

Cardiac tamponade from central venous catheterization

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Central venous catheterization has become a routine procedure in hospitals. It is used for monitoring central venous pressure, as a convenient route for infusion of various fluids and for renal dialysis. The procedure is associated with a number of major complications, one of which, cardiac tamponade, is seldom recognized and thus has a high death rate.

Only one report of cardiac tamponade associated with central venous catheterization has been published in the Canadian literature,¹ albeit reported from the United States, and the sole Canadian report was published abroad.² Recently such a case was the subject of a coroner's inquest in Ontario. I describe this case and review the English-language literature.

Case report

A 22-year-old woman with a 3-year history of Crohn's disease experienced fever and severe pain in the right lower quadrant of her abdomen during the eighth month of pregnancy. Both symptoms persisted until a month after delivery, although the pain subsided with conservative treatment. A peritoneal abscess was suspected, and laparotomy with evacuation and drainage of the abscess was carried out. After surgery a polyurethane central venous catheter (Deseret Medical, Inc., Sandy, Utah) was inserted via the right subclavian vein for alimentation. A chest x-ray film showed the catheter to be in the right atrium. On the third day after surgery the patient complained of chest pain and became dyspneic, cyanotic and hypotensive. Pulmonary embolism was suspected, and she was given strep-

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Presented by Dr. Karnauchow at the May 13, 1986 meeting of the Society of Northern Ontario Pathologists, Laurentian Hospital, Sudbury, and by Dr. Alex Steele at the National Defence Medical Centre, Ottawa, June 1986

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tokinase. However, her condition rapidly deteriorated, and resuscitation efforts failed.

At the time of autopsy it was not known that the patient had been receiving hyperalimentation, and the presence of 500 ml of milky fluid in the pericardium was interpreted as idiopathic chylopericardium. Also, the catheter was cut twice, once during evisceration and once during dissection of the heart, and its distal part was found lying free in the right ventricle.

Discussion

A search of the English-language literature identified 36 papers describing 49 cases of cardiac tamponade associated with central venous catheterization, 34 of them fatal, published between 1968 and 1984.¹⁻³⁶ The incidence rate, calculated from four small series,^{10,11,23,24} ranged from 0.25% to 1.4%. Most hospitals experienced only single fatal cases, but some reported two or three.^{4,6,7,25,27,30,31,33} Although Defalque and Campbell³⁷ suggested that the incidence may be greater than perceived (they knew of 11 unreported cases), the complication must be rare. In the two community hospitals in North Bay, Ont., the number of central venous catheterizations performed annually has risen during the last 2 years to about 250, and the present case was the first occurrence of this complication.

The signs and symptoms of cardiac tamponade appeared a few minutes¹ to 5 months³⁴ after insertion of the catheter. In 36% of the patients they developed in the first 24 hours and in 82% during the first week. They included pain or discomfort in the chest or epigastrium, nausea, dyspnea, tachycardia, engorgement of neck veins, pulsus paradoxus, hypotension, low-voltage electrocardiography tracings and enlargement of the area of cardiac dullness.

The antemortem diagnosis was reported in 23 of the 34 fatal cases: cardiac arrest (in 14 cases), pulmonary embolism (in 8) and cardiac tamponade (in 1). The diagnoses in the 15 nonfatal cases were cardiac tamponade (in 9 cases), pulmonary embolism (in 2), hydrothorax (in 2) and cardiac arrest (in

1); in 1 case the diagnosis was not reported. The rate of misdiagnosis was 73%, which was similar to the death rate (69%). It seems that misdiagnosis was the most important factor in fatal cases.

The misdiagnosis was corrected during resuscitation efforts with pericardiocentesis in five fatal^{5,7,12,30} and three nonfatal cases^{25,31,32} and during attempts to insert external pacemaker leads in one fatal² and one nonfatal case.²² In two fatal^{4,13} and three nonfatal cases^{26,31} the correct diagnosis was made at thoracotomy. In 25 cases the correct diagnosis was made only during postmortem examination, and in the present case even the initial postmortem diagnosis was wrong.

