Upper Limb Salvage With Endovascular Treatment of Acute Axillary Artery Occlusion Secondary to Proximal Humeral Fracture

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ABSTRACT: Acute axillary artery occlusion associated with proximal humeral fracture is rare. Traditionally, axillary artery complications associated with humeral fractures are managed with open surgery. However, open vascular repair presents a considerable challenge to even the most skilled surgeons. Endovascular treatment (EVT) offers an alternative to surgical management. We describe the case of an 82-year-old Japanese male with acute upper limb ischemia (AULI) secondary to acute axillary artery occlusion caused by a proximal humeral fracture. He was successfully treated with EVT. Unless there is vessel transection, EVT is feasible and offers a minimally invasive and prompt therapy for AULI resulting from axillary artery occlusion.

Key words: endovascular management, acute upper limb ischemia, proximal humeral fracture

A cute upper limb ischemia (AULI) is much less commonly encountered and clinically recognized than acute ischemia of the lower limb.1 According to a previous report, the early commencement of revascularization is crucial for limb salvage in patients with AULI.2 Sudden axillo-subclavian artery occlusion is one cause of AULI. However, it rarely occurs as a complication of proximal humeral fracture.3 Although there are some reports on endovascular treatment (EVT) for the management of axillo-subclavian artery injuries, such as lacerations, pseudoaneurysms, and arteriovenous fistulas,4 there are only a few reports on its application in acute axillo-subclavian arterial occlusions.5,6 We present a case demonstrating the value of immediate EVT in the management of AULI secondary to acute axillary artery occlusion caused by a closed humeral fracture.

CASE PRESENTATION

An 82-year-old Japanese male presented with severe pain in the left shoulder and arm, with discoloration of hand and fingers, 2 hours after falling at home. His medical history included osteoporosis and prostate cancer that were well controlled with medical treatment. On admission, his vital signs were stable. On physical examination performed approximately 2 hours after
Figure 1. Radiograph showing proximal fracture of the left humerus before (A) and after closed reduction (B).

Figure 2. Serial computed tomography images of the left axilla showing the axillary artery (large arrow), occluded near the fracture site without contrast extravasation, and a piece of fractured humerus bone (small arrow). Images are viewed in a cranial (A) to caudal (B) direction.
the fall there were no brachial, radial, or ulnar pulses in the left arm. There were no open wounds. The hand and forearm were pale and cool, but the skin of the fingers was dark, indicating critical ischemia. In spite of mild hypoesthesia, there was no weakness in his hand and fingers. His hemoglobin was 9.6 g/dL and the estimated glomerular filtration rate was 71.9 mL/min/1.73 m². The serum creatine kinase level was 123 IU/L. An initial radiography of the left shoulder revealed a three-part fracture of the left proximal humerus with severe medial displacement, according to Neer classification. To restore blood flow, he underwent immediate closed reduction under interscalene brachial plexus block (Figure 1). However, the distal pulses were still not palpable and the fingers remained dusky. An early phase contrasted computed tomography (CT) scan showed an abrupt obstruction of the left axillary artery adjacent to the fracture site, without evidence of contrast extravasation. This finding suggested occlusion associated with an intimal tear caused by the displaced shaft of the humerus rather than arterial transection. Late-phase contrasted CT images revealed a faint visualization of the brachial artery distal to the occluded axillary artery (Figures 2 and 3). His upper limb was thought to be salvageable because of the lack of weakness in his left hand and fingers.

**TREATMENT**

At first, thromboembolectomy with a Fogarty catheter or bypass surgery was considered as the primary procedure. However, there were no experienced surgeons on duty at nearby tertiary hospitals who could immediately perform such operations. Therefore, we opted for EVT for upper limb salvage. A transfemoral
approach under local anesthesia was used, with placement of a 6 Fr sheath into the right common femoral artery. Following intravenous heparin (5,000 U), selective angiography was performed. The axillary artery was occluded proximally without the visualization of distal vessels. A 6 Fr JR4 Launcher guiding catheter (Medtronic) was placed in the left subclavian artery with the aid of a 0.035˝ angled soft guidewire. Next, a 5 Fr JR4 Trail diagnostic catheter (Fukuda Denshi) was introduced using the mother-child technique. With the support of the 5 Fr diagnostic catheter antegrade advanced to a point just proximal to the occluded part of the artery, the guidewire was successfully passed through the occlusion and reached the brachial artery. The delivery of a Thrombuster II 6 Fr aspiration catheter (Kaneka Medix) from a femoral artery was not possible because of the tortuous axillosubclavian artery. Therefore, we tried to gain access through the brachial artery. The brachial artery provides a more direct, shorter, and less tortuous approach for the treatment of axillary artery lesions.

