of 6894 claims), most (91%) associated with IV catheters ( $n = 127$ ). The most common complications were skin slough (28%), swelling/infection (17%), nerve damage (17%), fasciotomy scars (16%), and air embolism (8%). Approximately half of these complications (55%) occurred after extravasation of drugs or fluids. Compared with other claims, IV claims involved a larger proportion of cardiac surgery (25% vs 2% for other,  $P < 0.001$ ) and smaller proportion of emergency procedures (8% vs 22% for other,  $P < 0.001$ ). Claims related to arterial catheters were few ( $n = 13$ , 8%), with only seven associated with radial artery catheterization.

**CONCLUSIONS:** Claims related to IV catheters were an important source of liability for anesthesiologists, approximately half of which resulted from extravasation of drugs or fluid. Claims related to radial arterial catheterization were uncommon.

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Peripheral IV and arterial vascular cannulations are relatively straightforward procedures. However, significant complications after each of these have been reported<sup>1-5</sup> and may be a source of liability for anesthesiologists. Extravasation injuries,<sup>1</sup> local or systemic infection,<sup>3</sup> air embolism,<sup>6</sup> thrombophlebitis,<sup>7</sup> and vascular insufficiency from arterial occlusion due to spasm or thrombosis,<sup>4,5</sup> have all been reported. We analyzed the claims related to peripheral IV or arterial (peripheral vascular) catheterizations from the American Society of Anesthesiologists (ASA) Closed Claims database to assess the anesthesia liability associated with performing and using peripheral vascular catheters. We hypothesized that the liability profile of claims related to

peripheral catheterization would differ from other anesthesia malpractice claims.

## METHODS

The ASA Closed Claims database is a structured evaluation of adverse anesthetic outcomes obtained from the closed claim files of 35 United States professional liability insurance companies. The data collection process has been described in detail.<sup>8,9</sup> Briefly, each closed claim file was reviewed by a practicing anesthesiologist and each review typically consisted of relevant hospital and medical records; narrative statements from involved health care personnel; expert and peer reviews; summaries of depositions from plaintiffs, defendants, and expert witnesses; outcome reports; and the cost of settlement or jury award. The reviewer completed a standardized form that recorded information about patient characteristics, surgical procedures, sequence and location of events, critical incidents, clinical manifestations of injury, standard of care, and outcome. Anesthesia care was addressed as appropriate, less than appropriate (substandard), or impossible to judge based on the legal concept of reasonable and prudent care at the time of the event.<sup>8,10</sup> Reliability of reviewer judgments has been found to be acceptable.<sup>10</sup>

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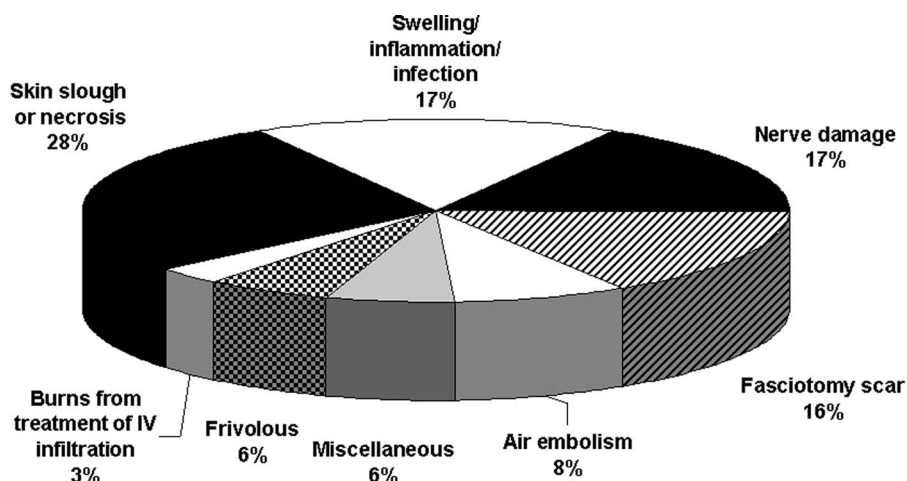
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**Figure 1.** Injuries related to IV catheters ( $n = 127$ ).



