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Clinically Silent Venous Thrombosis Following Internal and External Jugular Central Venous Cannulation in Pediatric Cardiac Patients

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The internal and external jugular veins routinely are cannulated for central venous access in both adult[1] and pediatric[2,3] patients. One complication of flow-directed catheter insertion via the internal jugular route in adults is clinically silent venous thrombosis.[4] This study evaluated prospectively the incidence of silent venous thrombosis in pediatric patients with central venous catheters inserted through the internal or external jugular veins.

METHODS AND MATERIALS

Institutional review board approval and individual parental consent was obtained prior to entering children into the study. Twenty-five consecutive patients undergoing open-heart operations between the ages of 2 and

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TABLE 1. Patient Data for External and Internal Jugular Catheter Groups with Means and ±SEM

	Age (yr)	Sex	Time on Bypass (min)	X-Clamp Time (min)	Low Temp on Bypass (°C)	Inotropes in ICU (%)	Cardiac Indices (l/m²/min)	Time in ICU (days)	Incidence of thrombosis (%)
External jugular group (N = 15)	6.2 ± 0.90	27% F	49.2 ± 6.6	34.2 ± 5.7	26.0 ± 1.4	27%	3.53 ± 0.42	4.4 ± 0.83	27%
Internal jugular group (N = 10)	6.2 ± 1.04	30% F	68.5 ± 11.6	51.8 ± 9.1	22.2 ± 1.2	33%	4.00 ± 0.49	3.1 ± 0.28	10%

13 years were studied. On the morning of the operation following induction of anesthesia and tracheal intubation, a catheter was inserted into either the internal (N = 10) or external (N = 15) jugular vein. The site of central venous cannulation was left to the discretion of the attending anesthesiologist, and previously described techniques were used for insertion of the internal jugular ("high" approach)[1] and external jugular[5] cannulae. Generally, for children weighing less than 12 kg, a 20-gauge, 8-cm-long Teflon® nonheparin-bonded catheter was inserted, while an 18-gauge, 12-cm-long Teflon® nonheparin-bonded catheter was used for children weighing more than 12 kg. A chest roentgenogram following surgery was used to establish the location of the catheter tip.

In all children, hypothermic cardiopulmonary bypass was established using a membrane oxygenator with blood flows greater than 2.4 $l/M^2/min$ after anticoagulation with a minimum of 400 U/kg of beef lung heparin. Cardiac repair was performed using either aortic cross-clamping with cardioplegic arrest or induced cardiac fibrillation. Circulatory arrest techniques were not used in any of the children.

For all 25 children, removal of the central venous catheter was performed under radiographic control upon discharge from the intensive care unit. Depending on the child's weight, up to 35 ml of MD-60 contrast material was injected through the catheter over 10 s during withdrawal. Roentgenograms were obtained at 2-s intervals to assess dye washout. The presence of thrombus within the venous system was diagnosed by a persistence of irregular radiolucency within the vascular lumen.

Statistical comparisons between patients with internal and external jugular cannulation were carried out using the unpaired t test with significance assumed at the $P < 0.05$ level.

RESULTS

Ten of the 25 patients had central venous cannulation via the internal jugular vein. Nine of the internal jugular catheters were inserted on the right side and one on the left. Fifteen patients had central venous cannulation via the external jugular vein. The right external jugular vein was used in 10 of these children, and the left in the other five. Comparisons of patients with internal and external jugular cannulation showed no significant difference in age, sex, height, weight, size of catheter, extracorporeal parameters, length of ICU stay, use of postoperative inotropes, or postoperative cardiac indices (table 1).

The incidence of silent venous thrombosis in patients with internal jugular venous cannulation was 10% (one out of ten). The only patient with thrombosis in this group had cannulation performed through the left internal jugular vein, and the thrombus was located in the proximal innominate.

