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Case Series

Axillary artery and brachial plexus injury secondary to proximal humeral fractures: A report of 2 cases

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ABSTRACT

INTRODUCTION: Axillary artery and brachial plexus injuries have been reported to be associated with proximal humeral fractures. In this report, we present two cases of axillary artery and brachial plexus injury secondary to proximal humeral fracture.
PRESENTATION OF CASES: Case 1: An 88-year-old woman with cognitive impairment slipped and fell at home. The diagnosis was left proximal humeral fracture. The second day, paralysis of left upper arm due to left axillary artery occlusion appeared. Axillary-brachial artery bypass surgery was performed. After that, a radial artery pulse was palpable. Ten months have passed since the operation, but the neurologic deficit has not been restored. Case 2: A 74-year-old woman fell from a ladder. She was diagnosed with a right proximal humeral fracture and right axillary artery occlusion. Emergency axillary-brachial bypass surgery and osteosynthesis were performed. After reestablishing the blood flow, there have been no signs of blood flow disorders but paralysis has remained.
DISCUSSION: In neither of the two cases, were obvious findings of brachial plexus injury detected during surgery. The delayed onset of motor palsy implied that an ischemic factor was implicated in case 1. The acute onset of motor palsy might have been caused by a mechanical factor such as the dislocated of humeral head in case 2.
CONCLUSION: Axillary artery and brachial plexus injury secondary to proximal humeral fracture is rare but it can develop severe sequels. By identifying the high-risk patients, diagnosis and management of this vascular and plexus injury might lead to improvement.

1. Introduction

Proximal humeral fractures constitute 4–5% of the total fractures in the body [1]. In epidemiological investigations looking at the number of fractures, proximal humeral fractures frequently occur in women older than 60 years and the incidence increases with age [2]. In 2010, 40,000 cases were reported in Japan, and it is predicted that the prevalence will exceed 50,000 cases by 2030 [3]. This is due to the increasing number of fractures associated with osteoporosis and minor trauma in patients over 80 years, with the background of the super-aged Japanese population.

Axillary artery and brachial plexus injuries have been reported to be associated with proximal humeral fractures, which are rare [4–8]. Menendez et al. reported that there was only 0.09% of patients with proximal humeral fractures with concomitant axillary artery injury [9]. Axillary artery injury is a serious complication that necessitates surgical repair in case of severe distal ischemia. The severity of injury to peripheral nerves varies from lesions in continuity, where spontaneous recovery is expected unless there is an ongoing insult, to lesions with loss of continuity, which require early surgical repair if there is to be any chance of recovery [7]. Therefore, cases that require surgical repair or decompression should be identified and referred early for specialist management. In this report, we present two cases of axillary artery and brachial plexus injury secondary to proximal humeral fracture.

This Case series has been reported in line with PROCESS criteria [10].

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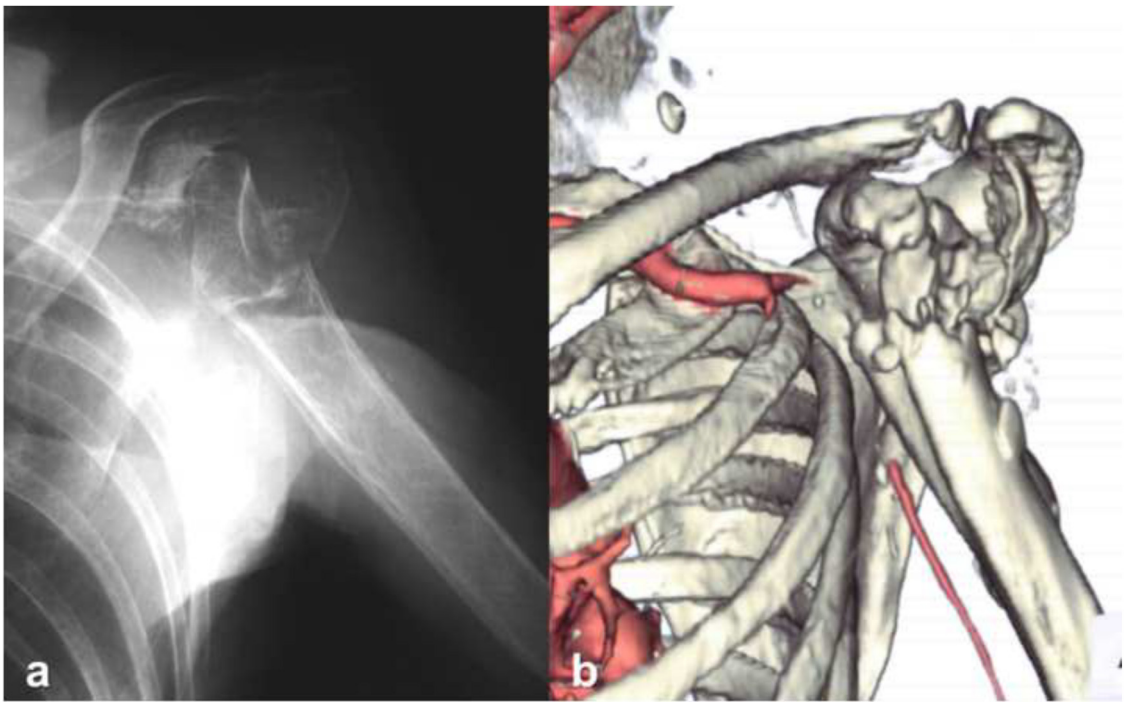

