Endovascular treatment of renal artery thrombosis caused by umbilical artery catheterization

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Renal arterial thrombosis, usually in association with aortic thrombosis, has been reported as a result of prolonged neonatal umbilical artery catheterization. A case of renal artery thrombosis attributable to umbilical artery catheterization, resulting in malignant renovascular hypertension, in a 15-day-old neonate, treated by catheter-directed thrombolysis through the involuting umbilical artery, was studied. Resolution of systemic hypertension and partial return of right renal function followed rapid thrombus dissolution. (J Vasc Surg 1998;28:949-53.)

Umbilical artery catheterization has proven useful in the treatment of critically ill neonates. The need for accurate pressure monitoring, frequent blood draws, and arterial blood gases requires access into the arterial system of infants. Although the placement of umbilical arterial lines has become more common, a considerable number of complications have been reported. Although some authors advocate conservative management,[4] the treatment of clinically relevant aortorenal thrombosis has been primarily surgical.[5-7] Therapy is designed to restore blood flow before tissue loss. However, the fragile nature of the arterial wall, coupled with critical illness in the neonate, creates an unfavorable environment for standard interventions. Thrombolytic therapy is currently an acceptable treatment in select cases of acute arterial occlusions.[8-10] Occlusions that respond favorably to thrombolytic therapy include acute thromboses (less than 14 days of symptoms) and those that can be crossed with a guidewire or catheter. The less invasive nature of thrombolytic therapy makes this a potential alternative to high-risk surgical procedures. The use of the umbilical artery as an access site to allow catheter-directed thrombolytic therapy for the treatment of renal artery thrombosis caused by umbilical arterial catheterization was studied.

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CASE REPORT

S.M. was born at a gestational age of 41 and ½ weeks to a 41-year-old woman whose pregnancy was complicated by pregnancy-induced hypertension. The delivery was complicated by a meconium aspiration, resulting in respiratory compromise. He was resuscitated and then transferred to the neonatal intensive care unit. Pulmonary hypertension developed and persisted, despite maximal treatment. A 5F umbilical artery catheter (Argyle, St Louis, Mo) was placed at the level of the third lumbar disc, and he was further resuscitated.

When the neonate was 5 days old, the umbilical artery catheter was removed. The next day, he was found to have systemic hypertension (Fig 1) and microscopic hematuria. Intravenous hydralazine therapy was initiated. Kidneys of equal size, without evidence of arterial flow to the right kidney, were demonstrated by means of a renal duplex scan, obtained when the neonate was 9 days of age; however, venous flow was evident, perhaps indicative of a more viable situation. A diethylenetriamine pentaacetic acid–technetium renal scan confirmed the absence of right renal function. Although interventions were considered at this time, none were undertaken because involved parties felt the hypertension could be medically controlled.

The development of pulmonary edema prompted a more aggressive approach to the management of his hypertension. Nitroprusside, furosemide, and enalapril were administered in a sequential fashion. Although his cardiac failure stabilized, he remained hypertensive. We elected to perform an angiogram, using the umbilical artery as an access site, with the intention of treating the renal artery thrombosis with catheter-directed thrombolytic therapy.

The procedure was performed under general anesthesia on day 15 of the neonate's life. The abdomen was prepared and draped, and the left umbilical artery was exposed through a periumbilical incision. Proximal and distal control were obtained, and an arteriotomy was made (Fig 2). A 0.035-in hydrophilic wire (Cook Radiology, Bloomington,

