CardioVascular and Interventional Radiology

Cardiovasc Intervent Radiol (1999) 22:381–384

Routine Chest Radiographs After Central Line Insertion: Mandatory Postprocedural Evaluation or Unnecessary Waste of Resources?

Brian Lucey, Jose C. Varghese, Philip Haslam, Michael J. Lee

Department of Radiology, Beaumont Hospital and Royal College of Surgeons in Ireland Medical School, Beaumont Road, Dublin 9, Ireland

Abstract

Purpose: To study the cost and impact on patient management of the routine performance of chest radiographs in patients undergoing imaged-guided central venous catheter insertion.

Methods: Six hundred and twenty-one catheters placed in 489 patients over a 42-month period formed the study group. Catheters were placed in the right internal jugular vein (425), left internal jugular vein (133), and subclavian veins (63). At the end of the procedure fluoroscopy was used to assess catheter position and check for complications. A postprocedural chest radiograph was obtained in all patients.

Results: Postprocedural chest fluoroscopy showed no evidence of pneumothorax, hemothorax, or mediastinal hematoma. Inappropriate catheter tip position or catheter kinks were noted with 90 catheters. These problems were all corrected while the patient was on the interventional table. Postprocedural chest radiographs showed no complications but proximal catheter tip migration was noted in six of 621 catheters (1%). These latter six catheters required further manipulation. The total technical and related charges for the postprocedural chest radiographs in this series were estimated at £15,525.

Conclusion: Postprocedural chest radiographs after image-guided central venous catheter insertion are not routinely required. A postprocedural chest radiograph can be performed on a case-by-case basis at the discretion of the interventional radiologist.

Key words: Central venous access—Hemodialysis—Chest radiograph

Correspondence to: M. J. Lee, M.D.

Traditionally, tunneled central venous catheters have been placed without image guidance by surgeons. More recently these catheters have been placed by interventional radiologists in interventional radiology suites [1–3]. Because surgical placement of tunneled central venous catheters is performed without image guidance, a chest radiograph has routinely been performed after each procedure to exclude a pneumothorax, hemothorax, or mediastinal hematoma and to assess the course of the catheter and the position of the catheter tip.

The use of imaging guidance by interventional radiologists [3, 4] has reduced the complications related to catheter insertion [1, 2, 5–13]. This is due to the use of ultrasound to guide puncture of the internal jugular or subclavian vein, which reduces the incidence of pneumothorax, and the use of continuous fluoroscopic guidance to precisely guide catheter tip placement. Although image guidance yields precise procedural information, the postprocedural chest radiograph is often still performed at many institutions including our own, usually at the insistence of the referring physician. We retrospectively studied the impact on patient care of routinely performed postprocedural chest radiographs in patients at our institution who had central venous catheters placed by interventional radiologists.

Material and Methods

The procedural notes and chest radiographs of 489 patients (M : F 220 : 269; mean age 58 years, range 14–88 years) who had 621 tunneled central venous catheters placed were retrospectively reviewed. These catheters were inserted over a 42-month period. Five hundred and fifty-three catheters were inserted for the purpose of long-term hemodialysis and 68 catheters were inserted for chemotherapy administration. The right internal jugular vein was preferentially cannulated and 425 right internal jugular catheters were

placed. In addition, 133 left internal jugular catheters, 42 right subclavian catheters, and 21 left subclavian catheters were placed. The catheters used were Quinton Permcath (18 Fr, 312), Vascath Softcell (13 Fr, 241) and Bard Hickman (9.5 Fr, 68).

All catheters were inserted in the interventional radiology suite. Coagulation status was assessed before the procedure and corrected accordingly. Sedo-analgesia in the form of intravenous midazolam and fentanyl was used for all procedures. Ultrasound was used to localize the vein to be punctured and the puncture site infiltrated with 1% lignocaine. A small incision was made in the skin. The vein was punctured using a 21 gauge micropuncture needle (Cook, Bloomington, IN, USA) under ultrasound guidance. After venipuncture, a 0.018-inch guidewire was passed through the micropuncture needle into the superior vena cava (SVC).