The physical or psychological injury for which the patient was seeking compensation was recorded in each claim. Each claim was assigned a severity of injury score that was designated by the on-site reviewer using the insurance industry's 10-point scale that rates severity of injury from 0 (no injury) to 9 (death).<sup>8</sup> For purposes of analysis, injuries were grouped into three categories: temporary or nondisabling (score = 0–5), disabling and permanent (score = 6–8), and death (score = 9).

This study focused on the analysis of claims related to peripheral IV and arterial vascular catheters. Complications associated with IV catheters were classified as to type of complication and whether or not it was related to extravasation of drugs or fluids. Patient demographics, severity of injury, and frequency and amount of payment to the plaintiff of these claims were compared with all other claims in the database. Differences between proportions were evaluated using the  $\chi^2$  analysis, the Fisher's exact test, and the z test.

Payments for settlement and jury award were expressed in dollar amounts adjusted to 2007 dollars using the Consumer Price Index.\* Because payment did not exhibit a normal distribution, the median and range were used for descriptive purposes. Statistical comparisons of payment distributions were made using the Kolmogorov-Smirnov test.  $P < 0.001$  was required for statistical significance.

## RESULTS

There were 140 claims for injuries between 1975 and 2000 related to peripheral vascular catheterization (2.1% of 6894 total claims in the database), of which 127 (91%) were related to IV catheters, whereas 13 (9%) claims were related to arterial catheters.

### Claims Related to IV Catheters

The most common complications related to IV catheters were skin slough or necrosis ( $n = 35$ ) followed by swelling/inflammation/infection ( $n = 22$ ),

nerve damage ( $n = 22$ ), fasciotomy scars from compartment syndrome ( $n = 20$ ), and air embolism ( $n = 10$ , Fig. 1). Most claims for air embolism resulted from air in blood bags from cell savers. Burns due to heat compresses used to treat IV infiltrations accounted for 3% of claims ( $n = 4$ , Fig. 1). Approximately half (55%) (95% confidence interval 46%–64%) of peripheral IV complications were related to the extravasation of drugs or fluids. The most commonly reported drugs causing skin slough were thiopental ( $n = 15$ ), vasopressors (dopamine [ $n = 2$ ], dobutamine [ $n = 1$ ], epinephrine [ $n = 1$ ]), and calcium chloride ( $n = 4$ ). Compartment syndromes accounted for 22% of all IV-related nerve damage cases. Interestingly, there were no claims for complications of IV catheters in patients who had previously had an axillary node dissection on the ipsilateral arm.

Miscellaneous claims ( $n = 7$ ) involved a rash from taping of the catheter, a sheared-off catheter, patient concern over placement of an IV catheter in the same arm as an arteriovenous fistula, a metal stylette from a catheter imbedded in the patient's thigh, ecchymosis from an IV, and accidental placement in a radial artery. One patient with severe vasculitis developed hand ischemia after administration of cold blood through the IV catheter. She required amputation of several fingers. Frivolous claims ( $n = 7$ ) involved allegations of pain after difficult IV cannulation without demonstration of any pathology or claims in which there was no relationship between the site of IV cannulation and the alleged area of injury. The death of a patient with a skin slough was unrelated to the IV catheter complication.

Claims related to IV catheters involve a larger proportion of cardiac surgery (25%) and a smaller proportion of emergency procedures (8%) than other claims in the database ( $P < 0.001$ , Fig. 2). There were no statistically significant differences in age, ASA status, and body habitus (obesity) between claims related to IV catheters compared with other claims (Table 1). Claims for IV catheter complications were more likely to involve temporary nondisabling injury than other claims ( $P < 0.001$ , Fig. 2).

\*Consumer Price Index Inflation Calculator. U.S. Department of Labor, Bureau of Labor Statistics. Available at: <http://www.bls.gov/data/home.htm>. Accessed June 2, 2008.