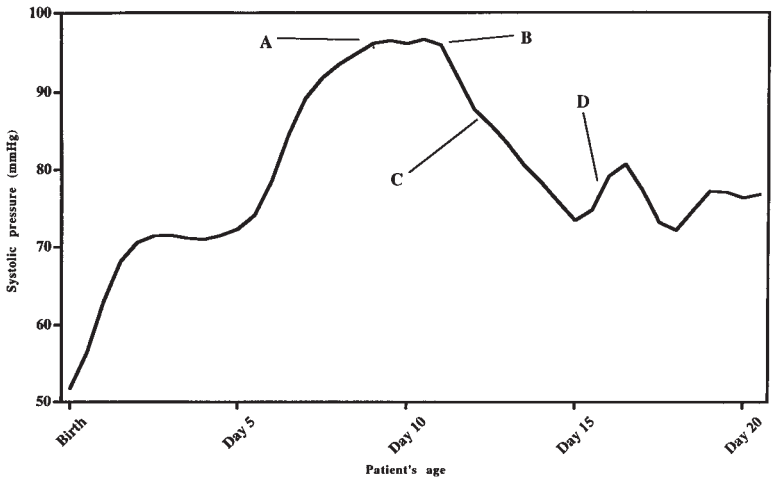

Fig 1. The neonate was born without evidence of hypertension. After the insertion of the umbilical artery catheter, systemic hypertension developed. This was initially treated with hydralazine (*A*). Nitroprusside (*B*) and captopril therapy (*C*) furosemide. Catheter-directed thrombolysis (*D*) was performed while the hypertension was controlled after an episode of congestive heart failure.

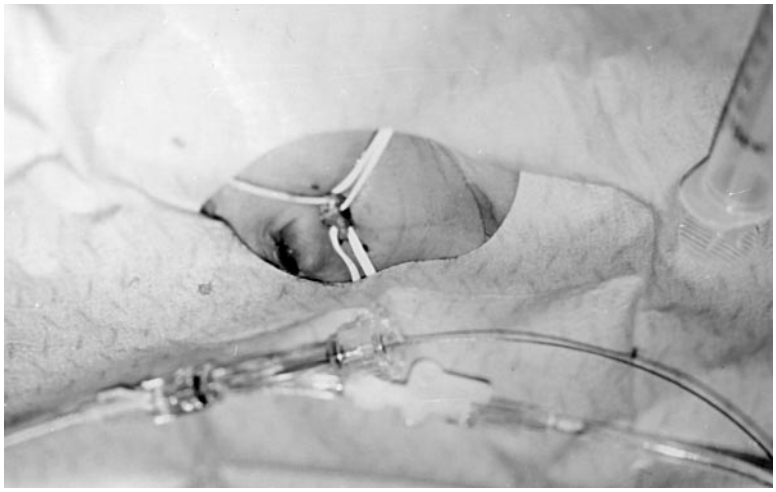

Fig 2. A periumbilical incision allowed rapid access to the umbilical artery. Proximal and distal control was established with vessel loops before the insertion of a 4F sheath. After diagnostic angiography, a coaxial system was introduced to allow catheter-directed thrombolytic therapy.

Ind) was used to enter the thoracic aorta. A 4F sheath (Cook Radiology, Bloomington, Ind) was placed without difficulty and was followed by a 4F pigtail catheter (Angiodynamics, Queensbury, NY). An angiogram was obtained (Fig 3), by means of which a nearly occluding thrombus isolated to the right renal artery was depicted. The right renal orifice was selectively cannulated with a 4F Berenstein catheter, and an 0.035-in infusion wire (MTI, San Diego, Calif) was placed through the thrombus. Pulse lysis was attempted with a total dose of 125,000 units of urokinase over 10 minutes. There was no appreciable change in the amount of thrombus. Catheter-directed urokinase therapy was initiated at a rate of 192 U/min via the infusion wire. This dose was calculated based on a standard adult dose of 4000 U/min[9] in patients with an approximate blood volume of 4 liters. Heparin was administered at a rate of 70 U/h, to prevent pericatheter thrombus formation. Careful attention was given to adequate management of the hypertension during the lytic infusion to minimize the risk of cerebral hemorrhage (Fig 1). Four hours after the initiation of urokinase therapy, complete thrombus dissolution was shown by means of a second angiogram (Fig 3).