This 0.018-inch guidewire was subsequently exchanged for a 0.035-inch "J" guidewire and the tract dilated with sequential dilators passed under fluoroscopic guidance with final insertion of a peel-away sheath. At this point the subcutaneous tunnel was made by making a second incision 12.5–15 cm inferior to the venipuncture site below the middle third of the clavicle. The skin was infiltrated with local anesthetic and a subcutaneous tunnel formed by blunt dissection. The catheter was attached to the tunneling device and pulled through the tunnel to the venipuncture site. The catheter was passed through the peel-away sheath and placed under fluoroscopic guidance so that the tip lay in the distal SVC or proximal right atrium (ideally the latter position for dialysis). The catheter was secured by suturing it to the skin at the catheter exit site. At the end of each procedure fluoroscopy was used to examine the position of the catheter tip and to check the catheter course for any kinks. Any malpositioned catheters or kinks were repositioned or straightened using guidewires. An erect postprocedural chest radiograph was routinely obtained in all patients and used to check for procedure-related complications, catheter course, and catheter tip position.

Results

A 100% technical success rate was achieved. Fluoroscopy of the thorax at the end of the procedure showed no evidence of pneumothorax, hemothorax, or mediastinal hematoma. Catheter course and position of the catheter tip were also deemed appropriate in 531 catheters. Catheter kinks at the venipuncture site or inappropriate catheter tip position was seen with 90 catheters. Twenty-six catheters showed kinks at the venipuncture site and 64 catheters had been placed too distally. These problems were corrected when recognized at the time of the procedure. Kinks in the catheter invariably occurred at the venipuncture site. These were rectified by finger dissection to enlarge the venipuncture site and by using a guidewire at the venotomy site to straighten out any kinks. If the catheter tip was placed too distally in the right atrium, the catheter was withdrawn until the tip lay in the lower SVC/upper right atrium. No patients were encountered who had the catheter tip sited too proximally.

The postprocedural chest radiograph showed no evidence of pneumothorax, hemothorax, or mediastinal hematoma in any patient. However, proximal migration of the catheter tip was seen in six of 621 catheters (1%). In these six patients the catheter tip had been sited correctly at the time of the procedure but when the patient was placed in the erect position for the chest radiograph there was proximal migration of the catheter tip into the SVC. Catheter tip migration in these patients was due to traction on the subcutaneous portion of the catheter because of large pendulous breasts in four patients and because of obesity in two patients. These six catheters were exchanged for longer catheters.

The technical and related charges for a chest radiograph at our institution were calculated to be £25.00 ($35) per examination, yielding a total cost of £15,525 ($21,735) for all chest radiographs performed in this study.

Discussion

Historically, central venous catheters have been placed by surgeons in the operating room, with complication rates due to puncture failure in 4% of cases and puncture-related complications in up to 10% of cases [14–19]. These complications include catheter malposition, pneumothorax (immediate or delayed), hemothorax, pleural effusion, pulmonary hemorrhage, and mediastinal hematoma. The complication rates associated with central venous catheter placement by interventional radiologists are minimal. Puncture failure does not occur because of precise sonographic localization of the vein [20–22], and fluoroscopic guidance throughout the procedure minimizes procedure-related complications [23]. Pneumothorax has been reported in 0–2.5% of cases [1, 2, 14]. Several series including our own have shown no incidence of hemothorax or mediastinal hematoma, while the incidence of catheter malposition is also as low as 0%.

Despite the low complication rates associated with image-guided central venous catheter placement, conventional wisdom at our institution and many others has decreed that routine chest radiographs are performed after every procedure. Indeed many physicians would not consider commencing hemodialysis without a postprocedural chest radiograph to rule out complications and check the catheter tip position. Despite the switch from surgical to radiologic catheter placement, the postprocedural chest radiograph has remained an integral part of the procedure.