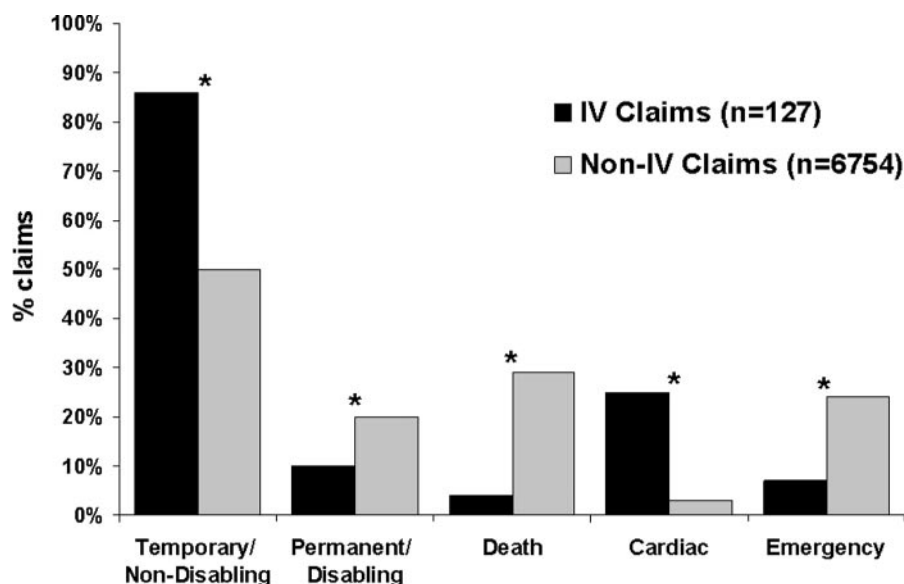


Figure 2. Patient and case characteristics associated with claims related to IV catheters. Claims with missing data were excluded. \* $P < 0.001$ .

Table 1. Case Characteristics<sup>a</sup>

	Intravenous catheters ( <i>n</i> = 127)	Arterial catheters ( <i>n</i> = 13)	All other claims ( <i>n</i> = 6754)
Gender, <i>n</i> (%)			
Female	78 (63%)	8 (62%)	3946 (59%)
Male	46 (37%)	5 (38%)	2758 (41%)
Age (yr)			
0–16	7 (6%)	2 (15%)	550 (9%)
17–69	103 (88%)	8 (62%)	5321 (82%)
70+	7 (6%)	3 (23%)	598 (9%)
Mean ± SD	45 ± 18	46 ± 26	43 ± 20
ASA status, <i>n</i> (%)			
1–2	49 (58%)	4 (44%)	3246 (68%)
3–5	36 (42%)	5 (56%)	1558 (32%)
Obese, <i>n</i> (%)			
Yes	19 (37%)	3 (43%)	1430 (43%)
No	32 (63%)	4 (57%)	1916 (57%)

No statistically significant differences were found between groups.

SD = standard deviation; ASA = American Society of Anesthesiologists.

<sup>a</sup> Table excludes missing data.

### Claims Related to Arterial Catheters

There were 13 arterial catheter claims, with seven involving the radial artery (Table 2). Two claims with severe injuries (death and permanent brain damage) involved iliac artery puncture from a femoral arterial catheter that caused a retroperitoneal hemorrhage. Arterial thrombosis and limb ischemia after femoral and brachial artery cannulations occurred in infants.

### Liability

Approximately half (54%) of all claims related to peripheral vascular catheters resulted in payment for injury (Table 3), similar to the proportion of all other claims (57%). Monetary compensation for claims related to peripheral catheters ranged from \$342 to \$12,525,000 (median \$47,700; Table 3). The size of payments for claims related to peripheral catheters was smaller compared with all other claims (median \$215,000;  $P < 0.001$ ). Claims related to air embolism

Table 2. Vessel and Complication in Arterial Catheter Claims (*n* = 13)

Complication	No. of claims
Radial artery	7
Retained wire/catheter	2
Radial nerve damage	2
Arterial thrombosis/ischemia	2
Hematoma/carpal tunnel syndrome	1
Femoral artery	5
Arterial thrombosis/ischemia	2
Iliac artery puncture/retroperitoneal hemorrhage	3
Brachial artery	1
Arterial thrombosis/ischemia	1

had the highest median payment and a rate of 100% payment-per-claim (Table 3).

