Neonatal thoracoabdominal aortic thrombosis associated with the umbilical artery catheter: Successful management by transaortic thrombectomy

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The case of a newborn infant who underwent a successful aortoiliac thrombectomy for thoracoabdominal aortic thrombosis induced by an umbilical artery catheter is presented. The case is notable both for the extent of the thrombotic process and the renal and cardiac failure noted initially. Only eight other attempts at neonatal aortic thrombectomy associated with umbilical artery catheters have been reported in the English language literature. Our experience, in addition to that in the literature, suggests that aggressive treatment should be considered in neonates with this severe complication. (J VASC SURG 1986; 4:119-23.)

The umbilical artery catheter has long been a useful means of vascular access in neonatal intensive care units. The indications for placement include exchange transfusion, frequent blood gas or serum chemistry studies, hemodynamic monitoring, nutritional support, administration of antibiotics or other parenteral medications, and as access for cardiac catheterization. Thrombotic complications arising from indwelling arterial catheters placed via the umbilical artery have been extensively described in the pediatric literature. The offending thrombus is frequently limited to the distal aorta and iliac vessels. We believe that this is the first case of successfully treated thoracoabdominal aortic thrombosis associated with the umbilical artery catheter.

CASE REPORT

The patient was a female infant, weighing 3.18 kg, born at term via spontaneous vaginal delivery after an uncomplicated labor of 12 hours. Meconium-stained amniotic fluid was noted at delivery and Apgar scores of 0 at 1 minute and 2 at 5 minutes were obtained. The infant was intubated and transferred to the neonatal intensive care unit at 8 hours of age. Diagnoses at admission included peripartum meconium asphyxia, aspiration, and central nervous system depression.

A polyvinyl umbilical artery catheter was introduced on the first hospital day for blood gas analysis. The tip of the catheter was positioned at T6-7 and no heparin was given other than as a flush after each blood gas determination (Fig. 1). The catheter was used for parenteral nutrition for 3 days early in the hospitalization because of the patient’s inability to tolerate feeding. The early hospital course was marked by (1) respiratory failure that required assisted ventilation for 10 days, (2) renal failure with a peak creatinine value of 2.2 mg/dl on the second day, which decreased to 1.0 by the fifth day, and (3) bilateral intraventricular hemorrhage and seizures treated with phenobarbital, phenytoin (Dilantin), and para-}

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to its bifurcation. The renal arteries were not visualized and the superior mesenteric artery filled through a small channel in the thrombus (Fig. 2). The origin of the celiac trunk was not opacified, and the celiac branches filled through collateral channels.

On the thirteenth day, the patient was taken to the operating room where an aortoiliac thrombectomy was carried out through a transverse infrarenal aortotomy. With No. 2 and No. 3 Fogarty catheters, a 6.5 cm long thrombus was removed from the aorta, smaller thrombi were removed from the iliac arteries. The thrombus removed from the aortic segment showed multiple, short side branches corresponding to the visceral arteries (Fig. 3). The transverse aortotomy was closed with interrupted 7-0 Prolene sutures and the patient was returned to the intensive care unit. At the conclusion of the procedure, flow was documented in the iliac arteries with the Doppler flowmeter. Both femoral and the right posterior tibial artery pulses became palpable postoperatively. A marked improvement in cardiac failure was noted immediately, and there was a dramatic decrease in hepatomegaly. Two days after the operation, thigh pressures were found to be 100 mm Hg on the right, with a thigh/brachial index of 1.17, and 84 mm Hg on the left, with an index of 0.93. Postoperatively the patient had persistent hypertension requiring captopril, hydralazine, and diuretic therapy. Renal excretory function gradually improved, and the serum creatinine value fell to 1.1 mg/dl at the time of discharge on the forty-third day. Femoral pulses remained palpable bilaterally.

Twelve months after discharge the patient's blood pressure was 90/48 mm Hg with captopril and hydralazine therapy. Renal excretory function and creatinine values were normal. Femoral pulses were palpable bilaterally. Unfortunately, the patient continues to manifest neurologic deficits related to perinatal hypoxia.

