Clot Dissolution: A Novel Treatment of Midgut Volvulus

**abstract**

Midgut volvulus due to malrotation may result in loss of the small bowel. Until now, after derotation of the volvulus, pediatric surgeons do not deal with the mesenteric thrombosis, which causes continuing ischemia of the intestine. On occasion, a "second look" laparotomy is performed in the hope that some improvement in blood supply to the intestine has occurred. We describe a new combined treatment to restore intestinal perfusion based on digital massage of the superior mesenteric vessels after derotation and systemic infusion of tissue-type plasminogen activator. This new therapy has been successful in 2 neonates with severe intestinal ischemia due to volvulus. *Pediatrics* 2012;129:e1601–e1604

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**KEY WORDS**

tPA, midgut volvulus, bowel ischemia

**ABBREVIATION**

tPA—tissue-type plasminogen activator

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Ischemic necrosis of the midgut as a consequence of midgut volvulus from malrotation is an acute catastrophic event with high mortality. It usually presents in the first month after birth but can occur in late childhood or adult life. Those who survive with extremely short bowel and intestinal failure require a long period of hospitalization followed by prolonged home parental nutrition. This is associated with substantial morbidity, which includes repeated episodes of septicemia, derangement of liver function, problems with venous access, and frequent admission to the hospital. The quality of life of these patients and their family can be poor. Intestinal and/or liver transplantation may be required. Therefore, it is essential to preserve as much intestinal length and function as possible to avoid subsequent morbidity and mortality.

Midgut volvulus is likely to occur in malrotation because failure of mesenteric fixation allows the small bowel to rotate about the narrow mesenteric pedicle. Standard treatment of midgut volvulus due to malrotation includes derotation and a Ladd’s procedure to widen the root of the mesentery. Approximately 15% of patients with malrotation and volvulus develop complete obstruction of the mesenteric vessels resulting in thrombosis and bowel infarction. Untwisting the volvulus does not always restore blood supply to the intestine because of mesenteric vascular thrombosis related to the severity of the twist. If the blood supply is not restored, necrosis and loss of intestine will occur. To limit resection at the time of the first operation, intestine of doubtful viability is often left in situ. A second look laparotomy is then performed after 24 to 48 hours in the hope that some compromised bowel will have recovered. Faced with complete necrosis of the small intestine, some surgeons advocate withdrawal of care.

We report for the first time a therapy specifically directed at the mesenteric thrombosis, which causes ongoing intestinal ischemia after derotation. This involves the use of a combined treatment comprising digital massage of the mesenteric vessels after derotation followed by continuous infusion of recombinant tissue-type plasminogen activator (tPA).

**PATIENT PRESENTATION**

**Patient 1**

A 6-day-old term boy infant was transferred to our tertiary referral center with signs of intestinal obstruction. Birth weight was 2920 g. Vomiting commenced on the first day after birth and soon became bile stained. On arrival in our hospital, the infant was clinically stable, and an upper gastrointestinal contrast study revealed obstruction in the third part of the duodenum. Surgery was performed at 41 hours of age. The findings were of a 720-degree volvulus with apparent infarction of the entire small bowel. The intestine was black, thinned, and there was blistering of part of the wall. The appearance of the intestine did not improve after derotation.

**Patient 2**

A 6-day-old girl born at 29 weeks gestation secondary to maternal antepartum hemorrhage was transferred to our hospital. Birth weight was 1498 g. Feeds were commenced on day 3 after birth but were not tolerated. Bilious vomiting, apnea, and hypotension were presumed due to sepsis. The infant’s symptoms did not improve, and an upper gastrointestinal contrast study, performed 48 hours later, was suggestive of malrotation and volvulus. On transfer she required minimal ventilatory support, was cardiovascula rly stable, but had a distended and tender abdomen. The patient underwent surgery within 4 hours of arrival. Laparoscopy was initially performed and immediately converted to a laparotomy because of visualization of necrotic intestine. The findings at laparotomy were of a 540-degree midgut volvulus with apparently necrotic jejunum and severe ischemia of the distal ileum (Fig 1A). Again, no visible improvement was noted with simple derotation of the intestine.