Although several attempts at brachial artery puncture were unsuccessful using a 0.035˝ antegrade guidewire as a landmark to obtain retrograde access, we achieved radial access under fluoroscopic guidance and introduced a 6 Fr long sheath. A 0.018˝ Thruway guidewire (Boston Scientific) was passed through the lesion in retrograde fashion, advanced into the guiding catheter in the left subclavian artery, and retrieved with a Goose-neck snare (ev3) to gain sufficient backup force. Next, aspiration thrombectomy via the transradial approach was performed using an aspiration catheter, and several large thrombi were aspirated from the axillary artery (Figure 4). With distal vessel angiographic visualization following aspiration, a 6 mm × 40 mm Sterling balloon catheter (Boston Scientific) was advanced over
the guidewire. The balloon was inflated at 8 atmospheres for 60 seconds. After the balloon dilatation, the distal blood flow was only partially restored and the cyanosis of the upper limb did not resolve.

We observed a flow-limiting, angiographically identifiable dissection that extended from the axillary artery to the subclavian artery. Therefore, we deployed a 6 mm × 40 mm SMART Control self-expandable stent (Cordis Corporation) distally and a 6 mm × 120 mm counterpart proximally, avoiding the origin of the vertebral artery. Unfortunately, there was a gap between the stents; therefore, an additional 6 mm × 18 mm Palmaz Genesis balloon-expandable stent (Cordis Corporation) was placed between them (Figure 5).

After postdilatation, the patency of the vertebral and internal thoracic arteries was protected and brisk flow was achieved in the axillary artery within 6 hours of the onset of symptoms (Figure 6). Strong brachial and radial pulses became palpable and the cyanosis of the upper limb disappeared. He suffered a right-sided cerebellar stroke, which was associated with the procedure, but symptoms including dizziness and nausea were controlled with conservative treatment. Double antiplatelet therapy was initiated with clopidogrel 75 mg/day and aspirin 100 mg/day. He underwent open reduction and an internal fixation of the proximal humeral fracture 1 month after EVT. He was discharged well after undergoing rehabilitation, and to date, he has had no symptoms of residual ischemia.

**DISCUSSION**

The most common causes of AULI include embolism (47%) and thrombosis (28%), whereas trauma accounts for only 25% of cases. In addition to direct arterial
trauma, remote arterial trauma can cause AULI when traction on a blood vessel causes an injury to the vessel at a site distant from the evident bony or soft tissue damage. In particular, the violent overstretching of an artery under hyperabduction can precipitate acute arterial injuries, which can involve a total or partial rupture of all arterial layers or intimal damage only, causing lumen occlusion. Although axillary artery injury sometimes occurs with shoulder dislocation and clavicle fractures, it is rarely concomitant with proximal humeral fractures.

Although open surgery has become the mainstay of primary treatment for acute upper limb ischemia related to trauma, the procedure is technically demanding, even for experienced operators. Furthermore, it often takes time to obtain reperfusion because of the anatomical complexity of the arteries that are adjacent to the clavicle and brachial plexus. In contrast, thromboembolectomy with a Fogarty catheter has gained widespread acceptance as first-line treatment for the management of nontraumatic AULI. The rate of limb salvage following thromboembolectomy has been reported as 98%.

EVT is seldom indicated, and consequently has been rarely used as the concurrent treatment of both traumatic and nontraumatic AULI. To our knowledge, there are few case reports on EVT for occluded axillosubclavian arteries associated with blunt trauma, including clavicular and scapular fracture. However, no reports on EVT for an occluded axillary artery related to proximal humeral fracture have been published. This may be because the number of cases is small. The humerus is more distant from the axillary artery than the clavicle and scapula, and fractures of the humerus rarely compromise the axillary artery.