DISCUSSION

The risk of intravascular thrombosis associated with umbilical artery catheters has been examined with transcatheter angiography and at autopsy. The angiographically determined incidence of thrombosis ranges from 24% to 95%. This incidence represents pericatheter thrombus, mural thrombus, and pericatheter fibrin sleeves. A number of autopsy series found that the incidence of thrombus formation varied from 12% to 58%, with many of these clots being clearly incidental in nature and unrelated to the cause of death.

Thrombus related to use of umbilical artery catheters is thought to arise by two mechanisms: (1) intimal trauma caused by the catheter itself or to the infusion of hypertonic solutions and (2) fibrin deposition on the catheter with subsequent platelet aggregation and red thrombus formation. Formanek, Frech, and Amplatz demonstrated that deposition of thrombotic material occurs on 50% of the poly-
ethylene catheters used during diagnostic procedures and that 100% of these catheters were involved if left in situ for more than 24 hours. They also demonstrated that this debris is stripped from the catheter on removal and is either deposited at the puncture site or embolized distally. This concept is supported by Alpert, et al. 9 who noted that in three of their five cases, the ischemia was made worse by removing the catheter.

It is clear that clinically significant thrombotic events are much less frequent than clots demonstrated either at autopsy or angiographically. In a series of 912 infants with umbilical artery catheters, Strauss, Escobedo, and Goldring10 found 26 had either radiographic or autopsy evidence of thrombus formation. However, only three (13%) were considered to be hemodynamically significant and none showed clinical evidence of visceral or extremity ischemia. On the other hand, in reviewing 165 neonates with umbilical artery catheters, Marsh et al. 11 found a 60% incidence of thrombus formation, of which 12 were believed to have led to major complications or death. These complications included both extremity and visceral infarction. Fatalities were also noted in other series.6,9,12-14

Potential factors that could affect the incidence and severity of thrombotic umbilical artery catheter complications include (1) position of the catheter, (2) type of catheter, (3) time indwelling, (4) amount of manipulation, and (5) composition of infusate.

The literature is equally divided between advocates of low-placed (L-3 to L-5)11,15-17 vs. high-placed T-6 to T-11 catheters. In a survey of intensive care nurseries, 52% preferred the high position whereas the other 48% used the low position.13 Mokrohisky et al.20 showed a higher complication rate for catheters in the low position (39% vs. 78%) in a randomized prospective trial done in 1978. However, the higher complication rate associated with low-placed catheters was documented solely by an increased occurrence of transient extremity cyanosis or blanching. A trial from authors in Sweden in 1979 selected 71 infants at random to receive one of four catheters: (1) long end-hole, (2) short end-hole, (3) long side-hole, or (4) short side-hole catheters.21 "Pullout" angiography showed no thrombus in the group with the long end-hole catheters, whereas those with short side-hole catheters had a 64% thrombus formation rate. The other two groups had a thrombus formation rate of approximately 30%. The clinical significance of these thrombi were not addressed in this study; and advocates of low-placed catheters claim that, although the high-placed catheters have a lower rate of thrombus formation, serious complications, such as visceral infarction, are more frequent.

The catheter material is also important. Silicone rubber catheters clearly have a much lower rate of thrombus formation (10%) than highly thrombogenic polyethylene (42%), polyurethane (44%), or Teflon (60%).8,15 It has also been found that the side-hole catheter has a higher rate of thrombus formation than those with end-holes, presumably caused by dead space at the tip of the side-hole catheter.21

The addition of low-dose heparin to infusate solutions (1 μg/ml) has been advocated by some,1,17 whereas others express reservations about giving even small amounts of heparin to these high-risk infants.6 Avoidance of low pH and hypertonic solutions is generally advocated, and most sources agree that duration of catheter use and amount of manipulation should be minimized.11,19

Treatment of the thrombotic complications of umbilical artery catheters depends on the level and extent of the process. Although many patients have small thrombi of little clinical significance that can be expected to lyse via activation of the fibrinolytic system, cases of major extremity and visceral infarctions have been reported.6,9,11 Extremity blanching associated with loss of limb pulses may be due to either vascular spasm or thrombus formation and may respond to prompt catheter removal.19