In both cases, after derotation, the intestine was exposed at room temperature, and digital massage of the mesenteric vascular tree intermittently for a total of 10 minutes was performed in an attempt to disrupt intravascular thrombus. This resulted in slight improvement of the appearance of the terminal ileum, but the appearance of the remainder of the small bowel remained unchanged. A Ladd’s procedure was performed before closure. Based on our favorable experience with tPA use in infants with ischemic limbs, we elected to use systemic tPA in these infants. At 6 hours postoperatively, intravenous tPA (alteplase) was given for 18 hours according to a protocol we developed for use in critical limb ischemia. Fresh-frozen plasma and low molecular weight heparin were given as we have previously reported. Coagulation parameters were monitored, and fibrinogen was maintained at levels >1 g/L. Cranial ultrasound examinations before and after the tPA infusion were normal.

Second look laparotomy was performed at 48 and 36 hours, respectively. In both neonates, the entire small bowel was well vascularized and viable (Fig 1B). The mesenteric arteries were visibly pulsating. Self limiting venous ooze was seen around the mesentery of the first patient.

In the first patient, tPA was restarted 6 hours after the second laparotomy but stopped after a further 8 hours because of suspected intra-abdominal bleeding. The infant recovered from surgery without further complications and was...
discharged from the hospital by day 20 on full enteral feeding. He is now 2 years of age, he has not required further admissions to the hospital, and he is growing along the 75th centile for weight and height.

In the second patient, no further tPA was given after the second look laparotomy. Enteral feeding was commenced on the ninth postoperative day but was not well tolerated. An upper gastrointestinal contrast study a week later suggested a jejunal stricture without complete obstruction. At operation, 6 weeks after the second look laparotomy, dense adhesions to the liver were found and a resection of 10 cm of jejunum was required. The remainder of the gut appeared well perfused and healthy. Enteral feeds were recommenced on the sixth postoperative day. The neonate reached full enteral feeding on postoperative day 22 and was transferred initially to her local hospital and then discharged from the hospital. She is now 20 months old, growing according to appropriate centiles for age.

DISCUSSION

Critical intestinal ischemia due to mesenteric thrombosis can persist after derotation of midgut volvulus and can lead to devastating consequences. There has been no successful treatment of this thrombosis. This is the first report of a successful combined treatment (massage and systemic tPA) specifically directed at the intravascular thrombosis, which is a consequence of the volvulus.

Our use of digital massage in this setting was based on our experience with limb and digital ischemia where dramatic reperfusion has sometimes occurred with this maneuver. Disruption of arterial thrombus by massage will result in fragments of blood clot passing downstream into the mesenteric vessels more distally. However, once the thrombus passes beyond the initial branching of the superior mesenteric artery, there is the possibility of collateral vessels improving blood supply to the gut. Disruption of venous thrombus will presumably allow clot to pass into the liver through the portal vein. The liver has a dual blood supply and we have not, so far, seen clinical signs of portal vein thrombosis or any other deleterious effects from this phenomenon.

tPA is a recombinant protein with thrombolytic activity. It exerts its effects by binding to clot-bound fibrin. This complex produces plasmin at the site of clot, which is then dissolved. Fresh-frozen plasma is given to provide plasminogen for subsequent activation thereby enhancing the thrombolytic effect. tPA has a half-life of 5 minutes, is not associated with a prolonged hypocoagulable state, and therefore does not need reversal. At low dose a systemic proteolytic state will not be induced. We advise monitoring of fibrinogen plasma levels, and this should remain above 1 g/L during low dose treatment.

tPA has been widely used in adult practice for acute myocardial infarction, pulmonary embolism, and mesenteric vascular occlusions. In the latter, tPA has been delivered directly to the site of thrombosis. Its use in infants and childhood has been limited to date.
It has been advocated mainly for empyema and obstructed central venous and peritoneal dialysis catheters. It has been recommended for dural sinus thrombosis in children, and there is a case report of its use in a neonate with aortic thrombosis due to protein S deficiency. However, in this infant, the intestine was not affected.

At our institution, we have also used tPA systemically for peripheral arterial occlusion in infants and children. We have chosen the systemic route rather than subject the infant to the additional risk of arterial catheterization. Nevertheless, systemic fibrinolysis is of concern because the use of tPA in infants is associated with a small risk of intraventricular hemorrhage. In the unlikely event that bleeding occurs, tPA infusion should be stopped and cryoprecipitate given.

CONCLUSIONS

We strongly recommend this combined treatment in patients with critical intestinal ischemia after derotation of a midgut volvulus. This novel form of treatment is simple and should be performed in the acute setting. In our experience, this has resulted in dramatic improvement in intestinal perfusion and rescue of irretrievably damaged small bowel.

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