Profuse bleeding from traumatic lateral plantar artery pseudoaneurysm after glass foot injury diagnosed by CT angiography: A case report

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Abstract
Retained foreign bodies and penetrating injuries to the plantar aspect of the foot are a common childhood problem. Inflammations or infections are common complications whereas vascular injury and pseudoaneurysm formation are rare. Three cases of post-traumatic lateral plantar artery (LPA) pseudoaneurysms due to foot lacerations by glass have been reported in children. This case is a six-year-old boy who presented with two episodes of bleeding after a foot laceration sustained when he stepped on glass. CT angiography showed an LPA pseudoaneurysm that was successfully managed by surgery. It should be recognized that penetrating injuries to the plantar aspect of the foot, may be associated with vascular injury and pseudoaneurysm formation. Appropriate investigations and management is important to prevent further complications.

1. Case report

A 6-year-old boy presented to the Emergency room (ER) with broken glass laceration to the plantar aspect of his right foot. Plain radiographs of the foot did not show any foreign body (FB). The wound was primarily repaired after local exploration. Sutures were removed on the tenth day. Three days later, he was seen in the ER with bleeding from the wound that was controlled by a compression bandage. Twenty days after the initial injury, bleeding occurred again when the dressing was removed in the clinic. After control of the bleeding by compression, CT angiography (CTA) of the right foot showed a pseudoaneurysm of right LPA and a small opacity in its wall, which was a retained piece of glass (Fig. 1). Under general anesthesia with tourniquet control, the wound on the plantar aspect of the right foot was reopened and copiously irrigated. A pseudoaneurysm of LPA associated with retained glass fragment was discovered. The glass was removed and the LPA ligated proximal and distal to the pseudoaneurysm and its feeding vessels. After releasing the tourniquet, the circulation to the foot was noted to be adequate. The child was discharged home the following day and upon review in the clinic three months he was well, and has remained asymptomatic for 8 years.

2. Discussion

Retained foreign bodies and penetrating injuries to the plantar aspect of the foot are a common childhood problem. However,
vascular injury and pseudoaneurysms are uncommon. In a pseudoaneurysm, there is a tear in the intimal and medial layers of the artery but the adventitia remains intact resulting in a local hematoma with direct communication with the lumen of the vessel [5]. Subsequently, there is fibrosis in the surrounding tissue together with recanalization so creating a new lumen in the false sac. Three reports of LPA pseudoaneurysms in children were found in the English medical literature, all had sustained foot lacerations from broken glass [2,4].

In a review of all LPA pseudoaneurysms that have been reported in children after foot lacerations including our patient, glass injury has been the cause [2,4]. It is likely that the vascular injury occurs at the initial injury, but it is unrecognized, and pseudoaneurysm forms later. In addition, in all reported cases there is a history of significant bleeding at the time of injury [2,4]. However, this was not so in our patient. Furthermore, all patients had the wounds sutured primarily, and presented later with an enlarging mass in the plantar aspect of the foot. In all cases including ours, bleeding also occurred several days after suture removal. This suggests that any child with excessive bleeding from the site of a foot laceration from glass injury should have a careful clinical examination, a meticulous wound exploration rather than a simple repair, and appropriate investigations to exclude vascular injury. Subsequently, the presence of a recurrent painful swelling, a pulsatile mass at the site of wound repair, or continued decline of hemoglobin without any other cause should be suspicious for LPA pseudoaneurysm and imaging studies are required [1–4].

The imaging modalities for the diagnosis of a pseudoaneurysm include Duplex ultrasonography (US), CTA, Magnetic resonance angiography (MRA) or conventional angiography [1–3,6,7]. Duplex US provides information on size, morphology, flow, neck anatomy and feeding vessels of a pseudoaneurysm [7]. It uses a combination of B-mode for vessel morphology and color pulsed wave Doppler techniques.

In a child with persistent pain or swelling at the wound site following a foot laceration from glass injury, US will differentiate a pseudoaneurysm of LPA from a hematoma or an abscess [3,7]. US is non-invasive, inexpensive, and portable for examination to be performed on the bedside or in the emergency room. However, US is operator-dependent and cannot generate three-dimensional vascular images. CTA of the lower limb was used in this child because two episodes of bleeding from the foot wound suggested a possible vascular injury. CTA has superseded all other imaging modalities as the first-line investigation for suspected traumatic vascular injury [6]. A pseudoaneurysm, its anatomic relations, and bleeding may be demonstrated. CTA has a good diagnostic accuracy with a sensitivity of 95%–100% and specificity of 87%–100%. Studies comparing CTA of the arteries of the lower limbs with conventional angiography have shown it to be comparable in accuracy, more time-efficient, less invasive, and less expensive in diagnosing traumatic arterial injuries [6]. The disadvantages of CTA are radiation exposure and the need for intravenous contrast media. MRA provides excellent quality imaging, delineating the vascular anatomy and flow. Contrast-enhanced MRA has demonstrated sensitivity and specificity ranging from 73% to 93% and 64% to 89% respectively in the investigation of the vasculature of the lower extremities [8]. The disadvantages of MRA include limited accessibility out of hours and weekends, longer time to acquire images, noisier image acquisition and intimidating gantry configuration and susceptibility to artifact in presence of metallic objects. In addition, sedation or general anesthesia may be required for younger children. The modality of choice for the investigation of the vasculature of the lower extremities in children may be influenced by the availability and accessibility of the imaging and expertise in performing and interpreting the results. US can be used in children to establish a diagnosis of LPA pseudoaneurysm. Once a decision to treat pseudoaneurysm has been made, CTA or MRA may be used for precise measurements, detailed anatomic views, and to determine collateral circulation of the foot. If repeated imaging studies are required, US or MRA may be used to decrease the radiation exposure from CTA. At present, conventional angiography, being an invasive procedure is rarely required for the diagnosis of arterial pseudoaneurysm of the foot in children. The procedure can lead to complications including hemorrhage, pseudoaneurysm and thromboembolism.