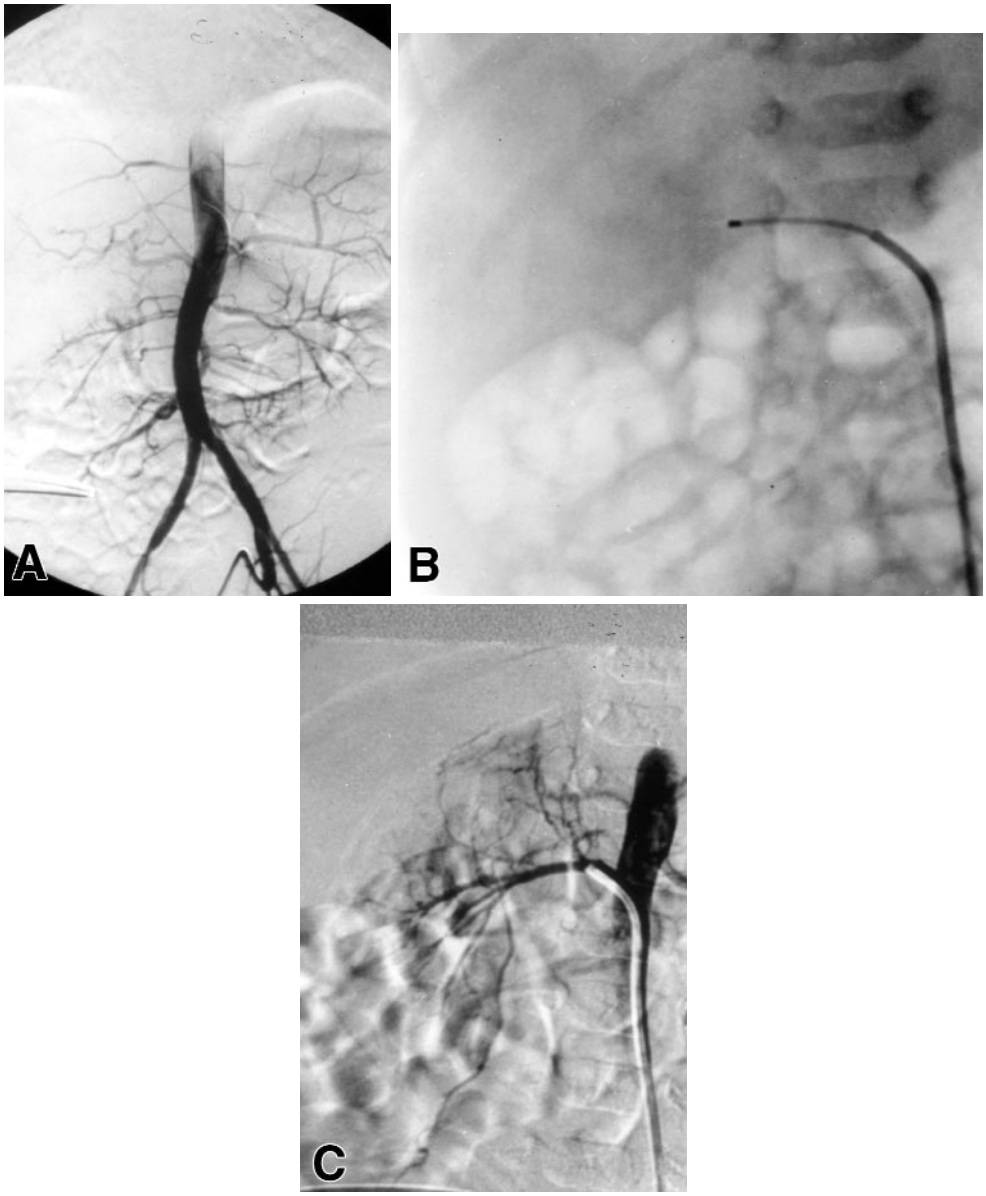

Fig 3. A, Linear thrombus is isolated to the right renal artery. **B,** This was followed by placement of an infusion wire through the thrombus. **C,** Complete dissolution of the thrombus, with markedly improved blood flow to the renal parenchyma, was demonstrated by means of an aortogram obtained 4 hours after the institution of thrombolytic therapy.

