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Subtotal splenic embolization is a safe and effective treatment for isolated splenic vascular tumors associated with consumptive coagulopathy

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Abstract

Consumptive coagulopathy is a known complication of large vascular tumors. We describe two episodes of consumptive coagulopathy in young children which were secondary to isolated splenic vascular tumors. One child was successfully treated by subtotal embolization of the spleen, while the second required splenectomy after an initial embolization improved — but did not fully control — his consumptive coagulopathy.

Keywords

Kasabach-Merritt syndrome; thrombocytopenia; consumptive coagulopathy; localized intravascular coagulation; hypofibrinogenemia

Introduction

Kasabach-Merritt phenomenon describes a consumptive coagulopathy arising as a consequence of a vascular tumor, usually of congenital type [1, 2]. The most likely pediatric vascular tumors to cause Kasabach-Merritt phenomenon are tufted angiomas and kaposiform hemangioendothelioma [3]. These angiomas differ from common “strawberry” angiomas by appearance (darker colored, generally larger in size) and by histology [4]. The coagulopathy can be severe, resulting in life-threatening bleeding [5]. Many of the vascular tumors causing Kasabach-Merritt phenomenon are cutaneous. However, visceral vascular tumors also occur in childhood, and they can represent an occult cause of consumptive

coagulopathy in an otherwise healthy patient [6]. The mortality rate of pediatric consumptive coagulopathy caused by visceral vascular tumors is 20 percent, in part due to a historically poor response to pharmacologic treatments [5, 7]. When isolated splenic vascular tumors cause consumptive coagulopathy, surgical splenectomy is often curative, but at the cost of a life-long increased risk of overwhelming sepsis [6, 8-10]. We describe two cases of consumptive coagulopathy in which subtotal splenic embolization was performed with the goal of correcting the life-threatening coagulopathy while preserving splenic function.

Case report

Patient 1 presented at 23 months of age with a chief complaint of vomiting and lethargy and no significant past medical history. He had ecchymoses over his eyes, abdomen, flank and lower extremities, without a history of significant trauma (Figure 1C). He had marked thrombocytopenia and evidence of consumptive coagulopathy (Table 1). He also was anemic, with a hemoglobin of 4.6 g/dL with 9% reticulocytes and evidence of schistocytes on his peripheral blood smear (Figure 1B). His spleen was palpable. A bone marrow aspiration was negative for malignancy. A CT scan showed heterogenous uptake of contrast in the spleen. An ultrasound of the abdomen showed an enlarged spleen measuring 11 cm sagittally, with heterogeneity and hypodense areas consistent with vascular malformation. The rest of his visceral organs appeared normal by CT and ultrasound, with no evidence of other vascular tumors.

He received blood product support, additional vaccination against *Pneumococcus*, and then interventional radiology performed a subtotal embolization of his spleen, using tris-acryl gelatin microspheres (Embospheres; Biosphere, Rockland, MA) injected into the splenic artery. Shortly after the procedure, he had a rapid improvement in his platelet count, fibrinogen and coagulation parameters. These numbers remained within or above the normal range, and a follow-up nuclear medicine spleen scan performed three months after the embolization showed a rim of spleen with normal function. At that time, the patient's D-dimer, fibrinogen, PT and aPTT had all normalized (Table 1). The patient continues to do well, more than 2 years after the embolization procedure. Due to residual splenic function, he is no longer on penicillin prophylaxis.

Patient 2 presented at 23 months of age with a chief complaint of a substantial increase in his head size. He had no significant past medical history. Computerized tomography of the head performed prior to referral revealed a large subgaleal hematoma without other abnormalities of the skull or brain (Figure 1E-G). The family reported an increase in head size in the four weeks after he had fallen and hit his head. His hemoglobin was 6.4 g/dL with 6% reticulocytes and a MCV of 75 fl. The blood smear showed thrombocytopenia and hypochromic erythrocytes with moderate polychromasia and schistocytes. He had evidence of consumptive coagulopathy with thrombocytopenia, hypofibrinogenemia and elevated D-dimer (Table 1). His spleen was palpable 6 cm below the left costal margin, and by ultrasound it measured 13.5 cm sagittally, with heterogeneous parenchyma. A CT scan of his abdomen revealed multiple round, hypodense lesions in the spleen with faint increasing contrast enhancement with delayed phase imaging, consistent with vascular tumors. The remainder of the patient's visceral organs appeared normal. He received blood product support with platelets and fresh frozen plasma. He was vaccinated against *Menigococcus* and *Pneumococcus* before undergoing subtotal splenic artery embolization using Embospheres. After the procedure, his fibrinogen and platelet count returned to the normal range. He was discharged from the hospital on oral penicillin and iron supplementation.

