A New Complication of Subclavian Vein Catheterization

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AIR EMBOLISM OCCURRING THROUGH THE TRACT of an intravenous catheter leading from the skin below the right clavicle into the subclavian vein shortly after its withdrawal on the 14th day was recently documented by X-ray in a 15-year-old boy with Crohn's disease. While not immediately fatal, the effort to support the patient included the placement of another catheter by the supraclavicular approach to the right subclavian vein which was shown at autopsy to have transfixed the vein and extended into the pleural cavity where 2,000 ccs. of blood and fluid were found. While hemothorax has previously been documented following attempts to enter a subclavian vein, we are not aware that an air embolism occurring after removal of the subclavian catheter has previously been encountered.

Since Aubaniac[1] first described the percutaneous approach to the subclavian vein in 1952, catheterization of this vessel has become popular. Two forces have been responsible for this, the first being awareness of the value of central venous pressure monitoring and the second being the value of parenteral hyperalimentation in humans as shown by Wilmore and Dudrick[7] in 1968. Numerous reports have appeared in literature discussing the complications of the procedure, and hemothorax, pneumothorax, subcutaneous emphysema, hydrothorax, air embolism upon insertion, infection, thrombophlebitis, and hemotomas have all been well documented.

The technique of percutaneous subclavian vein catheterization has been in use at Pennsylvania Hospital since 1965. In that time, over 2,000 catheterizations have been performed. Similar complications, as those stated above, have been experienced at this institution. However, the morbidity from the procedure has been low, and the diagnostic and therapeutic gains have been so high that the procedure has become more frequently used. Our recent experience with one patient in whom two new complications secondary to subclavian vein catheterization occurred is the basis of this report.

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Case Report

K. H., a 15-year-old black male, was admitted to Pennsylvania Hospital with the chief complaint of painful sores in the mouth. The patient had had frequent exacerbations of transmural colitis for the past three years with intermittent bouts of diarrhea, weight loss, and perirectal abscesses and fistulae formation. For three months prior to this admission he had been treated with large doses of steroids (60 mg. of prednisone daily) and salicylazosulfapyridine to try to effect a remission. Despite this treatment, remission did not occur and, in fact, the patient developed multiple oral abscesses probably as a complication of the steroid therapy. For this reason he was admitted to Pennsylvania Hospital and total abdominal colectomy was planned.

Because the patient was cachectic on admission, a six-week course of parenteral hyperalimentation was planned. The hyperalimentation fluid was administered through a catheter placed in the superior vena cava via the subclavian vein. Ten days after admission, while being treated in this fashion, he developed signs and symptoms of an acute abdomen and an exploratory laparotomy was performed.

At the time of laparotomy, a large pelvic abscess with diffuse purulent peritonitis was present, although no definite site of perforation could be observed in the colon. Total abdominal colectomy was performed and an end-ileostomy was created. The rectum was oversewn as a Hartmann's pouch.

Postoperatively he was dramatically improved until the fourth day when he became febrile. The fever appeared to be secondary to a wound infection. However, since the subclavian intercath had been in place for 14 days it was removed and the tip was cultured. One-half hour following removal of the subclavian catheter, the patient was sent to the Radiology Department for

chest films. He was transported in the erect position sitting in a wheel chair. Upon arrival at the Radiology Department, he was noted to be diaphoretic and dyspneic. Chest X-ray performed at that time revealed air in the pulmonary outflow tract with decreased vascular markings at the apices of both lung fields (Fig. 1). While still in the Radiology Department, another film was taken which showed cardiac enlargement, but the air that was previously present in the pulmonary outflow tract was now gone. The patient was immediately returned to the Intensive Care Unit and once again was tachypneic and at that time hypotension and tachycardia were present. The patient responded to the administration of large volumes of fluid; however, a third chest X-ray revealed a picture consistent with interstitial pulmonary edema. The patient was treated with salt-poor albumin, lasix and digoxin; there was favorable response to this therapy. About an hour later another subclavian was placed, this time by the supraclavicular route. One-half hour following this, the patient once again became tachypneic and was hypotensive and had a tachycardia. Shortly after that the patient arrested and resuscitation efforts were unsuccessful.

At postmortem examination air was demonstrated to be present in the pulmonary outflow tract. A patent tract was identified leading from the skin to the subclavian vain. This was the site of the initial subclavian vein catheter which had been in place for 14 days. Two thousand ccs. of fresh blood were found in the right pleural space. A hole was found in the subclavian vein on the right side in its intrathoracic portion; an intercath was still in place and was protruding through this hole.

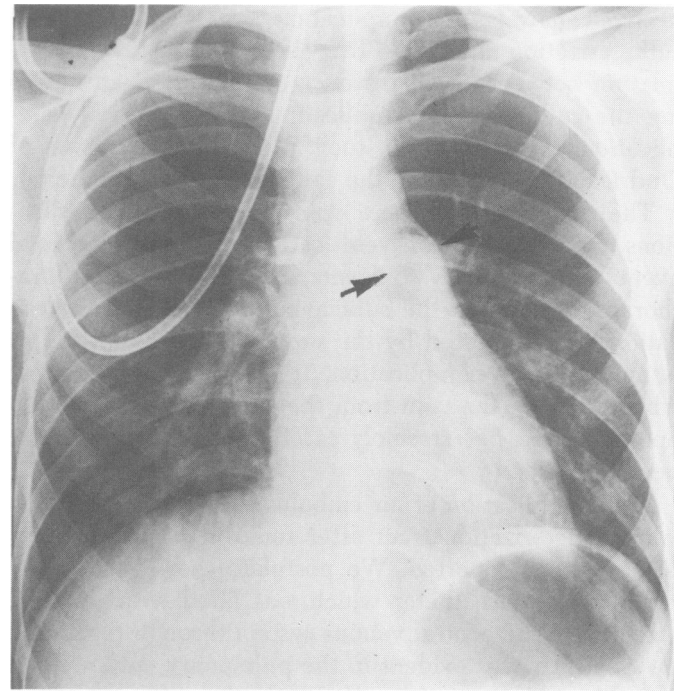

FIG. 1. Chest X-ray demonstrating air in the pulmonary outflow tract marked by black arrows and decreased vascular markings at the apices of both lung fields.

