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Repair of Superior Vena Caval Perforation during Pacemaker Placement with Video-Assisted Limited Thoracotomy

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ABSTRACT

We report a case of a patient who sustained superior vena cava perforation just proximal to the innominate-caval confluence during pacemaker implantation. Because this complication was recognized early and the dilator was left in place, the patient remained hemodynamically stable and successfully underwent a videoscopically assisted repair of the superior vena caval perforation through a limited thoracotomy incision.

INTRODUCTION

Central venous access via the jugular or subclavian approach has been used with increasing frequency for a variety of procedures, from central venous line placement to the implantation of pacemaker-defibrillator systems. Although generally effective and safe, this approach has a small but real risk of serious complications, including pneumothorax, hemothorax, vascular injury, and cardiac tamponade [Collier 1995, Robinson 1995, Johnson 1998, Baumgartner 1999]. Factors that increase the risk of untoward events include multiple attempts, a failed attempt at the initial site, and catheter misplacement [Johnson 1998]. One uncommon but often fatal complication of central venous access is great vessel perforation, which may occur in up to 1% of central venous line placements [Robinson 1995]. In particular, major venous perforation tends to occur when there is guidewire kinking during the advancement of a vessel dilator and when the right subclavian vein is the site of puncture. When one sustains an injury to the innominate-caval confluence, which is more commonly catheter related, median sternotomy has been advocated to expose this region for surgical repair [Robinson 1995].

We report a case of a patient who sustained a perforation of the superior vena cava just proximal to the innominate-caval confluence during pacemaker implantation. Because this complication was recognized early and the dilator was left in place, the patient remained hemodynamically stable during transport to the operating room. He successfully underwent videoscopically assisted repair of the superior vena caval perforation through a limited thoracotomy incision.

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CASE REPORT

A 76-year-old man with coronary artery disease, hypertension, and a history of abdominal aortic aneurysm repair was evaluated in the emergency room for dizziness of several months' duration. The electrocardiogram revealed the patient to have sinus bradycardia with a heart rate intermittently in the range of 30 to 40 beats per minute with second-degree atrioventricular block and right bundle branch block. The patient's electrolyte levels and hematocrit were normal. The patient was admitted and underwent pacemaker placement in the catheterization laboratory. The left subclavian vein was accessed via an infraclavicular puncture, and two guidewires (intended for a dual-chamber pacemaker placement) were placed into the central venous system. The location of the guidewires in the central venous system was confirmed with fluoroscopy. A pacemaker pocket was created above the pectoralis fascia. The placement of a dilator and sheath over one guidewire was followed by placement of a right ventricular lead. After sheath removal, the lead was evaluated and secured to the underlying fascia. Placement of the atrial lead was then attempted. A dilator with sheath was placed over the second guidewire. The dilator and guidewire were removed, leaving the sheath in place. The atrial lead could not be adequately advanced because of the extrinsic compression of the sheath, and the lead was removed. The guidewire and dilator were replaced in the sheath and advanced. Passage of the dilator over the guidewire was met with some resistance. Fluoroscopic examination demonstrated a different course for the guidewire than for the initial guidewire. At this point, it was suspected that the tip of the dilator had perforated the central venous system and that the guidewire was in the right pleural space. Because of the concern of vascular perforation, the dilator and sheath were left in place, the wire was removed, and contrast medium was injected into the dilator. After extravasation of the contrast medium into the pleural space was visualized, thoracic surgical consultation was obtained, and it was elected to proceed with surgical repair. During this period, the patient was hemodynamically unchanged with a blood pressure of 180/90 mm Hg. A VVIR pacemaker was connected to the previously

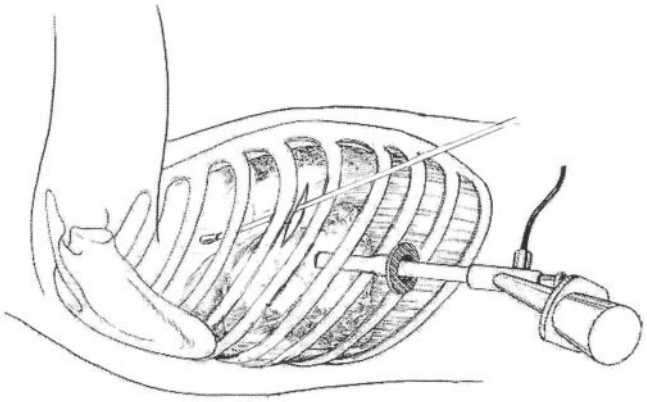

Figure 1. The thoracoscopic port was placed through the seventh interspace in the midaxillary line, and a limited thoracotomy incision was made at the fifth interspace.