Although the overall size of payments was smaller in peripheral catheter claims compared with other

**Table 3.** Payment by Peripheral Catheter Complication

Complications	<i>n</i>	No. of deaths	Substandard care, <i>n</i> (%)	Claims resulting in payment <sup>a</sup> , <i>n</i> (%)	\$ 2007 median payment <sup>b</sup>	\$ 2007 payment range <sup>b</sup>
Arterial catheter	13	1	2 (15%)	8 (62%)	\$49,000	\$9,675–\$12,525,000
Intravenous catheter	127	5	37 (29%)	64 (53%)	\$47,475	\$342–\$11,550,000
Skin slough or necrosis	35	1	9 (26%)	19 (58%)	\$66,270	\$2,104–\$154,476
Swelling/inflammation/infection	22	0	4 (18%)	8 (38%)	\$11,580	\$342–\$43,932
Nerve damage	22	0	4 (18%)	12 (55%)	\$49,575	\$3,860–\$1,215,500
Fasciotomy scar	20	0	7 (35%)	9 (47%)	\$42,750	\$14,000–\$140,000
Air embolism	10	4	9 (90%)	8 (100%)	\$325,000	\$25,800–\$4,120,200
Burn from treatment of IV infiltration	4	0	3 (75%)	3 (75%)	\$75,600	\$20,000–\$210,000
Frivolous	7	0	0 (0%)	1 (14%)	\$10,000	\$10,000–\$10,000
Miscellaneous	7	0	1 (14%)	4 (57%)	\$69,500	\$1,032–\$11,550,000
Total	140	6	39 (28%)	72 (54%)	\$47,700	\$342–\$12,525,000

IV = intravenous catheter.

<sup>a</sup> Claims with missing payment data were excluded from the calculation of percentages.

<sup>b</sup> Payment amounts were adjusted to 2007 dollars using the Consumer Price Index.

claims in the database, there were seven claims with payments in excess of \$1,000,000 (in 2007 dollar amounts) involving compensation for permanent brain damage, amputations, and permanent disability due to nerve injury. Three of these claims involved air embolism and permanent brain damage in young children. A fourth involved permanent brain damage in a 32 yr old as a result of an iliac artery injury and cardiac arrest upon removal of an arterial line postoperatively. This patient received a compensation of \$12,525,000. Two other outliers involved amputations, after arterial occlusion following arterial cannulation: in one case amputation of four fingers in a middle-aged patient (payment \$11,550,000) and the other a below-knee amputation in an infant. The final payment >\$1 million involved a young adult patient with multiple IV placement attempts followed by diazepam phlebitis. This patient had thrombosed hand veins excised and developed reflex sympathetic dystrophy, resulting in the loss of hand and arm function.

## DISCUSSION

Complications secondary to peripheral vascular catheters contribute to injuries to patients and financial liability to anesthesiologists. This analysis of peripheral vascular catheter-related complications has identified important mechanisms, demographics, and types of complications. As expected, approximately half of the claims related to IV catheters involved the extravasation of drugs or fluids outside the intended vascular structure.

Claims for peripheral vascular catheter complications comprise 2% of all claims in the ASA Closed Claims database. Although this proportion may seem small, it is similar in magnitude to those arising from gas delivery equipment<sup>11</sup> and central venous catheters<sup>12</sup> and more than from warming devices.<sup>13</sup>

Skin slough cases comprised the highest percentage of IV catheter claims. Thiopental was the most commonly reported drug in these claims. As the use of

thiopental as an induction drug declines, claims related to skin slough may decrease. A decreasing frequency of local complications of thiopental was reported even before the introduction of propofol.<sup>14</sup> Extravasation and gangrene after peripheral administration of dopamine have been reported.<sup>15,16</sup> If it is necessary to administer vasopressors into a peripheral vein in the urgent setting, the infusion pump should be set to detect small changes in infusion pressure to detect extravasation early.<sup>17,18</sup> A simple clinical test to detect extravasation involves inflation of a blood pressure cuff proximal to the IV site. This impairs flow of a gravity-dependent infusion when the cannula is intravascular, but has no effect in an extravascular location.<sup>19</sup> Successful use of transdermal nitroglycerin for prevention and treatment of phlebitis and extravasation has been described<sup>20,21</sup> and may be considered when the intravascular location of an IV catheter is in doubt. Also, an easily avoidable complication of thrombophlebitis/swelling is burn injury due to heat compresses. Cheney et al.<sup>13</sup> reported burn injuries due to direct application of warmed IV fluid bags and bottles to skin and cautioned that these devices should not be used for patient warming.