An autopsy was performed in 31 cases. No autopsy was performed in three cases because the diagnosis was made during resuscitation (in two cases^{4,13}) or by postmortem injection of radiopaque fluid through the catheter (in one¹²).

The site of perforation was not reported in 5 fatal and 11 nonfatal cases. Cardiac perforation was not found during autopsy in the present case and in four cases described in the literature,^{6,14,18,19} in one case not even on repeat examination.¹⁴ Most of the perforations occurred in the right atrium. All of the perforations of the right ventricle were fatal. In one fatal case the catheter curled up in the right ventricle and perforated the interventricular septum, left ventricle and the right circumflex coronary vein.²¹ The superior vena cava was perforated in two cases,^{1,27} and the right atrium was perforated at its junction with the superior vena cava in two cases.^{29,33} Hemorrhage into the cardiac wall was infrequent, as was myocardial necrosis.

Although radiologic localization of catheters is an important measure, it is not a guarantee against a mishap. Information about the chest x-ray film was given in 22 cases, but in 2 the catheter was obscured by a surgical instrument³² or the infusate shadow.¹⁵ The right ventricle can be perforated not only by a catheter in the right atrium³⁴ but also by a catheter that has slid down from the innominate vein.³⁰ In one nonfatal case the catheter was visualized in the innominate vein, but the perforation site was not discovered.²⁷ Similarly, a catheter in the superior vena cava can perforate the right atrium.^{31,33} Defalque¹ and Sheep and Guiney²⁷ reported perforation of the superior vena cava itself, and Krog and colleagues cited a case of perforation of the superior vena cava reported in the Scandinavian literature.³⁸ Hunt and associates³⁵ presented radiologic evidence of perforation of the pulmonary artery by a catheter believed to have been in a persistent left superior vena cava. Furthermore, perforation of the superior vena cava was reported to result in hemothorax³¹ and mediastinal infiltration.³⁹ The latter can also be caused by perforation of the subclavian vein.⁴⁰ Thus, there seems to be little substance to the argument whether the catheter tip should be situated in the superior vena cava³⁷ or the right atrium.⁴¹ The evidence suggests that the catheter can perforate not only the cardiac chambers but also any vein it

dwells in, including the superior vena cava. While experience with soft catheters is limited, four cases of cardiac perforation by such catheters have already been reported,^{23,33,34,36} two of them fatal.^{34,36}

The site of insertion was reported in 47 cases. Among the fatal cases, an arm vein had been used in 19 and the jugular vein in 6. Krog and coworkers³⁰ showed that in adults a catheter inserted via an arm vein can be moved up to 7 cm by raising or abducting the arm. The movement was reduced to 2 cm when the catheter was inserted via the jugular vein. In infants a catheter inserted via the jugular vein was found to move up to 3 cm.¹⁵

The amount of pericardial fluid causing cardiac tamponade varied from a surprising 180 ml² to 1000 ml⁴ in adults and from 8 ml²⁵ to 150 ml¹⁵ in infants. In 41% of cases the fluid was pure infusate, and in 22% it was either bloody or pure blood; in the remaining 37% the type of fluid was not stated.

Eight of the surviving patients were treated by pericardiocentesis^{6,19,23,25,27,32,36} and two by mere withdrawal of the catheter.^{23,24} In one patient a pericardial "window" was created.³³ Two patients underwent thoracotomy and evacuation of the infusate,^{26,31} and in two the perforation was repaired.^{9,31} Repair of the myocardial defect, however, is not always necessary, since serious bleeding is reported to occur in only 21% of perforations.⁴²

Cardiac tamponade cannot always be prevented, but certain measures can decrease its incidence rate and, more important, the associated death rate. A pericardiocentesis kit, including a large syringe, should be kept near the patient. Soft Silastic catheters are preferable, and the catheter should be inserted via the subclavian or jugular vein. If for some compelling reason an arm vein must be used, the arm should be securely immobilized to prevent excessive movement in the elbow and shoulder joints. The catheter tip should not be advanced beyond the right atrium, and its position should be verified as soon as possible on an x-ray film. The patient must be warned to avoid wide and abrupt movements of the neck, shoulder or arm, depending on the site of insertion. The functioning of the system should be frequently checked by lowering the infusate container to ascertain backflow of blood. This may be difficult if the infusate itself is blood.