The results of our study show that the postprocedural chest radiograph is unnecessary if the jugular route is chosen for insertion and is probably not needed for the subclavian route. It adds information that would alter patient management in only 1% of patients. In our study there were six patients in whom the postprocedural chest radiograph provided information that altered patient management. These six patients either had large pendulous breasts or were obese, and proximal catheter tip migration is prone to occur in these patient types. Craft et al. [24] also found similar problems in their series of 153 Hickman catheters inserted in 120 patients. Catheter migration occurred in four of 18 obese patients versus five of 102 nonobese patients. Early in our

experience with image-guided catheter insertion we encountered problems with catheter tip migration in these individuals. We now use longer catheters in these patients and a more medially placed tunnel on the anterior chest wall. These patients are usually readily identifiable and in our practice constitute a small percentage of the total number of patients referred for central venous catheters. This small population can be selected beforehand to undergo erect screening after catheter placement or an erect postprocedural chest radiograph.

It is very difficult to determine accurately the cost of a single examination such as a chest radiograph in a large institution. The easiest cost to define is the value of the raw material such as film and developer. Radiographer and radiologist fees can be estimated on the basis of the reimbursement schedule of national insurance bodies. From a study of the above factors we approximated the cost of a chest radiograph at our institution to be £25 ($35). Therefore, a cost saving of approximately £15,525 could have been realized during the study period by not performing routine postprocedural chest radiographs.

As health care costs spiral it is becoming increasingly important to justify all expenses incurred during the course of patient management. Every effort is made to reduce unnecessary expenditure. Certainly, the shift from operating rooms to interventional radiology suites for central venous catheter placement can be expected to decrease the cost of catheter placement. We have shown additionally that the avoidance of postprocedural chest radiographs can decrease the cost associated with these procedures even further. Indeed, Chang et al. [25] reported similar findings in their recent study of 572 catheter insertions. No immediate complications were encountered on the routine postprocedural chest radiograph. They did, however, have two delayed pneumothoraces, both of which required chest tube drainage. We did not have any delayed pneumothoraces in our group of 621 catheter placements.

The access routes used in our patient group were similar to those used by Chang et al. [25], except that we used more subclavian access routes (63 vs 37). Interestingly, the pneumothorax rate for the subclavian route is thought to be higher than that associated with the internal jugular route [1, 9]. Theoretically, the reason for the increased pneumothorax rate is the proximity of the subclavian vein to the apex of the lung. We feel that the absence of pneumothorax in our 63 patients in whom we placed subclavian catheters reflects our policy of puncturing the subclavian vein lateral to the first rib (anatomically we are in fact puncturing the axillary vein). Careful fluoroscopy to locate the lateral border of the first rib followed by sonographic localization of the axillary and subclavian veins and sonographic guidance of the micropuncture needle into the axillary vein helps minimize the rate of pneumothorax.

In summary, imaging guidance not only helps to decrease the complication rate associated with central venous catheter placement but also obviates the need for a routine postprocedural chest radiograph when the jugular route is chosen and probably also the subclavian route. In our practice we no longer routinely perform postprocedural chest radiographs for either route. Chest radiographs are performed at the discretion of the interventional radiologist performing the procedure. Therefore, only if there is difficulty gaining venous access or if the patient has a body habitus that may cause proximal migration of the catheter tip will a postprocedural chest radiograph be obtained.