placed ventricular lead and placed in the pacemaker pocket. The left infraclavicular wound was partially closed with the dilator and sheath left in place and covered with a sterile plastic occlusive dressing. The patient was transported to the operating room. After induction of general anesthesia and placement of a double-lumen endotracheal tube, the patient was placed in the left lateral decubitus position, leaving access to the infraclavicular region for later dilator and sheath removal. The patient was prepared and draped. The right lung was deflated, and a thoracoscopic port was placed through the seventh interspace in the midaxillary line (Figure 1). A video thoracoscope was placed via the port into the right thoracic cavity, and the dilator with sheath through the superior vena cava was identified (Figure 2). Because of the anticipated difficulty in terms of thoracoscopic repair and suture tying, it was elected to proceed with a 4-cm limited lateral thoracotomy at the fifth intercostal space. Port-access instruments were used to place a 4-0 polypropylene (Prolene) purse-string suture into the wall of the superior vena cava around the dilator. During the placement of the purse-string suture, it was occasionally necessary to place the video thoracoscope into the thoracotomy incision to better visualize the injury. The dilator and sheath were retracted, and the suture was secured with a knot-cinching device (Figure 3). The area was hemostatic, the thoracoscope was removed, and a chest tube was placed through the site of the thoracoscopic port. The incision was closed in layers. The left infraclavicular region was reprepared and draped, and the wound was closed in layers. The patient did well in the postoperative period. He was discharged at 1 week postoperatively, and the pacemaker and thoracotomy wounds healed uneventfully. The patient died 2 years after this event from complications associated with lung cancer.

DISCUSSION

The most suitable route for electrode placement in patients undergoing pacemaker placement is via subclavian vein puncture, which is successful in upwards of 97% of cases [Kirk 1987]. This approach for central venous access, however, is associated with a nearly 1% incidence of hemothorax and vascular injury, which may result in severe bleeding, infusion of fluids into extravascular sites, and death [Kirk 1987, Robinson 1995]. In a review of 10 cases, Robinson et al reported that most vascular perforations occurred when the right subclavian vein approach was attempted and were often related to guidewire kinking during the advancement of a dilator [Robinson 1995]. In these investigators' experience, 4 of the 10 patients died of immediate or subsequent complications from the perforation. Baumgartner et al found that injuries to the innominate-caval confluence are usually catheter-related and that injuries to the subclavian-jugular venous confluence frequently result from penetrating trauma [Baumgartner 1999]. Surgical exposure to the innominate-caval confluence typically requires median ster-

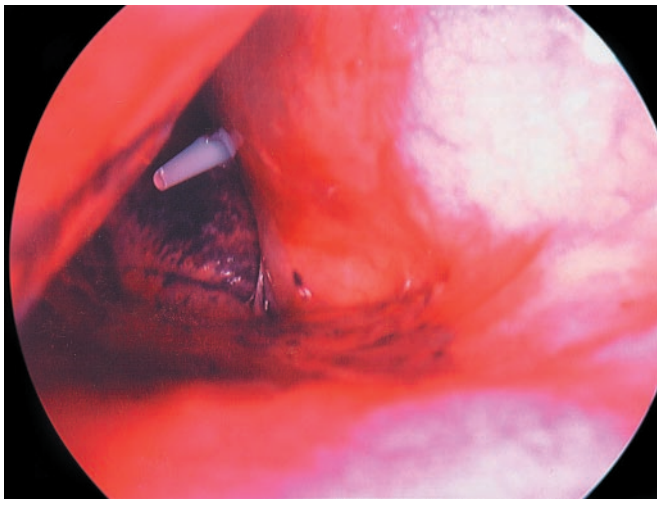

Figure 2. Intraoperative photograph obtained with video-assisted thoracoscopy demonstrating the dilator and sheath penetrating the superior vena cava into the right pleural space. The right lung is deflated.

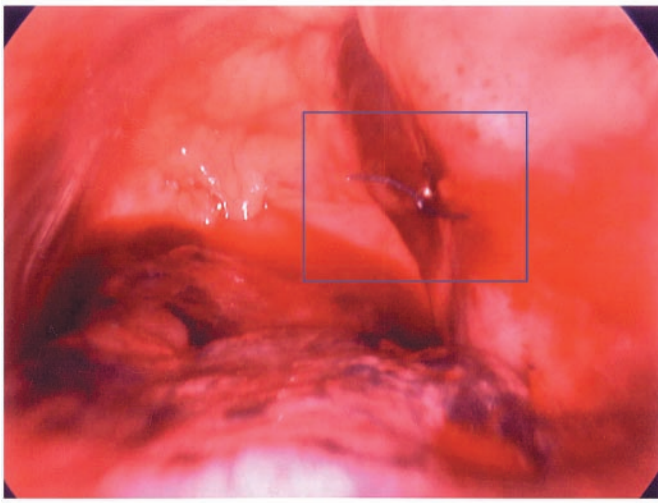

Figure 3. Intraoperative photograph obtained with video-assisted thoracoscopy demonstrating the completed suture repair of the superior vena caval perforation.

notomy. What has been emphasized in these previous reports is that physicians performing this procedure have formal training in central venous catheterization and be aware of the procedure's complications, particularly vascular injury, and the presumed cause, diagnosis, and treatment [Collier 1995, Robinson 1995].