Fig. 1. Case 1. An 88-year-old woman who had a large hematoma on the anterior part of the left shoulder. The proximal humeral fracture was severely displaced (a). CT angiography revealed disruption of the axillary artery blood flow at the level of distal of thoracoacromial artery (b).

2. Report of the cases

2.1. Case 1

An 88-year-old woman with cognitive impairment slipped and fell at home. She complained of left shoulder and hip pain and was unable to step, and visited an orthopedic clinic on the next day. History taking was difficult because of the poor verbal communication and short-term memory loss secondary to cognitive impairment. Physical examination revealed a large hematoma on the anterior aspect of the left shoulder. Active range of motion of the left shoulder was severely limited due to pain, while motor function was intact distal to the elbow. Radial pulse was palpable. Radiographs showed fracture dislocation of the shoulder, which was classified as C3 according to the Arbeitsgemeinschaft fur Osteosynthese Fragen (AO) classification. The proximal humerus was broken into 4 major parts, which were the greater and lesser tubercles, humeral head displaced inferior to the glenoid, and proximal humeral metaphysis angulated valgus at the fracture site (Fig. 1a). She complained of left hip pain that was caused by the intertrochanteric femoral fracture, and therefore she was admitted for surgery.

On the second day of hospital stay, cyanosis was noted in the fingers of the left hand and SpO_2 decreased to 82%. Active motion of the left elbow, wrist and fingers was completely lost and the withdrawal reflex was not elicited upon painful stimulation of the lateral side of the upper arm, forearm or hand. An angiogram revealed defective blood flow through the left axillary artery and inflow of contrast agent into the brachial artery through the collateral circulation. Computed tomography (CT) angiography revealed that the blood flow through the axillary artery was disrupted distal to the origin of the thoracoacromial artery (Fig. 1b). The brachial artery was enhanced distally from the level of the proximal one-fourth of the humeral shaft.

Surgical repair of the left axillary artery occlusion was performed by vascular surgeons under general anesthesia. A deltopectoral approach was used to expose the fracture and the neurovascular injury site. The outer membrane of the axillary artery was injured (Fig. 2) and a thrombus was formed inside. The brachial plexus was identified and appeared intact. The injured segment of the axillary artery was left in situ and a bypass to the brachial artery was created using an artificial blood vessel (Gor Tex® EPTFE graft