References

1. Lund GB, Trerotola SO, Scheel PF Jr, Savader SJ, Mitchell SE, Venbrux AC, Osterman FA Jr (1996) Outcome of tunneled hemodialysis catheters placed by radiologists. Radiology 198:467–472
2. Trerotola SO, Johnson MS, Harris VJ, Shah H, Ambrosius WT, McKusky MA, Kraus MA (1997) Outcome of tunneled hemodialysis catheters placed via the right internal jugular vein by interventional radiologists. Radiology 203:489–495
3. Denny D (1993) Placement and management of long-term central venous access catheters and ports. AJR 161:385–393
4. Teichgraber UKM, Benter T, Gebel M, Manns MP (1997) A sonographically guided technique for central venous access. AJR 169:731–733
5. Millner MR, Kerns SR, Hawkins IF Jr, Sabatelli FW, Ross EA (1995) Tesio twin dialysis catheter system: A new catheter for hemodialysis. AJR 164:1519–1520
6. Robertson LJ, Mauro MA, Jaques PF (1989) Radiologic placement of Hickman catheters. Radiology 170:1007–1009
7. McDowell DE, Moss AH, Vasilakis C, Bell R, Pillai L (1993) Percutaneously placed dual lumen silicone catheters for long-term hemodialysis. Am Surg 59:569–573
8. Bour ES, Weaver AS, Yang HC, Gifford RRM (1990) Experience with the double lumen silastic catheter for hemoaccess. Surg Gynecol Obstet 171:33–39
9. Herbst CA Jr (1978) Indications, management, and complications of percutaneous subclavian catheters: An audit. Arch Surg 113:1421–1425
10. Koski EM, Suhonen M, Mattila MA (1992) Ultrasound-facilitated central venous cannulation. Crit Care Med 20:424–426
11. McIntyre AS, Levison RA, Wood S, Phillips RK, Lennard-Jones JE (1992) Duplex Doppler ultrasound identifies veins suitable for insertion of central feeding catheters. J Parenter Enteral Nutr 16:264–267
12. Pozzoli M, Galli F, Capomolla S, Forni G, Cobelli F, Tavazzi L (1994) Utilita delle tecniche ultrasonographiche nell'incannulazione della vena gingulaure internal in pazienti cos insufficienza cardia cronia. G Ital Cardiol 24:1211–1221
13. Yonei A, Nonoune T, Sari A (1986) Real-time ultrasonic guidance for percutaneous puncture of the internal jugular vein. Anaesthesiology 64:830–831
14. Mansfield PF, Hohn DC, Fornage BD, Gregurich MA, Ota DM (1994) Complications and failures of subclavian-vein catheterization. N Engl J Med 331:1735–1738
15. Morton JE, Jan-Mohamed RMI, Barker HF, Milligan DW (1991) Percutaneous insertion of subclavian Hickman catheters. Bone Marrow Transplant 7:39–41
16. Barrios CH, Zuke JE, Blaes B, Hirsch JD, Lyss AP (1992) Evaluation of an implantable venous access system in a general oncology population. Oncology 49:474–478
17. Brothers TE, Von Moll LK, Niederhuber JE, Roberts JA, Walker-Andrews S, Ensminger WD (1988) Experience with subcutaneous infusion ports in three hundred patients. Surg Gynecol Obstet 166:295–301
18. Carde P, Cosset-Delaigue MF, LaPlanche A, Chareau I (1989) Classical external indwelling central venous catheter versus totally implanted venous access systems for chemotherapy administration: A randomized

trial in 100 patients with solid tumors. Eur J Cancer Clin Oncol 25:939–944
19. Slater H, Goldfarb IW, Jacob HE, Hill JB, Srodes CH (1985) Experience with long-term outpatient venous access utilizing percutaneously placed silicone elastomer catheters. Cancer 56:2074–2077
20. Gallieni M, Cozzolino M (1995) Uncomplicated central vein catheterization of high risk patients with real time ultrasound guidance. Int J Artif Organs 18:117–121
21. Lameris JS, Post PJ, Zonderland HM, Gerritsen PG, Kappers-Klunne MC, Schutte HE (1990) Percutaneous placement of Hickman catheters: Comparison of sonographically guided and blind techniques. AJR 155: 1097–1099
22. Skolnick ML (1994) The role of sonography in the placement and management of jugular and subclavian central venous catheters. AJR 163:291–295
23. Burnett AF, Lossef SV, Barth KH, Grendys EC, Johnson JC, Barter JF, Barnes WA (1994) Insertion of Groshong central venous catheters utilizing fluoroscopic techniques. Gynecol Oncol 52:69–73
24. Craft PS, May J, Dorigo A, Hoy C, Plant A (1996) Hickman catheters: Left-sided insertion, male gender, and obesity are associated with an increased risk of complications. Aus NZ J Med 26:33–39
25. Chang TC, Funaki B, Szymski GX (1998) Are routine chest radiographs necessary after image-guided placement of internal jugular central venous access devices? AJR 170:335–337