Because of the lethality of major vascular injuries associated with central venous access for line placement or pacemaker implantation, this case and previous reports illustrate the importance of an awareness of vascular complications and an early recognition of the problem. With the subclavian approach, after an uneventful central venous access using a needle with blood return and an easy passage of the guidewire, the introduction of the dilator and sheath over a guidewire should occur with little resistance once the dilator tip is beyond the level of the clavicle. One should maintain a firm hold on the guidewire during the advancement of the dilator and sheath [Robinson 1995]. It is often not necessary to pass the dilator to its full extent in most patients, because the area that requires dilation is only the soft tissue in the subclavicular region; the sheath can then be advanced over the dilator once both the dilator and sheath are intravascular. If there is a difficulty with the passage of the dilator and sheath at the level of the clavicle, the initial entry site may be too close to the clavicle with the involvement of the periosteal tissue. In this situation, one may need to reaccess the subclavian vein slightly away from the clavicle to be able to pass the dilator and sheath combination and to avoid compression of the sheath once the dilator is removed. When there is resistance beyond the level of the clavicle during dilator and sheath introduction or if the dilator moves the wire forward, one should consider the possibility of venous injury [Robinson 1995]. If the procedure is performed in the operating room or in the catheterization laboratory, fluoroscopy can be used to assess whether the wire is kinked at the tip of the dilator or if the tip of the wire is in an unusual location, suggesting that the tip of the dilator may be extravascular. If the guidewire is removed in this situation before fluoroscopic evaluation is obtained, it is imperative to aspirate from the lumen of the dilator, particularly if there is difficulty removing the guidewire or if there is kinking of the guidewire. If there is no blood return from the lumen, one should consider the possibility of central venous injury. At this point, it is important not to remove the dilator and sheath, and intravenous contrast medium should be injected through the lumen of the dilator. If the contrast medium is extravascular (eg, in the mediastinum or pleural space), the dilator should be left in place and capped, and the patient should be evaluated for surgical exploration and repair.

If a limited surgical approach, such as video-assisted limited thoracotomy or thoracoscopy, is used, it is imperative that the bleeding be controlled, as is the case when the dilator is left in place. Although video-assisted thoracoscopy has been used to repair penetrating traumatic injuries to the chest [von Oppell 2000], its use in central venous access injuries has not been well described. The main difficulty with this approach for superior vena caval injury is achieving adequate exposure to repair the vessel. With the advent of newer thoracoscopic instrumentation, such as that used in port-access cardiac surgery, such a repair is possible. Notwithstanding, it may be necessary to enlarge the incision somewhat to permit additional maneuvering during the suture repair. In summary, physicians performing central venous catheterization must be aware of its complications, particularly vascular injury and its presumed cause, and be prompt in diagnosis and treatment. If the injury is suspected to be in the superior vena cava and the patient is hemodynamically stable, one can consider videoscopically assisted surgery through a limited thoracotomy or thoracoscopic surgery.

REFERENCES

Baumgartner FJ, Rayhanabad J, Bongard FS, Milliken JC, Donayre C, Klein SR. 1999. Central venous injuries of the subclavian-jugular and innominate-caval confluences. Tex Heart Inst J 26:177-81.

Collier PE, Goodman GB. 1995. Cardiac tamponade caused by central venous catheter perforation of the heart: a preventable complication. J Am Coll Surg 181:459-63.

Johnson EM, Saltzman DA, Suh G, Dahms RA, Leonard AS. 1998. Complications and risks of central venous catheter placement in children. Surgery 124:911-6.

Kirk AJ, Turner MA. 1987. Surgical aspects of permanent cardiac pacemakers. Life Support Syst 5:223-31.

Robinson JF, Robinson WA, Cohn A, Garg K, Armstrong JD 2nd. 1995. Perforation of the great vessels during central venous line placement. Arch Intern Med 155:1225-8.

von Oppell UO, Bautz P, DeGroot M. 2000. Penetrating thoracic injuries: what we have learnt. Thorac Cardiovasc Surg 48:55-61.