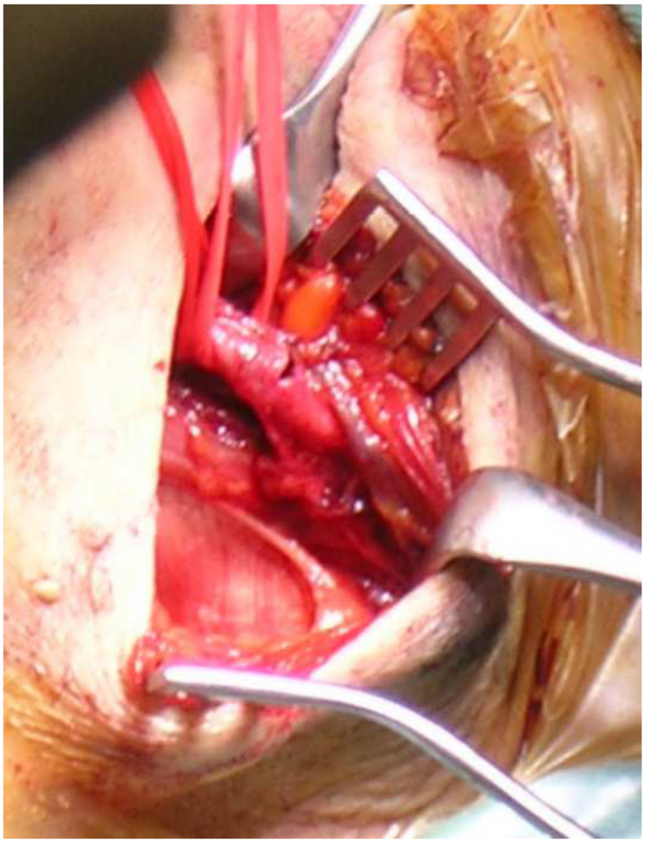

Fig. 2. Injury of the outer membrane of the axillary artery was found.

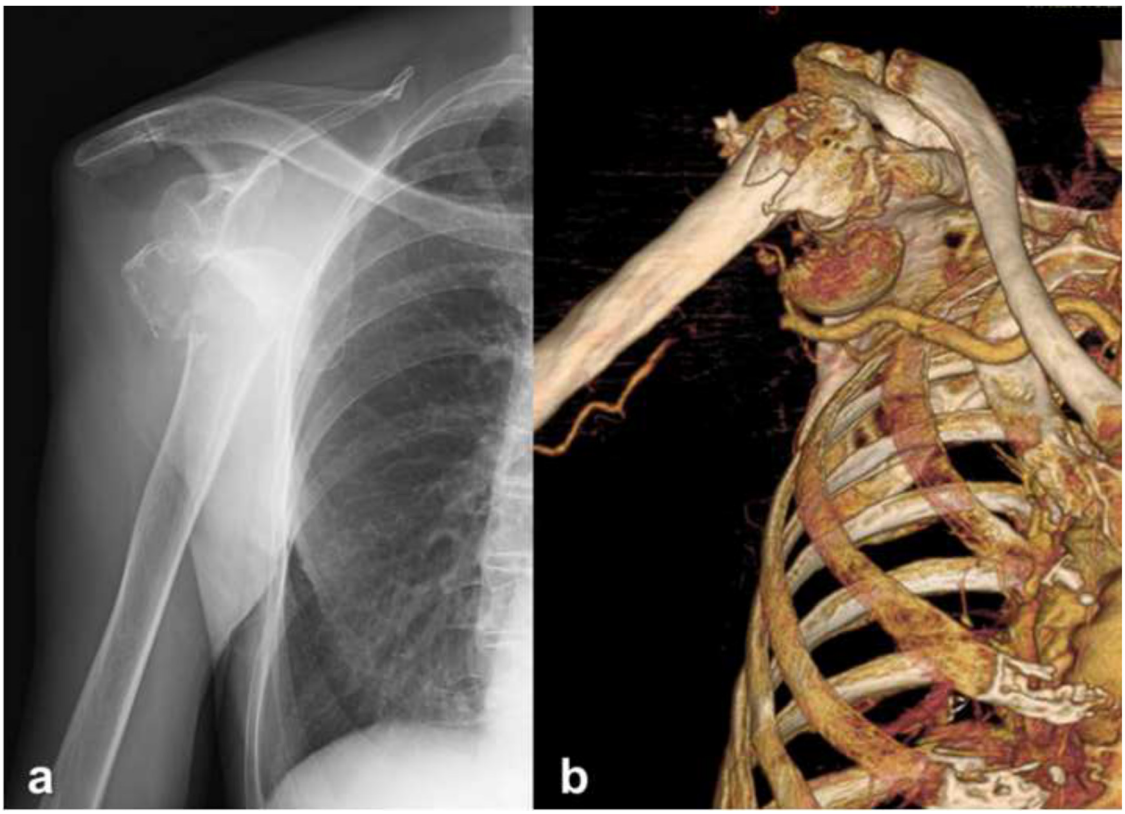

Fig. 3. Case 2. A 74-year-old woman fell down from a ladder (about 1.5 m high) during farm work. She sustained a right proximal humeral fracture (a). CT angiography revealed disruption of the axillary artery blood flow at the level distal to circumflex humeral artery, but the brachial artery was enhanced (b).

with ring, Japan Fore Co., Ltd. medical products division, Tokyo, Japan). Approximately 12 h elapsed between confirming left arm cyanosis until reestablishing blood flow. No surgical procedure was performed for the humeral fracture, apart from humeral head removal, to avoid invasive surgery given the non-dominant arm injury and the patient's old age.