Claims due to air embolism had the highest median compensation and a 100% rate of payment-per-claim. Several of these resulted from air in the blood bag from the shed red cell recovery devices. Air embolism from IV infusion may be potentially preventable by meticulous attention to de-airing the infusion set and IV/blood bags and incorporating autoventing filters in pressure infusion devices.<sup>22,23</sup>

Cardiac surgery cases represented the largest single surgical case type among peripheral catheter malpractice claims. Although the database lacks specific data on arm tucking in each case, we speculate that this finding is the result of the common practice of arm tucking during cardiac surgery, which results in the inability to monitor IV catheters intraoperatively. The Australian Incident Monitoring study also observed



33 cases involving peripheral venous access, including 14 cases of extravasation in their analysis of 2000 incidents.<sup>24</sup> There were compartment syndrome claims in which there were warning signs of infiltration such as a slowly dripping IV. A low threshold to visually check the site of peripheral IV when the IV is dripping slower than normal may help detect an IV infiltration early on, and thus prevent the development of a compartment syndrome.

There were surprisingly few claims related to arterial vascular catheterization. Our findings of limited liability associated with radial arterial cannulation are consistent with prospective reports of the safety of radial artery cannulation.<sup>25,26</sup> Although partial or complete radial artery occlusion after decannulation occurred in a quarter of almost 1700 patients, no ischemic damage to the hand or disability occurred in any of the patients.<sup>25</sup> In contrast, liability associated with femoral arterial catheters may be greater. Cases of intraperitoneal hemorrhage from laceration of the external iliac artery<sup>27</sup> and retroperitoneal hematoma<sup>28</sup> from femoral artery catheterization have been reported. As a retroperitoneal hematoma may be concealed, anesthesiologists should be alert to this possibility. Other preventive measures may include puncturing the femoral artery below the inguinal ligament rather than above it; avoiding transfixion and thus puncture of the posterior wall; and adequate compression in case of unsuccessful cannulation.<sup>29</sup>

The limitations of interpreting the data gathered from the ASA Closed Claims Project Database have been described.<sup>8,9</sup> The database does not have data on the total number of adverse outcomes (the numerator) or the total number of anesthetics performed (the denominator), thus making it impossible to provide any numerical estimates of the risks associated with peripheral vascular catheterizations. Our data are retrospective, gathered over a time span of more than three decades and were collected in a nonrandom manner from direct participants. Finally, the database has only that information which the reviewer could obtain from the insurance company files. Incompleteness of specific detailed information regarding the sequence of events or mechanism of injury makes closed claims analysis weaker than prospectively collected data. Although our data cannot be used for establishing cause-and-effect relations, patterns of injury in this study of peripheral vascular catheter complications have identified important preventable patient complications, such as air embolism, burn injuries due to heat compresses for infiltrations/thrombophlebitis, and compartment syndromes.

In summary, claims related to IV catheters were an important source of liability for anesthesiologists. Approximately half of these complications involved the extravasation of drugs or fluids. Claims related to radial artery catheterization were uncommon.

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## REFERENCES

- Steinmann G, Charpentier C, O'Neill TM, Bouaziz H, Mertes PM. Liposuction and extravasation injuries in ICU. *Br J Anaesth* 2005;95:355-7
- Frezza EE, Mezgebe H. Indications and complications of arterial catheter use in surgical or medical intensive care units: analysis of 4932 patients. *Am Surg* 1998;64:127-31
- Hampton AA, Sherertz RJ. Vascular-access infections in hospitalized patients. *Surg Clin North Am* 1988;68:57-71
- Mangar D, Laborde RS, Vu DN. Delayed ischaemia of the hand necessitating amputation after radial artery cannulation. *Can J Anaesth* 1993;40:247-50
- Scheer B, Perel A, Pfeiffer UJ. Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine. *Crit Care* 2002;6:199-204
- Adhikary GS, Massey SR. Massive air embolism: a case report. *J Clin Anesth* 1998;10:70-2
- Barbut F, Pistone T, Guiguet M, Gaspard R, Rocher M, Dousset C, Meynard JL, Carbonell N, Maury E, Offenstadt G, Poupon R, Frottier J, Valleron AJ, Petit JC. Complications due to peripheral venous catheterization. Prospective study [in French]. *Presse Med* 2003;32:450-6
- Cheney FW, Posner K, Caplan RA, Ward RJ. Standard of care and anesthesia liability. *JAMA* 1989;261:1599-603
- Cheney FW. The American Society of Anesthesiologists Closed Claims Project: what have we learned, how has it affected practice, and how will it affect practice in the future? *Anesthesiology* 1999;91:552-6
- Posner KL, Sampson PD, Caplan RA, Ward RJ, Cheney FW. Measuring interrater reliability among multiple raters: An example of methods for nominal data. *Stat Med* 1990;9:1103-15 (Erratum: *Stat Med* 1992;11:1401)