Discussion

The proof of the effectiveness of both intravenous hyperalimentation and central venous pressure monitoring have been the great impetus to the popularization of subclavian vein catheterization. Aubaniac[1] first described the procedure in 1952 and demonstrated its usefulness as a route for administration of intravenous fluids and for withdrawing blood for laboratory sampling in patients in whom other veins were not available. It did not gain popularity in this country until 1962 when Wilson[8] showed that central venous pressure monitoring played a key role in the management of critically ill patients and at that time described a modified technique for percutaneous catheterization. In 1968, when Wilmore and Dudrick[7] showed that with only intravenous feeding solutions adequate nutrition and normal growth could be achieved in humans, subclavian vein catheterization became even more popular. Since that time multiple reports have appeared in the literature describing both alternate techniques and complications of the procedure.

In 1965, Yoffa *et al.*[10] advocated the supraclavicular approach to the vein. They felt that this approach was easier and demonstrated that there was no evidence of hematomas or pneumothoraces in any of their patients. They achieved entrance into the vein in 80% of cases on the first try, and out of 130 veni-punctures only failed to enter the vein in five cases. They pointed out that patients should be kept in the recumbent position so that the vein will be fuller and therefore easier to enter and also that the risk of air embolus will be diminished. In 1970, Johnson *et al.*[5] reported a case of air embolism during the introduction of the catheter into the vein. This patient was in a hypovolemic state. Flanagan *et al.*[3] in 1969 also reported a case of air embolism secondary to this procedure. The patient in this case was in the semi-Fowler position and had a low central venous pressure. These authors, using a modification of Poiseuille's Law, calculated that with a 14-gauge needle, whose internal diameter is .072 inches, 100 ccs. of air per second could be transmitted, if there were a pressure drop of 5 cm. of water. They also experimentally showed that volumes of air of this magnitude rapidly administered intravenously to dogs altered cardiopulmonary physiology. Though the minimal volume of air lethal to human beings has not yet been clearly demonstrated, Yaedel[9] in 1968 reported that 100 ccs. of air which was rapidly forced through the vascular system from a classic blood storage container caused a fatal air embolus. Gallitano *et al.*[4] in 1972 advocated the infraclavicular route for subclavian vein catheterization. They reported on over 600 cases with no morbidity or mortality. In ten per cent of the cases they were unable to cannulate the vein and did not persist. They felt that persistence in cannulating the vein led to complications. They advocate its use by a wider number of people in all hospitals. Bernard *et al.*[2] undertook an interesting study in which they did a pros-

pective analysis of complications of subclavian vein catheterization and found that there was an inverse correlation between the experience of the physician inserting the catheter and complications. Their overall complication rate was 4.5%; they used a modification of Dudrick's technique for the infraclavicular approach.

The case presented here demonstrates two complications from subclavian vein catheterization. The fatal event was secondary to hemorrhage through the intrathoracic portion of the subclavian vein. This catheterization was attempted by the supraclavicular route. This is an avoidable complication. It has been stressed that when entering the vein from the superior approach, the operator must be extremely careful not to introduce the needle too far.

The complication of air embolus through a subclavian vein catheterization tract after removal of the catheter has not been reported. We postulate that shortly after removal of the catheter which was filled with solution, air entered the central venous system through the catheter tract. Air was evident in the pulmonary outflow tract on a chest X-ray performed shortly thereafter.

Most patients in whom subclavian vein catheters are in place for a short period of time will probably not develop a fibrous tract around the catheter. We feel the complication of air embolus after removal will arise in patients who have had a catheter placed for a prolonged period of time and therefore would most likely occur in those patients receiving intravenous alimentation. Such patients may, in addition, present with muscle wasting and a decrease of subcutaneous fat tissue, both of which may contribute to the embolization via a tract by diminishing the distance between the skin and subclavian vein.

Our recommendation is that in all patients in whom the catheter has been in place long enough for a tract to develop, in any patient receiving hyperalimentation solution and in any patient who has muscle wasting and subcutaneous tissue lost, the needle wounds should be treated as capable of sucking air upon removal of the catheter. This is especially the case if the central venous pressure is in the low normal range. This complication can be prevented by covering the entrance wound with a vaselinized gauze pad, which should be left in place long enough for obliteration of the tract. Though in this particular case the air embolism was not immediately fatal, it did lead to serious complications and quite obviously could have been fatal.

Summary

A case is presented of a 15-year-old boy who sustained an air embolism following the removal of a subclavian vein catheter. The air embolism occurred via the tract left from the subclavian vein catheter. The patient also sustained a second complication of subclavian vein catheterization, that being massive hemothorax from a supraclavicularly placed subclavian vein catheter. This occurred secondary to the catheter transfixing the vein and allowing massive bleeding into the right hemithorax. References are made to various complications of subclavian vein catheterization and evidence is presented to substantiate the air embolism in this case. Though the air embolism was not immediately fatal, it led to hemodynamic alterations. Vaselinized gauze placed on the punctured site when the catheter is removed will prevent the complication of air embolism.

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