The incidence of silent venous thrombosis in patients with external jugular venous cannulation was 27% (four out of 15), with the thrombus occurring in the external jugular vein (2), in the right atrium (1), and at the subclavian jugular junction (1). However, in two of the patients with thrombosis the catheter tip was located outside the thoracic cavity due to curving of the catheter back up into the ipsilateral neck via another vessel (fig. 1). All the other patients had placement of the catheter tip within the thoracic cavity. If the two patients with catheter tips outside the thoracic cavity were excluded from the group, the incidence of silent venous thrombosis in the patients with external jugular venous cannulation was 15% (two out of 13), which is not significantly different from the internal jugular cannulation group ($P > 0.05$). The two patients with silent venous thrombosis whose external jugular catheter tips were within the thoracic cavity did not differ from other patients within the group in regard to age, sex, height, weight, size of catheter, extracorporeal parameters, length of intensive care unit stay, or need for postoperative inotropes.

Upon comparison of the combined patients in the internal jugular and external jugular groups with catheter tips placed within the thoracic cavity, no significant difference was found between patients who had silent

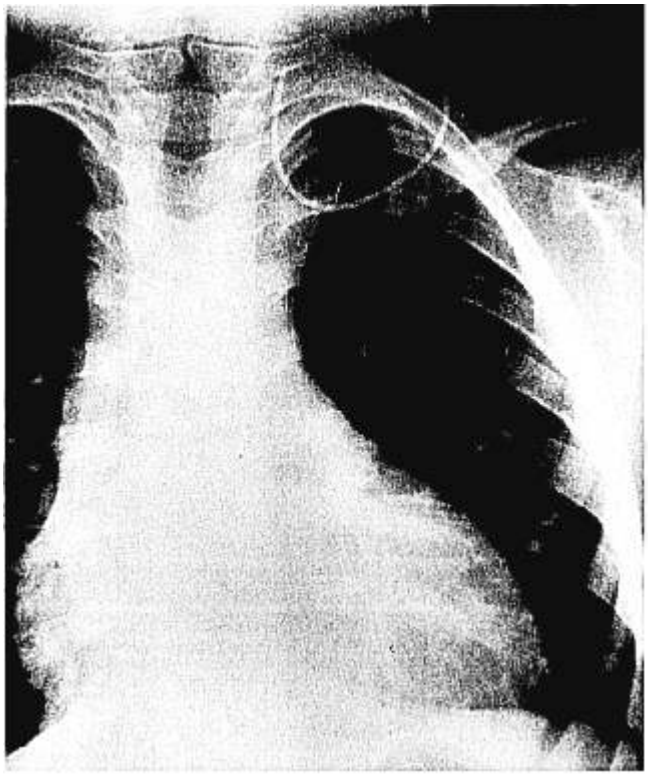

FIG. 1. Chest roentgenogram showing a left external jugular catheter take an abnormal route up an ipsilateral neck vein.

venous thrombosis develop and patients who did not except for a shorter ICU stay for thrombosis patients for reasons that are not clear.

In both patients whose catheter tip inadvertently curved back up into the neck, the left external jugular had been used for central venous access. Clinically silent venous thrombosis was found in each of these patients. In one case the central venous catheter had been in place for a prolonged period due to an extended ICU stay complicated by sepsis.

DISCUSSION

Withdrawal angiography is an accepted method for demonstrating the presence of thrombus formation around intravascular cannulae.[5,6] One difficulty with this technique is the inability to adequately visualize a small thrombus or a thrombus extending upstream from the site of catheter insertion. In children, visualization of thrombi is further restricted by a limitation in amount of contrast material that can be used. Therefore, the actual incidence of silent intravascular thrombosis may be higher than shown with this method.