*References 2, 4, 6, 9, 11, 12.
ization may also be considered if the infant's overall condition permits.\textsuperscript{11,12,24} O'Neill, Neblett, and Born\textsuperscript{25} described 15 patients with clinical and Doppler findings of femoral artery occlusion. Although there was no tissue loss in these limbs, on follow-up they all demonstrated abnormal Doppler flow patterns consistent with collateral flow around iliac or femoral artery occlusion, raising the question of limb growth rate discrepancy as a long-term sequela in these cases.\textsuperscript{26,27}

Flanigan et al.\textsuperscript{23} in an early review observed that medically managed major aortoiliac thrombosis carried a 100\% mortality rate. In a later report, this group advocated an aggressive approach to the loss of femoral pulses associated with umbilical artery catheters.\textsuperscript{24} This includes immediate removal of the catheter followed by systemic heparinization, if not contraindicated, for those who do not immediately regain their pulses. Depending on the infant's overall condition and degree of ischemia, surgical intervention is considered if pulses have not returned within 6 hours. Flanigan et al.\textsuperscript{24} have published experience with two successful aortoiliac thrombectomies in neonates, one with concomitant renovascular hypertension. O'Neill, Neblett, and Born\textsuperscript{25} also reported success in three of four infants with extensive abdominal aortic thrombosis, two of whom had concomitant large bowel infarction. Henry et al.\textsuperscript{28} reported two cases of thrombectomy in which the infant died in the postoperative period, one of whom showed thrombus at the level of the celiac axis.

Ours is the first reported case of successful surgical management of thoracoabdominal thrombosis caused by the umbilical artery catheter. The association between aortic thrombosis and congestive heart failure has been noted previously by Henry et al.\textsuperscript{28} Nonetheless, the rapid onset of cardiac failure and massive hepatomegaly followed by its equally rapid postoperative resolution was remarkable. We believe that a clot in this location places all visceral vessels in jeopardy and creates a truly emergent condition. Like Flanigan et al.\textsuperscript{23} and O'Neill, Neblett, and Born\textsuperscript{25} we used a transverse aortotomy placed just above the aortic bifurcation and No. 2 and No. 3 Fogarty catheters for removal of the thrombus. The extremely small visceral arteries precluded any attempt at direct thrombectomy of these vessels, and improvement in visceral flow depended entirely on the extraction of thrombus extending into the side branches along with the main clot.

Nonoperative therapy may be an alternative in some cases, the decision for which should be made on the basis of the overall condition of the patient and the extent of thrombosis. Adelman et al.\textsuperscript{30} successfully managed nine cases of isolated renal artery thrombosis associated with umbilical artery catheters with intensive supportive therapy and dependence on native fibrinolysis. Malin et al.\textsuperscript{30} described three cases of neonatal renovascular hypertension associated with major aortoiliac thrombus and umbilical artery catheters that were managed successfully without surgery, with large doses of antihypertensive medications and peritoneal dialysis. All infants had stopped taking medication by 8 to 26 months of age, but there was little mention of the status of the lower extremity circulation. Fibrinolytic therapy has also been attempted in the setting of neonatal aortic thrombosis, with varying degrees of success. Flanigan et al.\textsuperscript{23} reported two unsuccessful attempts at clot lysis using urokinase with subsequent successful thrombectomy. Pritchard et al.\textsuperscript{31} on the other hand, reported a successful case of aortic clot lysis after a 44-hour local infusion of streptokinase.

Despite the vast potential in the infant for thrombolysis and collateral development, the well-documented potential for visceral, renal, and spinal cord\textsuperscript{32} complications in these patients with extensive aortic thrombosis cannot be ignored. The place for nonoperative and/or fibrinolytic therapy is yet to be defined and may be applicable to only a selected group of these patients. Thrombectomy, if applied early in the course of these critically ill patients, has been successful and establishes a standard against which nonoperative therapy must be judged.

\textbf{REFERENCES}

8. Formanek G, Frech RS, Amplatz K. Arterial thrombus for-


