Formosan Journal of Musculoskeletal Disorders 2 (2011) 109–112

Contents lists available at ScienceDirect

Formosan Journal of Musculoskeletal Disorders

journal homepage: www.e-fjmd.com

Case Report

Digital gangrenes after distal radius fracture

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ARTICLE INFO

Article history:
Received 12 February 2011
Received in revised form
22 April 2011
Accepted 3 May 2011

Keywords:
arterial injury
complication
digital gangrene
distal radius fracture

ABSTRACT

The reported complication rates of the distal radius fractures vary widely from 6% to 80%. Unlike damage to neural and tendinous structures, vascular complications have been extremely rare. We described an unusual case of distal radius fracture complicated with digital gangrenes because of occlusion of radial and ulnar arteries.

1. Introduction

Several studies have reported that complication rates of distal radius fractures vary widely from 6% to 80%.[1] These complications may occur from the fracture itself or treatment.[2] McKay et al[1] constructed a complication checklist, which included complications involving nerve, bone, and tendon, but no complications about vascular injury were in the checklist. There are few reports about vascular complications, including iatrogenic pseudoaneurysms related to fixation devices, or chronic attritional pseudoaneurysms.[3] Acute vascular injury or thrombosis after distal radius fractures are extremely rare.

In a retrospective study comparing 189 arterial injuries of upper extremity trauma, 21.2% involved antebrachial arteries and 13.2% were caused by blunt injury.[4] The result implicated the vulnerable vasculature at wrist. de Witte et al[3] reported six cases of distal radius fractures with asymptomatic acute vascular injury. All of them were found incidentally during volar approach and no sequelae developed even after vessel ligation. With extensive utilization of volar approach, overlooked vascular injuries will be more often recognized. These vascular injuries are considered to be associated with severe displaced fractures, fractures with an ulnar fracture, or open fractures.[3] We presented a rare case of comminuted, displaced distal radius fracture, complicated with occlusion of radial and ulnar arteries, and ended with digital gangrenes and amputation.

2. Case report

A 77-year-old man visited our emergency department because of pain and deformity of his right wrist after a fall. He had a history of diabetes mellitus, hypertension, Stage IV chronic kidney disease, and hyperuricemia. He used to smoke cigarettes but has quitted for many years. Physical examination showed swelling, tenderness, deformity, and limited range of motion of his right wrist. The motion and sensation of fingers were intact and the capillary refilling time was within two seconds. The pulsation of radial and ulnar arteries at wrist level was not checked because of severe swelling and tenderness. Plain radiograph showed right comminuted distal radius fracture with displacement (AO/Orthopaedic Trauma Association classification 23-C1.2) (Fig. 1). His right wrist was fixed with a long arm splint temporarily without attempted closed reduction at the emergency department.

Four hours after the injury, the patient underwent osteosynthesis with 2.4-mm juxta-articular locking compression plate (Synthes, Paoli, PA, USA) and one Kirschner wire. The fracture was exposed through volar approach between flexor carpi radialis and radial artery. A tourniquet had been inflated to 250 mmHg for about 50 minutes. There was no arterial cannulation. No radial artery injury was noted intraoperatively or after the release of tourniquet. Postoperative plain radiograph revealed reduced fracture but small remnant loss of radial height and volar tilt (Fig. 2). In addition to

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2210-7940/$ – see front matter
doi:10.1016/j.fjmd.2011.06.007

Fig. 1. Plain radiograph showed right comminuted distal radius fracture with displacement.

postoperative cold compression, the patient wore a short arm splint and elevated his wrist with sling. Swelling, oozing, and cold fingertips improved gradually. On the postoperative sixth day, the patient was discharged with palpable radial artery pulsation.

One week after the discharge, the patient came back to our emergency department. He sustained cold and swelling in the right hand, cyanotic right index, and little finger. The little fingertip even turned black and pulsation of radial and ulnar arteries diminished. Plain radiograph showed no loss of reduction or implant failure. The patient received parenteral infusion of unfractionated heparin and prostaglandin E1. Angiography for catheter-directed thrombolytic therapy showed total occlusion of radial and ulnar arteries except few branches from the radial artery (Fig. 3). Nevertheless, the ischemia of right index and little finger did not resolve. Dry

Fig. 2. Postoperative plain radiograph revealed reduced fracture but with small remnant loss of radial height and volar tilt.

Fig. 3. Angiography for catheter-directed thrombolytic therapy showed total occlusion of radial and ulnar arteries except few branches from the radial artery.

gangrenes distal to the proximal interphalangeal joint of these two fingers developed 6 months later (Fig. 4). The patient finally underwent digital amputations.

