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Image-guided placement of long-term central venous catheters reduces complications and cost

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Abstract

BACKGROUND: The goals of this study were to evaluate the complication rate for intraoperative placement of a long-term central venous catheter (CVC) using intraoperative ultrasound (US) and fluoroscopy and to examine the feasibility for eliminating routine postprocedure chest X-ray.

METHODS: Retrospective data pertaining to operative insertion of long-term CVC were collected and the rate of procedural complications was determined.

RESULTS: From January 2008 to August 2013, 351 CVCs were placed via the internal jugular vein using US. Of these, 93% had a single, successful internal jugular vein insertion. The complications included 4 arterial sticks (1.14%). Starting in October 2012, postprocedure chest radiography (CXR) was eliminated in 170 cases, with no complications. A total of $29,750 in charges were deferred by CXR elimination.

CONCLUSIONS: This review supports the use of US for CVC placement with fluoroscopy in reducing the rate of procedural complications. Additionally, with fluoroscopic imaging, postprocedural CXR can be eliminated with associated healthcare savings.

More than 15 million central venous access cases are performed annually in the United States with associated rates of complications ranging from 5% to 19%.[1,2] When ultrasound (US) guidance is used for central venous catheter (CVC) placement in the internal jugular vein (IJV), mechanical complications have been reported to be less than 5%.[3–8] The most common complications that can occur include hematoma, arterial puncture, arteriovenous fistula, nerve injury, and pneumothorax.[9] Incurring any of these complications can result in the need for additional invasive procedures and affect the overall morbidity.

Although most CVCs are temporary in nature and placed in intensive care or emergency room settings, there are other CVC types used for long-term care, such as those needed for chemotherapy or nutritional support. These CVCs are planned procedures and often take place in the operating room with sedation to implant the device. Numerous issues, such as patient anatomy, comorbidities, primary disease process, long-term durability of the catheter, and indications for placement, must be considered.

The modern literature now contains numerous guidelines based on research and safety data that recommends US guidance in the placement of CVC and as such was the primary consideration for undertaking a review of our center data.

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The purpose of this study was to review the use of US for guidance by general surgeons when placing a CVC in patients for long-term venous access at our institution. The rate of complications associated with placement was collected and the associated use of fluoroscopy when compared with routine postprocedural radiography was evaluated.

Patients and Methods

Between January 2008 and August 2013, 351 patients underwent surgical placement of a long-term use CVC employing US and fluoroscopy. All procedures were performed by 2 surgeons at a single, university-based center. The majority of CVC placements were performed in an outpatient setting. The data extracted included patient demographics, procedure-related details, and outcome details, as indicated below.

The operative technique for placement of the CVC was similar between surgeons. The CVCs placed included PowerPort, Hickman, or HemoSplit (Bard Access Systems, Salt Lake City, UT). When appropriate, the anatomic site for CVC placement took into account patient diagnosis, such as previous or planned surgical treatment or radiation therapy. Patients were given either a general anesthetic or monitored anesthesia care sedation. US guidance using either the SiteRite (Bard Access Systems) or the SonoSite (FujiFilm, Bothell, WA) was used to obtain IJV access. Dynamic imaging US technique was used by both surgeon operators to visualize needle insertion into the vascular structure. Intraoperative fluoroscopy was used in all cases to confirm correct anatomic catheter placement.

Patient demographics and procedure-related details included the following: patient age, surgical time, number of insertion site attempts, final site of line placement, and early placement-related complications. The time for surgeon placement of CVC was collected in only those cases in which the CVC was the only procedure performed. Procedure-related complications that were analyzed included the following: carotid artery punctures, pneumothoraces, hemothoraces, significant bleeding, and hematoma formation.

Within the overall study period (from October 2012 to August 2013), a quality improvement project to analyze cost effectiveness of utilizing only intraoperative fluoroscopy with the elimination of immediate postoperative chest radiography (CXR) was implemented.

Relevant data were collected in Microsoft Excel 2013 and analyses were performed employing IBM SPSS Statistics (Chicago, IL, version 21). Data are reported as mean ± standard deviation and median with interquartile range (25th and 75th percentiles). Nonparametric testing using the Mann–Whitney *U* test was reported for nonnormally distributed variables. The study received prior approval by the institutional review board, with a waiver of consent granted.

Results

Between January 2008 and August 2013, a total of 351 patients underwent US-guided CVC placement with the IJV as the initial attempted site. Table 1 lists descriptive information of the study population. Patient demographics included a mean age of 56.3 ± 14.8 (range 19 to 94) years, body mass index 28.8 ± 7.9 (range 16 to 57), and sex was 58.4% female. The preoperative American Society of Anesthesiologist score for 55.8% of the patients was greater than or equal to 3. Monitored anesthesia care with intravenous sedation was used in 85.5% of the cases, with the remaining 14% receiving a general anesthetic. The majority of cases (94.3%) had a PowerPort placed, with 4.6% having a Hickman catheter and the remaining 1.1% having a dialysis catheter placed. The median time for the surgeon to place the CVC was 33 minutes, with an interquartile range of 16 minutes ($n = 326$).

Of the 351 cases, 93% (327) had a single, successful insertion via the IJV on the anatomic side originally attempted. The left IJV was the most common site employed with 51.3% of cases (180 of 351). There were 16 cases (4.6%) in which the initial IJV insertion was unsuccessful, requiring the subclavian vein site to be employed. Of these 16 cases, 13 were placed in the left subclavian after unsuccessful attempt made in the left IJV.

Of the entire group, there were no hemothoraces or pneumothoraces (either immediate or delayed), or hematoma, or significant bleeding events as a result of line placement. A total of 4 carotid artery punctures occurred, requiring only pressure to the site as treatment. Two of these were via the right IJV, with both successfully placed in the same anatomic site. This resulted in overall procedural complication rate of 1.14% when both US and intraoperative fluoroscopy was employed.

There were a total of 24 cases (6.8%) that required an additional attempted insertion site after failure of the initial IJV insertion. In 19 of these cases (79.1%), the IJV was cannulated but the wire could not be successfully passed into the central circulation. In 2 cases (8.3%), there was conversion to a second site because of arterial puncture. In

Table 1 Descriptive demographic data

Demographic data	
Age (years)	
Range	19.2–93.6
Mean ± standard deviation	56.3 ± 14.8
Median (25th, 75th percentile)	58.4 (47, 67.2)
Sex	
Female	58.4%
Male	41.6%
Body mass index (kg/m^2)	
Range	15.9–57
Mean ± standard deviation	28.8 ± 7.9
Median (25th, 75th percentile)	27.4 (23, 33.4)