Ten months after surgery, no signs or symptoms of circulatory disorders were reported in the left upper extremity. However, the neurologic deficit was not restored, with residual paralysis of the left arm resulting in functional impairment.

2.2. Case 2

A 74-year-old woman with no significant medical history fell down from a ladder (approximately 1.5 m high) to the ground during farm work. She was bruised on the right shoulder. She visited a private clinic, and then was sent to our hospital. Initial examination revealed a subcutaneous hematoma and tenderness around the right shoulder. Active motion of the right shoulder was severely impaired due to pain. Hyperesthesia was found in the dermatome supplied by the right median nerve, and active flexion of the right thumb, index and middle finger was lost. Radial pulse was not palpable.

Radiographs showed fracture dislocation of the right shoulder, which was classified as type C3 of the AO classification (Fig. 3a). The proximal humerus was broken to 4 parts, which were the greater and lesser tubercles, the humeral head migrated inferior to the glenoid, and the proximal humeral metaphysis was displaced anteromedially. CT angiography revealed disruption of the axillary artery blood flow distal to the circumflex humeral artery, while the brachial artery was enhanced distally from the level of proximal one-fourth of humeral shaft (Fig. 3b).

Vascular reconstruction by vascular surgeons and osteosynthesis by orthopedic surgeons were performed on the same day. Following a deltopectoral approach, the conjoined tendon was reflected by osteotomy of the coracoid process to clearly visualize the axillary artery and brachial plexus. The injured segment of axillary artery was discolored and extended 5 cm distally from the origin of posterior circumflex humeral artery (Fig. 4a). No visible injury was identified in the brachial plexus. The great saphenous vein was transplanted as an axillary-brachial bypass, and thereafter the radial pulse became palpable (Fig. 4b). Approximately 10 h had elapsed from the time of injury until reestablishing the blood flow. After that, the humeral fracture was treated with internal fixation using a locking plate system.

One year and 10 months after surgery, active range of elevation, external and internal rotation was 70°, 0° and T 12, respectively. Radial pulse was palpable. Active flexion of the thumb, index and middle fingers improved. The humeral fracture was completely healed and there was no radiological evidence of osteonecrosis of the humeral head.

The patients's family were asked if data concerning the case could be submitted for publication, and they consented.

3. Discussion

The anatomical position of the axillary artery makes it susceptible to injury secondary to proximal humeral fracture. The relatively "fixed" axillary artery by some branches increases injury risk secondary to shoulder dislocation and/or proximal humeral fracture [11]. Brown GW has additionally proposed a mechanism by which the pectoralis minor muscle acts as a fulcrum for the artery, causing vascular injury by kinking, shearing or compression [12]. In particular, the third part of the axillary artery, extending from the lateral border of the pectoralis minor to the lower border of the

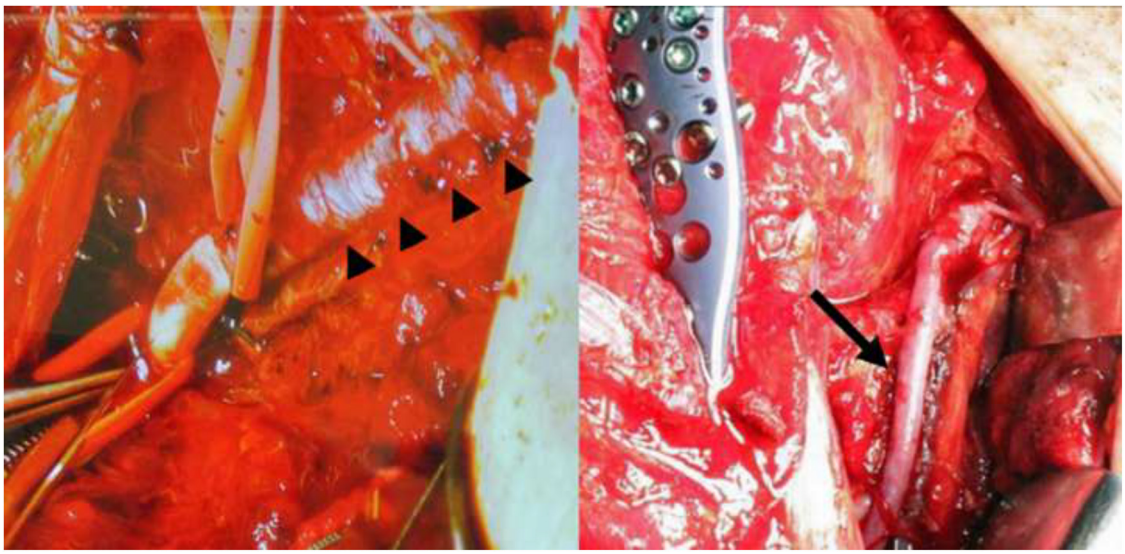

Fig. 4. The arrow-heads shows intimal tear of the axillary artery with a secondary thrombus (a). The arrow shows the great saphenous vein graft, which was transplanted for axillary-brachial bypass (b).

teres major, gives 3 branches (anterior and posterior circumflex humeral arteries and subscapular artery), limiting its mobility and increasing its susceptibility to damage.

