Intracardiac Knotting of the Catheter during Right Heart Catheterization

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Serious complications of cardiac catheterization have been infrequent. They have included atrial arrhythmias, ventricular tachycardia, premature ventricular beats, ventricular standstill, pulmonary artery thrombosis, and perforation of the heart. In addition to these complications, knotting of the catheter has been rare. When knotting has occurred, it has been possible to withdraw the catheter from the heart and to deal with the knotted end in a peripheral vein.

In the case reported here the knot involved the chordae tendineae of the tricuspid valve, and an open cardiotomy was required to extricate the catheter.

Case Report

The patient, a 38-year-old white man, was admitted to Wadsworth General Hospital on October 20, 1959, because of shortness of breath and repeated episodes of congestive failure over the previous 9 months. Because of the possibility of a pulmonary arteriovenous fistula, right heart catheterization was done, primarily to perform selective dye-dilution curves.

A No.-8 Courand single-lumen catheter was introduced into the left basilic vein and was passed into the right ventricle under fluoroscopic monitoring. Attempts at placing the tip of the catheter in the pulmonary artery were unsuccessful, for the catheter repeatedly knuckled; the tip remained in the right ventricle, while a loop passed into the pulmonary artery. At this time it was decided to substitute another catheter. As the catheter was withdrawn, the proximal loop disappeared. Clear visualization of the tip of the catheter was difficult because of the patient's obesity and superimposition of the tip of the catheter over the spine. When traction was made, there was tugging on the catheter synchronous with the heart beat. Fluoroscopic examination showed the tip of the catheter in the region of the tricuspid valve, but no knot was apparent. Several manipulations were attempted: these included advancing and withdrawing the catheter, clockwise and counterclockwise twisting, introduction of a Bing wire, and injecting saline rapidly with hopes that the jet fluid at the tip of the catheter would dislodge it. Attempts at introducing the catheter farther into the right ventricle were followed by runs of ventricular premature beats. Attempts at withdrawal also resulted in premature beats, and the patient complained of retrosternal pain.

Posteroanterior, lateral, and oblique films showed an overhand knot at the tip of the catheter near the tricuspid valve area (figs. 1 and 2). Further attempts were made to remove the catheter during observation with an image amplifier. These included considerable traction that raised the heart 4 to 5 cm. from the diaphragm. When all measures failed, it was concluded that the tip of the catheter was knotted in the chordae tendineae of the tricuspid valve, and that the only possibility of removal was by cardiotomy.

A right anterior thoracotomy with sternal transection was performed under hypothermia. Under purse-string suture control a finger was introduced into the right atrium through the atrial appendage. The knot in the catheter could be felt entangled in the chordae tendineae of the anteromedial commissure of the tricuspid valve, but extrication of the catheter by closed manipulation was not possible. Inflow was then stopped by occlusion of the venae cavae and the atrium was opened. The area of the tricuspid valve was well visualized, and a tight overhand knot in the tip of the catheter was seen. The catheter itself just proximal to the knot had become intertwined with a bundle of chordae just as one would twist 2 pieces of coarse wire together (fig. 3). The knot in the catheter prevented untwisting and traction only made the intertwining more firm. Ecchymosis of the adjacent papillary muscle was noted. The catheter was cut and removed, and the atrial incision was closed. Total circulatory occlusion was 3 minutes and 28 seconds. The patient's postoperative course was uneventful, and he was discharged from the hospital 3 weeks after surgery.

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Figure 1
The right anterior oblique roentgenogram demonstrates a true overhand knot in the region of the tricuspid valve.

Figure 2
Enlargement of the right anterior oblique roentgenogram demonstrates more clearly the overhand knot at the tip of the catheter.

Figure 3
Photograph showing position of the knotted catheter emerging from the superior vena cava, crossing the right atrium, and becoming entangled in the tricuspid valve. 1, septal leaflet of the tricuspid valve; 2, overhand knot at the tip of the catheter; 3, loop of chordae tendinae around catheter. (This photograph was made for demonstration purposes on another human specimen in the autopsy room after removal of the anterior atrial wall.)

Discussion
Serious complications of cardiac catheterization have been infrequent. Courmand states that he has never experienced a similar complication. Paul Wood described several instances during right heart catheterization when the catheter knotted but reduction was easily accomplished by moving the catheter to and fro. Earl Wood has not had a similar complication but refers to 2 cases in which the cardiac catheters broke in two during the procedure. The catheters were smooth-bore Nylon catheters without a woven Nylon covering. Bing has never had difficulty with the catheter knotting and entangling in the chordae, but he describes a case in which a true knot formed at the tip of the catheter that could be withdrawn into a peripheral vein.

Not infrequently during the catheterization there is looping of the catheter in either the right ventricle or right atrium. These loops are usually seen by the fluoroscopist, and
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manipulation of the catheter obviates knots. If true knotting of the catheter does occur, however, it is usually possible to pull the knot peripherally into the brachial vein, where it can be easily removed.

The catheterization procedure on this patient was performed with fluoroscopic monitoring. There was difficulty in seeing the catheter clearly because the patient was large and obese, and because the loop of the catheter overlay the thoracic spine. The catheter appeared to be unlooping as it was being withdrawn from the pulmonary artery, but apparently a tight overhand knot at the tip of the catheter was being formed. Presumably the catheter passed between the chordae tendineae of the tricuspid valve as it was being introduced into the right ventricle. When the catheter was withdrawn, the knot was drawn tight and would not pass between the chordae. Twisting the catheter in attempts at removal aggravated the problem by intertwining the catheter in the chordae.

There is no general agreement whether a rigid or flexible catheter should be used. Perforation of the right ventricle has been reported during right heart catheterization.4 Because of this hazard Cournand is more concerned about rigidity than flexibility.5 Soon after a catheter is introduced into the bloodstream, the temperature of the blood causes softening of the catheter and it becomes more flexible. Frequently a second catheter must be used. Dexter comments that if catheters are very limp, they are far more traumatic and more prone to tie themselves into knots than are stiff catheters.9 At the Peter Bent Brigham Hospital the cardiac catheters are hardened in the oven at 100 C. for 30 minutes with the catheter tip held in the desired curved position.

The etiology of the chest pain during the attempts to remove the catheter by traction is not known. It may have been produced by displacement of mediastinal structures, since there was shifting of the superior vena cava to the left when traction was applied and the heart was displaced upward. Ecchymosis of the papillary muscle was noted at time of cardiotomy, and it is possible that the chest pain was related to ischemia secondary to traction on the papillary muscle.

Summary

A complication of right heart catheterization is reported in which the catheter became knotted and entangled in the chordae tendineae of the tricuspid valve. Removal required open cardiotomy with hypothermia and temporary inflow occlusion.

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