In the present case the jury suggested, in addition to some of these recommendations, that the coroner ask the Bureau of Radiation and Medical Devices of the Department of National Health and Welfare to make it mandatory for manufacturers of central venous catheters to print a warning on the package concerning the risks associated with use of the catheters. The jury also suggested that the department issue a letter of alert to inform users about the risks.

When a patient with an indwelling central venous catheter complains of chest pain and presents some of the described symptoms and signs, one must assume that he or she has cardiac

tamponade until it is proven otherwise. Time should not be wasted on chest radiography, electrocardiography or any other diagnostic procedure. The infusate container must be immediately lowered to provide both confirmation of the diagnosis and the means to syphon out the infusate. If there is no improvement or the patient's condition is critical, the infusate must be aspirated by a syringe with the catheter or a pericardiocentesis needle or both. Subxiphoid pericardiocentesis is thought to be safer, but the parasternal route is faster. The catheter should be withdrawn after the aspiration. Thoracotomy should be reserved as the last resort or when clotting of blood in the pericardium is suspected. After resuscitation it is advisable to keep the patient in the intensive care unit for observation, as subsequent pericardial effusion may occur.^{6,9,17}

If pericardiocentesis yields no fluid, one should first rule out the possibility of mediastinal infiltration^{7,10,13} or pleural accumulation of infusate,^{13,27} blood³¹ or air.^{8,13,21} Only then should other cardiac problems or pulmonary embolism be considered.