3. Discussion

Blunt arterial injury occurs less commonly than penetrating arterial injury. In two case series of 51 and 189 upper extremity arterial injuries, the proportion of blunt injury was 18% and 22.7%, respectively.[4,5] The mechanism includes soft tissue contusion, acute traction on the extremity, or fracture and dislocation, resulting in complete arterial disruption, laceration, or merely tears of the intima. These blunt traumas are mainly caused by motor vehicle accident, with extensive soft tissue destruction and higher amputation rates.[4] Even low energy trauma, such as a fall, may produce vascular injury through intima disruption. The intima damage initiates platelet activation and coagulation cascades, which promotes thrombus formation and even total occlusion of vessels. The thrombotic artery may be only thickened in gross[6] and difficult to identify intraoperatively. On the other hand, persistent swelling of the wrist in severe displaced and comminuted distal radius fractures is supposed to cause external compression, which further puts these slightly-injured arteries at risk of thrombosis.[7] Besides, direct compression on the injured vessels might reduce the blood flow and result in distal thrombosis.[8]

Fig. 4. Dry gangrenes distal to the proximal interphalangeal joint of these two fingers developed 6 months later.

Embolism is another concern for digital ischemia. Lin et al[8] described a case of multiple digital gangrenes after a radial artery penetration injury and proposed the possible mechanism to be dispersion of thrombembolic particles from the injured artery to the digital arteries. One pathological study found digital embolization from the proximal thrombosis in 30% of 20 young patients with thrombotic ulnar artery.[9] Both thrombosis and embolism are able to impair circulation of the hand, cause regional digital ischemia, and lead to this rare vascular complication after distal radius fracture.

As for nontraumatic acute arm ischemia, cardiac embolism results in 58–93% of the cases and atrial fibrillation is the most common etiology. Other sources of emboli include proximal upper limb arterial stenosis caused by atherosclerotic plaque or external compression (e.g. cervical ribs and thoracic outlet obstruction) and chronic trauma from the use of crutches.[10] On the other hand, nontraumatic thrombosis can result from atherosclerotic plaques, aneurysms, arteritis from connective tissue disorders, radiation, hyperthrombotic conditions, malignancy, or steroid use.[10] Thrombotic occlusion develops in the subclavian and axillary arteries more frequently, comprising about 77% of upper extremity thrombosis. Only 8.2% of nontraumatic thrombosis occurred distal to the elbow.[10] Even in diabetic patients, occlusive arterial disease of the upper extremity occurs rarely in upper extremity rather than lower limbs.[11] It is proposed that incidence of critical ischemia of the hand and fingers increases in patients with chronic renal failure and calciphylaxis, which seems a principal contributor.[12] The patient we reported had multiple comorbidities, such as diabetes mellitus, hypertension, Stage IV chronic kidney disease, and hyperuricemia. He had also been a heavy smoker. Although there was no presentation of calciphylaxis, Stage IV chronic kidney disease might be a risk factor for the patient to sustain the rare vascular complication after distal radius fracture.

Many studies in literature explored organization of the arteries of hand and digits by techniques of direct dissection, radiopaque contrast medium, or injection of hardening material. The two main circuits, the superficial and deep palmar arches, have a variety of anatomical variations as complete and incomplete arches.[13–16] Consequently, the ability of the radial and ulnar arteries to compensate for each other varies from person to person. In patients with inherent incomplete arches, a single radial or ulnar arterial injury may cause digital ischemia. McNamara et al[7] reported ischemia of the index finger and thumb secondary to thrombosis of the radial artery. Among all nine patients, four had only index finger involvement. Edwards[13] found that dorsal digital arteries were poorly developed except in the thumb, which implicated the index finger more vulnerable than the thumb to radial artery injury. Furthermore, the multiplicity of arterial sources is reduced sharply from the hand to the digits. When one of the two palmar digital arteries is predominant, the digit may mostly depend on this single artery.[13] Therefore, the circulation of the digit is much easier to be affected by a single embolus. Although there is no actual information about the arterial organization of hand and digits in the patient we presented, anatomy variations, thrombi, and emboli formation are possible etiologies for the unusual distribution of digital gangrenes.

Dragas et al[4] reported that most casualties of upper extremity vascular injuries presented more than 12 hours from injury and underwent 90% of the amputations. Prompt and correct diagnosis with aggressive management, such as primary anastomosis or vein graft, to restore blood flow early is the key to better outcomes. The hard signs of vascular injury include absent distal pulses, ischemic limb, pulsatile external bleeding, and enlarging hematoma, whereas the soft signs include diminished pulse, nonexpanding hematoma, anatomically related nerve injury, and proximity of

wound to major vessels. However, at least 10% of patients with arterial injury might have palpable pulses distal to the site of injury.[17] For highly suspected cases, duplex ultrasonography or arteriography would be necessary to demonstrate arterial disruption, intimal flaps, or acute pseudoaneurysm.[18]

In summary, to prevent missing the rare and functionally devastating vascular complication after distal radius fractures, vascular status should be evaluated carefully, especially in comminuted and severely displaced fractures. Duplex ultrasonography is a competent screening tool if soft signs of vascular injury is present. During surgery, fixation devices as plate or Kirschner wire should be in an appropriate position to avoid vascular injury. Volar approach helps to explore the vessels and we suggest routine tourniquet release to check any active bleeder before wound closure. Patients should follow the instructions to elevate and cool the injured wrist for postoperative swelling control, which may prevent further thrombosis formation. Above all, vascular injuries may occur with fracture-dislocation in any joints. Early diagnosis and treatment to prevent further disability rely on a high index of suspicion.

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