One day after the procedure, the patient was normotensive; all antihypertensive medications were discontinued. Symmetrical renal arterial flow was demonstrated by means of duplex ultrasound scan. His creatinine level normalized. Normal function of the left kidney was shown by means of a renal scan, whereas the right kidney was functioning at 60% of expected levels. The patient remained stable and was discharged home on postprocedure day 10. Approximately 1 month after discharge, enalapril was reinstituted to control moderate systolic hypertension. At that time, good flow to the right kidney was revealed by means of duplex scan examination. At 4 months, the absence of flow to the right kidney in conjunction with minimal renal function was demonstrated by means of scheduled ultrasonographic and renal scans.

DISCUSSION

The current use of umbilical artery catheterization is associated with a low morbidity rate. This

contrasts with historical reports of a high incidence of acute complication[15] and radiographic evidence of clinically silent pericatheter thrombus formation in most patients with umbilical artery lines.[1] More recent studies cite an incidence rate of clinically significant thrombus formation of 1% to 10%.[2,7]

Angiographic access in neonates has historically been associated with significant complications involving the femoral arteries. Although the establishment of percutaneous access is quite feasible, the size of the artery compared with the size of interventional devices makes neonates prone to thrombus formation. Intimal injury, the age of the neonate, and the presence of spasm have all been implicated in the formation of neonatal thrombotic complications.[13,20] The use of systemic heparinization during interventional procedures was shown to diminish, but not eliminate, the incidence of arterial thrombosis.[21] The involuting umbilical artery provides access to the arterial system without the need to puncture the femoral artery. Although frequently used for monitoring devices, this route has not been well-explored for catheter-directed therapies. The small periumbilical incision and minimal dissection required to obtain vascular control allows the artery to be ligated after the procedure.

Thrombus formation was demonstrated by means of a prospective evaluation in approximately 85% of all neonates after umbilical artery catheter placement.[1] However, the incidence of clinically significant thrombus formation ranges from 3% to 33%.[2,3] Various types of indwelling catheters have been tested in vitro and in vivo.[6] Silicone rubber was noted to be less thrombogenic than polyethylene, polyurethane, or Teflon.[16] The presence or absence of side-holes and the position of the catheter within the aorta were found to significantly contribute to de novo thrombus formation.[17] There is no evidence to suggest that the type of infusion or frequency of catheter manipulations relate to thrombus formation.[6] Low cardiac outputs, hypercoaguability, and small vessels provide conditions favoring thrombus formation.

The use of thrombolytic therapy in newborns has been investigated. The systemic administration of a variety of agents has not been successful.[22-24] Intermediate results were obtained with early methods of local thrombolytic agent infusions in the setting of aortic thrombosis.[25,26] The limited success of this therapy has been attributed to many factors, including the immaturity of the neonatal fibrinolytic system and lower levels of circulating plasminogen in this age group.[6] Low profile, more efficient infusion catheters and wires, new thrombolytic agents, and the use of fresh-frozen plasma may allow the provision of less-invasive therapy with minimal morbidity and mortality.

Lysis was achieved in S.M. after a 4-hour infusion of urokinase. The rapid clot dissolution is likely attributable to the volume and age of the thrombus, as well as the local administration of an appropriate amount of thrombolytic agent.

Successful therapy was evidenced by the decrease in the serum creatinine level and the discontinuation of all antihypertensive and diuretic medications. Although early evidence of bilateral renal function approached equality, a renal size discrepancy and a significant functional deficit was demonstrated by means of re-evaluation at 4 months. These findings may be attributed to the initial insult, or rethrombosis of the microcirculation, possibly caused by the institution of an angiotensin-converting enzyme inhibitor at 1 month of age. The follow-up plans on the child involve medically managing his hypertension. We assume that, because there is minimal to no function of the right kidney, a more aggressive approach is not warranted in the absence of intractable hypertension.

The use of the umbilical artery as an access site to the central arterial system of neonates avoids complications associated with femoral artery puncture and cutdown. Catheter-directed thrombolytic therapy in the neonate is feasible and effective when properly managed. The diminished morbidity and mortality rates of less invasive interventions will allow earlier and more aggressive treatments, thus increasing the potential for renal salvage and avoiding the need for long-term antihypertensive therapy.

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