The occurrence of AULI represents an emergency indication for surgical intervention to prevent gangrene of the affected extremity. If the arm is to be successfully salvaged in patients with AULI, revascularization should be achieved within 6 hours of the onset of symptoms. Therefore, an immediate access to vascular surgeons capable of accomplishing complex operations is crucial. If the restoration of blood flow is delayed, there is a risk of acute renal failure secondary to myoglobinemia. However, the immediate availability of skilled vascular surgeons may be limited, particularly in rural areas in Japan. In this setting, EVT is a viable alternative to surgery. In the present case, EVT was used to prevent critical ischemia and successfully salvage the upper limb of the patient.

In general, EVT is feasible unless there is hemodynamic instability, vessel transection, or the absence of an adequate proximal vascular fixation site. One major advantage of EVT over open surgical repair is that general anesthesia is not required, enabling faster revascularization and minimizing blood loss. Furthermore, EVT can be immediately performed after diagnostic angiography, in which vascular access remote from the local injury is obtained. Kim et al described the efficacy of percutaneous aspiration thromboembolectomy using a 6 Fr or 7 Fr guiding catheter via a transbrachial approach with placement of a 7 Fr sheath. Successful recanalization was achieved in all 11 patients enrolled in that study, although no cases of concomitant trauma such as fractures were included. In our case, although we made several attempts under fluoroscopic guidance, we were unable to obtain brachial access. Although ultrasound-guided retrograde arterial access in the
brachial artery would have made the procedure faster, we were inexperienced in the procedure. Therefore, we opted for a more familiar procedure, radial access under fluoroscopic guidance. Brachial access usually allows the use of a 7 Fr sheath. Instead, we obtained radial access and selected a 6-Fr sheath because a 7-Fr one was too large to insert into his radial artery. Despite use of a 6 Fr aspiration catheter, by repeating aspiration and stent placement, a large amount of thrombus was aspirated and acceptable reperfusion was achieved within the critical period for limb salvage.

Although 5- to 10-month patency has been reported in a few cases, the long-term results of deploying stents in the axillary artery have not yet been well investigated. In the present case we had no alternative because upper limb ischemia persisted even after balloon dilatation and the aspiration of the thrombus. Long-term follow-up is required to confirm stent patency in this patient.

We believe that, for choosing the type of stent for axillary artery, the following factors are important: acceptable flexibility and sufficient radial strength. SMART Control stents demonstrate these factors. Therefore, we used these stents to cover the axillary artery lesion. In general, the axillary artery and superficial femoral artery are similar because they have high mobility. We speculate that the clinical effectiveness of the SMART Control stents for both axillary artery and superficial femoral artery lesions may be similar. The evidence of the long-term result of the SMART Control stent for superficial femoral artery lesions has been established. As for a balloon-expandable stent (Palmaz Genesis), although it was not suitable for axillary artery lesions because of the lack of flexibility, we had to use it for covering a short gap between the two SMART Control stents. From our experiences, a balloon-expandable stent does not increase the likelihood of stent strut fracture if it is short.

There are potential procedure-related complications associated with the use of EVT for acute axillo-subclavian artery occlusion secondary to trauma. The risk of distal embolization during recanalization of an occlusion must be considered. The placement of the stent near the origin of the vertebral artery should be avoided to prevent vertebrobasilar embolization. Consideration must also be given to the possibility that traversing the occlusive lesions with a guidewire may cause bleeding because the occlusion may be the result of partial or complete arterial transection. Therefore, a CT must be performed before the procedure to determine whether there is a hematoma around the artery or a hemothorax. Either of these findings suggests the transection of the artery, in which case open surgical repair is a preferred treatment option.

CONCLUSION

In the management of AULI, treatment should be initiated as early as possible after the onset of ischemic symptoms. EVT offers a minimally invasive and prompt alternative to open surgery or thromboembolectomy with a Fogarty catheter for AULI resulting from an occluded axillary artery.

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REFERENCES