Abnormal pulsation of the radial artery can result from arterial injury. Hasan reported that physical examination was highly predictive of vascular injury, with 92% of the patients having abnormal distal pulses [13]. On the other hand, because the upper limbs are rich in collateral circulation, vascular damage cannot be ruled out even if the radial pulse is palpable [14]. It is necessary to confirm the patency of the axillary artery with CT angiography, especially in cases with remarkable anterior shoulder dislocation [15].

Vascular injuries secondary to proximal humeral fractures are uncommon; consequently, a literature review yielded a limited number of case reports. Hasan reported a review of the literature published in English, which consisted of 18 reports on a total of 24 adult patients with acute axillary artery injury associated with proximal humeral fracture secondary to blunt shoulder trauma [13]. The mean age of this group was 63.8 years (range, 30–91 years) and 75% of their injuries resulted from a simple fall, highlighting that elderly and osteoporotic patients are at an increased risk of sustaining this injury complex. Sixty-three percent of the patients had significant medial displacement of the humeral metaphysis, often with complete loss of contact to the head. All arthrograms demonstrated occlusion at the third part of the axillary artery. The most common vascular injury (63% of patients) was an intimal tear with secondary thrombosis. In our center, we encountered two cases of elderly women who sustained C3 fracture, as per the AO classification, caused by trauma. The axillary artery injuries occurred in the third part, with thrombus formation secondary to the intimal tear.

In a report of 15 cases of brachial plexus paralysis secondary to proximal humeral fracture, six cases were associated with axillary artery injury [7]. Most of the nerve injuries were neurapraxia and axonotmesis, which healed with conservation; however, some patients presented with progressive deterioration in nerve function. The causes of brachial plexus injury associated with proximal humeral fracture are compression by hematoma and femoral head, and ischemia of the brachial plexus [16]. In our 2 cases, no obvious findings of brachial plexus injury were detected during surgery. The dislocated humeral head fracture suggested that the nerve injury in both patients was primarily caused by a mechanical factor, and the delayed onset of motor palsy implied that an ischemic factor was implicated in case 1.

As mentioned above, an arteriogram should be performed promptly if arterial injury is suspected. If arterial blood flow is disrupted, surgical options for vascular repair include thrombectomy [6], saphenous vein grafting [17], and excision with primary repair. Shuck reported that performing arteriotomy and thrombectomy without addressing the intimal lesion will almost certainly lead to recurrent occlusion [18]. Early surgical management is critical, as devastating complications, including limb loss, have been described with prolonged ischemia [19]. Non-operative management of axillary artery injury is not recommended.

4. Conclusion

In conclusion, we reported 2 cases of axillary artery and brachial plexus injury as a complication of fracture dislocation of the shoulder. After performing a bypass surgery for the axillary artery, the circulatory disorder improved, while the neural palsy persisted. Careful and repeated investigations of circulation and neural function are needed for patients with fracture dislocation of the shoulder. Complete occlusion of the axillary artery must be treated by vascular reconstruction.

Conflicts of interest

The authors declare that they have no conflict of interest.

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Ethical approval

This case report was approved by the Hirosaki University Fraduate School of Medicine Ethics Committee. Reference number is 2017-1132.

Consent

Case 1 – the head of our hospital have taken responsibility that exhaustive attempts have been made to contact the family and that the paper has been sufficiently anonymised not to cause harm to

the patient or their family. We have uploaded a signed document to this effect.

Case 2 – Written informed consent was obtained from the patient's family for the publication of this case report. A copy the written consent form is available for review for the Editor-in-Chief of this journal.

Author contribution

Yukiko Karita M.D., Yuka Kimura Ph.D., Shizuka Sasaki Ph.D., Taisuke Nitobe Ph.D., Eiichi Tsuda Ph.D., Yasuyuki Ishibashi Ph.D. all contributed to this manuscript.

Registration of research studies

Resaerchregistry No. 4127.

Guarantor

Yukiko Karita.

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