11. Caplan RA, Vistica MF, Posner KL, Cheney FW. Adverse anesthetic outcomes arising from gas delivery equipment: a closed claims analysis. *Anesthesiology* 1997;87:741-8
12. Domino KB, Bowdle TA, Posner KL, Spittellie PH, Lee LA, Cheney FW. Injuries and liability related to central vascular catheters: a closed claims analysis. *Anesthesiology* 2004;100:1411-8
13. Cheney FW, Posner KL, Caplan RA, Gild WM. Burns from warming devices in anesthesia. A closed claims analysis. *Anesthesiology* 1994;80:806-10
14. Davies DD. Local complications of thiopentone injection. A further report. *Br J Anaesth* 1979;51:1147-9
15. Siwy BK, Sadove AM. Acute management of dopamine infiltration injury with Regitine. *Plast Reconstr Surg* 1987;80:610-2
16. Bhatt-Mehta V, Nahata MC. Dopamine and dobutamine in pediatric therapy. *Pharmacotherapy* 1989;9:303-14
17. Philip JH. Model for the physics and physiology of fluid administration. *J Clin Monit* 1989;5:123-34
18. Scott DA, Fox JA, Philip BK, Lind LJ, Cnaan A, Palleiko MA, Stelling JM, Philip JH. Detection of intravenous fluid extravasation using resistance measurements. *J Clin Monit* 1996;12:325-30
19. Goodie DB, Philip JH. Is the i.v. obstructed or infiltrated? A simple clinical test. *J Clin Monit* 1995;11:47-50
20. Denkler KA, Cohen BE. Reversal of dopamine extravasation injury with topical nitroglycerin ointment. *Plast Reconstr Surg* 1989;84:811-3
21. Tjon JA, Ansani NT. Transdermal nitroglycerin for the prevention of intravenous infusion failure due to phlebitis and extravasation. *Ann Pharmacother* 2000;34:1189-92
22. Rieger A, Philippi W, Spies C, Eyrich K. Safe and normothermic massive transfusions by modification of an infusion warming and pressure device. *J Trauma* 1995;39:686-8
23. Pedersen NT, Hessov I. Venous air embolism through infusion sets. Theoretical considerations, model experiments and prevention. *Acta Anaesthesiol Scand* 1978;22:117-22
24. Singleton RJ, Webb RK, Ludbrook GL, Fox MA. The Australian Incident Monitoring Study. Problems associated with vascular access: an analysis of 2000 incident reports. *Anaesth Intensive Care* 1993;21:664-9
25. Slogoff S, Keats AS, Arlund C. On the safety of radial artery cannulation. *Anesthesiology* 1983;59:42-7
26. Martin C, Saux P, Papazian L, Gouin F. Long-term arterial cannulation in ICU patients using the radial artery or dorsalis pedis artery. *Chest* 2001;119:901-6
27. Zavala NG, Gravlee GP, Benckart DH, Park SB, Gahtan V. Case 3-1996. Unusual cause of hypotension after cardiopulmonary bypass. *J Cardiothorac Vasc Anesth* 1996;10:553-6
28. Illescas FF, Baker ME, McCann R, Cohan RH, Silverman PM, Dunnick NR. CT evaluation of retroperitoneal hemorrhage associated with femoral arteriography. *AJR Am J Roentgenol* 1986;146:1289-92
29. Muralidhar K. Complication of femoral artery pressure monitoring. *J Cardiothorac Vasc Anesth* 1998;12:128-9