References

- Defalque RJ: Fatal complication of subclavian catheter. *Can Anaesth Soc J* 1971; 18: 681-682
- Dane TEB, King EG: Fatal cardiac tamponade and other mechanical complications of central venous catheters. *Br J Surg* 1975; 62: 6-10
- Friedman BA, Jurgelcit C: Perforation of atrium by polyethylene CV catheter. *JAMA* 1968; 203: 1141-1142
- Barton JJ, Vanecko R, Cross M: Perforations of right atrium and resultant cardiac tamponade. A complication of catheterization to measure central venous pressure. *Obstet Gynecol* 1968; 32: 556-560
- Kline IK, Hoffman WI: Cardiac tamponade from CVP catheter perforation. *JAMA* 1968; 206: 1794-1795
- Thomas CS, Carter JW, Lowder SC: Pericardial tamponade from central venous catheters. *Arch Surg* 1969; 98: 217-218
- Fitts CT, Barnett LT, Webb CN et al: Perforating wound of the heart caused by central venous catheter. *J Trauma* 1970; 10: 764-769
- Pruitt EA, Stein JM, Foley FD et al: Intravenous therapy in burn patients. *Arch Surg* 1970; 100: 399-404
- Brandt RI, Foley WJ, Fink GH et al: Mechanism of perforation of the heart with the production of hydropericardium by a venous catheter and its prevention. *Am J Surg* 1970; 119: 311-316
- Adar R, Mozes M: Fatal complications of central venous catheters. *Br Med J* 1971; 3: 746
- Henzel JH, DeWeese MS: Morbid and mortal complications associated with prolonged central venous cannulation. *Am J Surg* 1971; 121: 600-605
- Homesley HD, Zelenik JS: Hazards of central venous pressure monitoring: pericardial tamponade. *Am J Obstet Gynecol* 1971; 109: 1216-1217
- Borja AR, Masri Z, Shruck I et al: Unusual and lethal complications of infraclavicular subclavian vein catheterization. *Int Surg* 1972; 57: 41-45
- Bone DK, Maddrey WC, Egan J et al: Cardiac tamponade: a fatal complication of central venous catheterization. *Arch Surg* 1973; 106: 868-870
- Fischer GW, Scherz RG: Neck vein catheters and pericardial tamponade. *Pediatrics* 1973; 52: 868-871
- Kuiper DH: Cardiac tamponade and death in a patient receiving total parenteral nutrition. *JAMA* 1974; 230: 877
- Ross S: Contrast-medium tamponade following insertion of a central venous catheter. *Anesthesiology* 1974; 41: 518-519
- Greenall MJ, Blewith RW, McMahon MJ: Cardiac tamponade and central venous catheters. *Br Med J* 1975; 2: 595-597
- Guest J, Leiberman DP: Late complications of catheterisation for intravenous nutrition [C]. *Lancet* 1976; 2: 805
- Inglesias A, Rupilanchas JJ, Maronas JM et al: Perforation of the right ventricle and cardiac tamponade caused by a venous catheter. *Postgrad Med J* 1977; 53: 225-226
- Csanky-Treels JC: Hazards of central venous pressure monitoring. *Anaesthesia* 1978; 33: 172-177
- Criado A, Reig E, Arcas M et al: Accidental diagnosis and resuscitation in a case of cardiac tamponade caused by central intravenous catheter. *Crit Care Med* 1981; 9: 349-350
- Kulkarni PB, Dorand RD, Simmons EM: Pericardial tamponade. Complication of total parenteral nutrition. *J Pediatr Surg* 1981; 16: 735-736
- Jaurrieta-Mas E, Pallares RR, Sitges-Serra A et al: Successful diagnosis and treatment of cardiac perforation due to subclavian catheter during total parenteral nutrition. *JPEN* 1982; 6: 157-159
- Opitz JC, Toyama W: Cardiac tamponade from central venous catheterization: two cases in premature infants with survival. *Pediatrics* 1982; 70: 139-140
- Hansbrough JF, Narrod JA: Cardiac perforation and tamponade from a malpositioned subclavian dialysis catheter. *Nephron* 1982; 32: 363-364
- Sheep RE, Guiney WB: Fatal cardiac tamponade. Occurrence with other complications after left internal jugular vein catheterization. *JAMA* 1982; 248: 1632-1635
- Merrill RH, Raab SO: Dialysis catheter-induced pericardial tamponade. *Arch Intern Med* 1982; 142: 1751-1753
- Edwards H, King TC: Cardiac tamponade from central venous catheters. *Arch Surg* 1982; 117: 965-967
- Krog M, Berggren L, Brodin M et al: Pericardial tamponade caused by central venous catheters. *World J Surg* 1982; 6: 138-143
- Barton BR, Hermann G, Weil R: Cardiothoracic emergencies associated with subclavian hemodialysis catheters. *JAMA* 1983; 250: 2660-2662
- Collier PE, Ryan JJ, Diamond DL: Cardiac tamponade from central venous catheters. Report of a case and review of the English literature. *Angiology* 1984; 35: 595-600
- Maschke SP, Rogove HJ: Cardiac tamponade associated with a multilumen central venous catheter. *Crit Care Med* 1984; 12: 611-613
- Harford JF Jr, Kleinsasser J: Fatal cardiac tamponade in a patient receiving total parenteral nutrition via a Silastic central venous catheter. *JPEN* 1984; 8: 443-446
- Hunt LB, Olshansky B, Hiratzka LF: Cardiac tamponade caused by pulmonary artery perforation after central venous catheterization. *Ibid*: 711-713
- Inomato Y, Tanaka K, Satomura K et al: A case of sudden death in the course of intravenous hyperalimentation. *Nippon Geka Hokan* 1984; 53: 672-676
- Defalque RJ, Campbell C: Cardiac tamponade from central venous catheters. *Anesthesiology* 1979; 50: 249-252
- Gothman B, Wallensten S, Wickbom G: Cited in Krog M, Berggren L, Brodin M et al: Pericardial tamponade caused by central venous catheters. *World J Surg* 1982; 6: 138-143
- Gies UP, Johnson CF, Zajchuk R et al: Extrapericardial (mediastinal) cardiac tamponade. *Arch Surg* 1970; 100: 305-306
- Dosios TJ, MacGovern JJ, Gay TC et al: Cardiac tamponade complicating percutaneous catheterization of subclavian vein. *Surgery* 1975; 78: 261-263
- Bell JA, Bradley PD, Jenkins BS: Malposition of the central venous catheters. *Lancet* 1973; 1: 105-106
- Gorlin R: Perforations and other cardiac complications. *Circulation* 1968; 37: 36-38