Over the next several months, while he maintained a normal platelet count and his hemoglobin normalized, he continued to have mild hypofibrinogenemia and elevated D-dimers (Table 1). He underwent complete splenectomy, with subsequent resolution of his coagulopathy. Histopathologic evaluation showed papillary growths of cells positive for endothelial markers CD31, CD34 and CD68, consistent with littoral cell angioma [11, 12]. He has been maintained on daily oral penicillin for prophylaxis, but he did develop pneumococcal sepsis three months after his splenectomy. He successfully received intravenous antibiotics and now is well with no evidence of ongoing consumptive coagulopathy.

Discussion

While Kasabach-Merritt phenomenon is a known complication of vascular tumors in infants, consumptive coagulopathy due to isolated splenic vascular tumors has rarely been reported [13, 14]. Agents such as steroids, interferon alpha or chemotherapy may be effective, but these visceral vascular tumors are often refractory to pharmacologic treatments [2, 7]. While splenectomy is usually curative, [8, 9] in pediatric patients total removal of the spleen is undesirable, given the increased susceptibility to infection with encapsulated bacteria, necessitating penicillin prophylaxis at least through childhood [10].

In these two cases, subtotal splenectomy was performed by interventional radiology employing splenic artery embolization. The technique involves peripheral permanent occlusion of a portion of the spleen, which will increase platelets sufficiently and limit post embolization pain. More proximal occlusion of the splenic artery with coils or other occlusive agents can result in collateral reperfusion of the spleen. Permanent distal occluding agents, including polyvinyl alcohol foam particles and Embospheres are inert noninflammatory particles that are injected slowly, allowing the particles to pack distally. The particle size chosen is approximately 300 micron particles to allow for good distal arterial packing. Onyx (ev3, Irvine, CA) ethylene vinyl alcohol copolymer can also be used to occlude blood vessels feeding vascular tumors and hemangiomas [15, 16]. In the cases presented here, the use of embolic particles allowed for fine control of the amount and location of occlusion, an important consideration when the goal is to preserve splenic function. Employing a variety of modalities, subtotal splenic embolization is an accepted technique for treatment of hypersplenism in children [17].

In the first patient, this approach led to resolution of the coagulopathy with preservation of residual splenic function. In the second patient, embolization was partially effective, in that his symptoms resolved, but laboratory evidence of a consumptive coagulopathy continued. A surgical splenectomy was performed, leading to resolution of the coagulopathy. The patient's splenic lesions radiographically had appeared to be littoral cell angioma, a benign vascular tumor of the spleen, which has endothelial and histiocytic characteristics and is rarely seen in children [11, 18, 19]. Repeat embolization of part of the remaining spleen was considered as a function-sparing alternative, but due to the radiographic appearance of the lesions, the staff and family chose surgical splenectomy. The diagnosis of littoral cell angioma was confirmed by histopathologic examination of the removed spleen.

The recent case reports of success treating large congenital vascular tumors with propranolol provide another potential treatment for vascular tumors [20]. Although some case reports describe successful treatment with propranolol of hepatic hemangiomas in infants [21, 22], it is not clear that the success of propranolol in treating congenital cutaneous vascular tumors will extend to visceral vascular tumors in older children, such as described here. Trials evaluating propranolol as an agent for cutaneous and visceral vascular tumors of childhood are currently underway [23, 24]. Subtotal splenic embolization is a minimally invasive

treatment of isolated splenic vascular tumors, and it provides the benefit of prompt symptomatic relief with the potential to preserve sufficient splenic function.

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Figure 1.

Clinical manifestations of splenic vascular tumors causing life-threatening consumptive coagulopathy. A. CT scan of patient 1 at presentation, showing a markedly heterogeneous spleen (arrow). B. Peripheral blood smear of patient 1 at presentation, showing thrombocytopenia and schistocytes (arrow). C. Consumptive coagulopathy presenting as multiple cutaneous ecchymoses in a toddler. D. CT scan of patient 1 after splenic embolization, showing resolution of the heterogeneous pattern (arrow). E. Consumptive coagulopathy presenting as sub-galeal hematoma in patient 2. F, G. CT scan of head of patient 2 at presentation, showing extensive subgaleal hematoma without evidence of intracranial bleed.

Table 1
Change in hematologic parameters after subtotal splenic embolization

Patient 1	Fibrinogen Normal range=150-450 mg/dL	D-dimer Normal range=0-2.27 mg/L¹¹	aPTT Normal range=22.8-33.3 sec	PT (sec) Normal range=9.6-11.5	Platelets Normal range=150-350 mm³
At presentation	49	>55	74	39	5,000
7 days post embolization	603	2.5	26.1	13.7	1,022,000
3 months post embolization	244	1.88	27.4	11.9	307,000

Patient 2	Fibrinogen (mg/dL)	D-dimer (mg/L)	aPTT (sec)	PT (sec)	Platelets (mm³)
At presentation	54	12	29.7	16.8	18,000
7 days post embolization	205	12	26.1	12.1	290,000
3 months post embolization	99	13	26.2	12.1	160,000
6 months post splenectomy	249	2	23.1	11.0	242,000