Some pseudoaneurysms may resolve from spontaneous thrombosis. Because LPA is superficial and not protected by musculature, continued trauma during ambulation does not allow healing and resolution of the pseudoaneurysm to occur [2,3]. Therefore, there is an increased risk of rupture and hemorrhage as was evident in this child. Non-surgical treatments of pseudoaneurysms include external compression, ultrasound guided compression, and ultrasound guided thrombin injection. The use of compression either by bandage or ultrasound for pseudoaneurysm is based on pressure causing spontaneous thrombosis. Successful use of both treatments in LPA pseudoaneurysm would require the child to be non-weight bearing for some time to allow healing. In 2003, Morini et al. suggested that compression bandage and ultrasound guided compression could be used to treat LPA pseudoaneurysm [9]. An infant, who sustained an LPA pseudoaneurysm after Achilles tenotomy was placed in a cast for 4 weeks to correct clubfoot, the pressure on the pseudoaneurysm resulted in spontaneous thrombosis [10]. In ultrasound guided compression, US is used to locate the pseudoaneurysm tract and pressure applied to the aneurysmal sac to the point of flow cessation [7]. Pressure is held in cycles of 10–20 min and the pseudoaneurysm is then reassessed. Absence of flow or the presence of thrombus on US confirms success. Complications include pseudoaneurysm rupture, distal arterial thrombosis and ischemia and recurrence [7]. Success rates of 66%–85% have been reported in adults. This might be a lengthy treatment causing pain and discomfort, so sedation is necessary in children. The neck of the aneurysmal sac of the pseudoaneurysm is compressed with an US probe and the needle’s position is confirmed within the pseudoaneurysm cavity in ultrasound guided thrombin injection. Injection of thrombin is stopped when thrombosis occurs [7]. Ultrasound guided thrombin injection has been used successfully in a child with medial plantar pseudoaneurysm, but not in LPA pseudoaneurysm [11]. Success rates are 93%–100% and recurrence rates are 3% in adults. Children may require sedation or general anesthesia for this procedure. Complications of this treatment include local infection, arterial thrombosis and/or thromboembolism and allergy to bovine thrombin.
repair of LPA pseudoaneurysm in children should be reserved for complications such as rupture and bleeding as occurred in our patient, and/or expanding pseudoaneurysm. Because of adequate collateral circulation and absence of vessel disease, we believe ligation of both ends of LPA may be performed successfully [2,4,12]. Morini et al., have expressed concern about the possibility of LPA ligation resulting in foot ischemia and its sequelae, including work intolerance, extremity growth retardation, and ulcerations [8]. So far, there has not been any report of such complications in children treated with arterial ligation. To avoid these complications, preoperative assessment of established collateral circulation of the foot should be performed in children with LPA pseudoaneurysm. The posterior tibial artery can be compressed at the ankle and the loss of pulsation in the pseudoaneurysm and perfusion of the forefoot assessed by DUS [11]. Subsequently, the equivalent of the Allen test in the foot is performed by maintaining compression on the dorsalis pedis artery and assessing complete filling of the forefoot [12]. In the operating room and after tourniquet control, vascular clamps are applied to the LPA, proximal and distal to pseudoaneurysm. Subsequently, the tourniquet is released to check for perfusion to the foot. If circulation is adequate, the LPA is ligated and circulation to the foot reassessed [2,4,12]. However, if there is any doubt about the circulation to the foot, arterial repair or reconstruction must be considered. Arterial repair and reconstruction in children require a substantially different approach from that used in adults. Many factors must be considered in children, which include vessels of small caliber, higher propensity for spasm, risk of infection, the children’s capability to rapidly develop collateral circulation, the inevitability of growth, and strong tendency for stenosis and growth arrest to occur. The methods to reconstruct arteries include primary repair, vein patch angioplasty, and interposition repair using reversed greater saphenous vein, other autologous vein, or synthetic grafts [13]. Children who undergo treatment for LPA pseudoaneurysm require long term follow-up to monitor the growth and any circulatory problems with the foot.

3. Conclusion

Traumatic LPA pseudoaneurysm is uncommon in childhood. It must, however, be appreciated that penetrating injuries to the plantar aspect of the foot from glass may be complicated by vascular injury and the formation of LPA pseudoaneurysm. US, CTA or MRA may be used in establishing diagnosis. Non surgical treatment could be used for the asymptomatic pseudoaneurysm and surgery reserved for complicated lesions. In children with adequate collateral circulation ligation of LPA at both ends may be performed successfully. However arterial reconstruction may be indicated if collateral flow is inadequate. Early diagnosis and appropriate management of traumatic LPA pseudoaneurysm is important to prevent complications such as rupture and bleeding.

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References