Intravascular catheters serve as sites for intravascular thrombus formation, whether the catheters are transvenous pacemaker leads,[7] pulmonary artery catheters,[4,8] or femoral venous catheters.[9] The children in our study had an incidence of silent venous thrombosis of 10% when the internal jugular vein was cannulated and 15% when the cannula was placed within the thoracic cavity through the external jugular vein. These results are low when compared with the work of Chastre *et al.*,[4] who found deep vein thrombosis in 22 of the 33 adult patients admitted to the intensive care unit who had pulmonary artery catheters introduced through the internal jugular vein. One reason for the higher incidence of thrombosis in the study of Chastre *et al.* could be related to the greater intravascular surface area the pulmonary artery catheter and introducer sheath provided for thrombus formation. Also, our postcardiac surgical patients may have had additional protection from deep vein thrombosis due to dilution of clotting factors during cardiopulmonary bypass and residual heparin. In one study of adult postcardiac surgical patients with pulmonary artery catheters placed through the internal jugular vein evaluated with echocardiography and venography, no thrombosis was observed.[10] Since heparin-bonded catheters can reduce the incidence of intravascular thrombosis,[11] use of these catheters in the future might further decrease the incidence of silent venous thrombosis.

All central venous cannulations in this study were performed by experienced pediatric cardiac anesthesiologists. The insertion site was left to the anesthesiologist's discretion, which may have lead to a bias in the selection of children for each group. The external jugular vein was normally the first choice for cannulation, but if the external jugular vein could not be visualized easily or the "J" wire could not be manipulated under the clavicle, the internal jugular vein was cannulated. Therefore, children in the external jugular group generally had large external jugular veins with relatively straight courses, while children in the internal jugular group either had small external jugular veins or sharp angulation of the external jugular under the clavicle. Since external jugular cannulation had been attempted initially for some children in the internal jugular group, trauma from needle punctures also might have predisposed this group to the formation of silent venous thromboses. Thrombosis was observed in only one patient in our internal jugular group, but with a larger study population the effect of the bias in patient selection might have become more evident.

The most interesting finding in our study was both patients with catheter tips located outside the thoracic cavity developed silent venous thrombosis. These patients had central venous access attempted through the external jugular vein, but the catheter tip curved up into an ipsilateral cervical vein instead. By taking an abnormal

venous path, these catheters interrupted the smooth flow of blood, creating turbulence and possibly enhancement of thrombin deposition. In addition, the curve in the catheter brought more of its length into contact with the vessel wall. This could lead to areas of relative blood stasis as well as endothelial injury.

Though the number of patients in the study were small we tentatively can conclude that the incidence of clinically silent venous thrombosis from internal and external jugular cannulations in children following open heart surgery is low. In addition, when the tip of the central venous cannula is located outside the thoracic cavity, the risk for development of venous thrombosis may be increased and these catheters should not be left in place for extended periods.

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The One that Got Away: Misplaced Esophageal Stethoscope

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In addition to accidently inserting endotracheal tubes into the esophagus or stomach,[1,2] nasogastric tubes have been inserted into the cranium,[3,4] and esophageal stethoscopes into the trachea.[5] We present here a case in which an esophageal stethoscope passed completely into the stomach.

Report of a Case

An 18-year-old man with scoliosis was scheduled for posterior spinal fusion. After inducing anesthesia with thiopental, endotracheal intubation was accomplished with a 7.0-mm (I.D.) endotracheal tube. A #24 (French) esophageal stethoscope was inserted orally without difficulty, with proper placement confirmed by auscultation of heart and breath sounds. A #18 (French) Salem Sump® ¶ gastric suction tube was inserted into the stomach via the nose, after much difficulty in achieving tube passage. Proper placement was confirmed by aspiration of green fluid.

Following insertion of the nasogastric tube by the second anesthesiologist, the first anesthesiologist, seeing no esophageal stethoscope in place and assuming it had been removed to facilitate placement of the nasogastric tube, inserted a #24 (French) esophageal stethoscope into the esophagus, confirming proper placement by auscultation of heart and breath sounds. The patient was turned prone, and anesthesia and surgery were without apparent incident. After 6 h of operative time, the esophageal stethoscope was removed, the trachea extubated with the patient awake and responsive and the patient taken to the recovery room in satisfactory condition.

Interpretation by two radiologists of postoperative radiographs of the chest and thoracolumbar spine taken in the recovery room on the day of surgery stated, "An N-G tube is in the fundus of the stomach," and "The tip of the N-G tube is again noted to be at the level of the G-E junction."

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