

Brachial Artery Injury Management -Case Series

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Abstract

We performed this retrospective study to analyse our strategies for managing and surgically treating brachial artery injuries. Twenty patients of traumatic brachial artery injuries underwent surgery at our institution, from May 2013 to January 2016.

Fifteen patients were male and five were female (age range, 20 to 45 years; mean, 30 years). Twelve of the patients had penetrating injuries (2 had stab wounds; 2, window glass injuries; and 8, industrial accidents), 8 had blunt trauma injuries (traffic accidents). Five patients had peripheral nerve injury. All patients underwent Doppler ultrasonography examination.

The repair of the twenty arterial injuries involved end-to-end anastomosis for 8 injuries, reverse saphenous vein graft interposition grafts for 8, and primary repair for 4. Venous continuity was achieved in 8 of 12 patients who had major venous injuries. Nine of the 20 patients required primary fasciotomy. Follow-up showed that 2 of the 5 patients with peripheral nerve injury had apparent disabilities due to nerve injury. There were no deaths.

We believe that good results can be achieved in patients with brachial artery injuries by use of careful physical examination, Doppler ultrasonography, and restoration of viability with vascular repair and debridement of nonviable tissues. Traumatic neurologic injury frequently leads to disability of the extremities so it should be addressed by plastic surgeon with SOS use of nerve grafting.

Keywords: Brachial artery injury/complications/diagnosis/surgery; Peripheral nerve injuries; Saphenous vein; Thrombosis/etiology; CT angiography.

Introduction

Traumatic brachial artery injuries constitute a relatively large proportion of peripheral arterial injuries [1]. In recent years, the limb salvage rate has reached nearly 100% because of early transport of patients to the hospital, early

diagnosis, increased surgical experience, and developments in the treatment of hypovolemic shock and the use of antibiotic therapy [2 - 4].

We report the results of a retrospective analysis of our strategies for the management and surgical treatment of traumatic brachial artery injuries.

Patients and Methods

Twenty patients of traumatic brachial artery injuries underwent surgery at our institution, from May 2013 to January 2016.

The brachial artery injuries were diagnosed by physical examination, Doppler ultrasonography, and arteriography. The following findings were considered to be signs of arterial injury: active bleeding, rapidly growing and pulsatile hematoma, pale and cold extremities, absent or very weak distal pulses, associated neurologic deficits, and associated injuries to bony and soft tissues. Decreased Doppler arterial systolic pressures detected on Doppler ultrasonography were considered to be diagnostic for arterial injury. Angiography was performed when the arterial injuries would be difficult to expose surgically and when the presence of arterial injury was problematic to predict.

The indications for fasciotomy were palpably tense compartments, major vein ligation, hypovolemic shock, ischemia lasting more than 6 hours, and any motor or sensory deficits. Orthopaedic reconstruction was performed after revascularization of the extremity.

Optimal debridement of injured soft tissues was performed, and then injured and bleeding arterial and venous structures were exposed [Figures 1A and 1B]. Heparin was administered intravenously for systemic anticoagulation before the vessels were occluded proximally and distally with non-traumatic vascular clamps. Fogarty balloon catheters were used routinely for thrombectomy of the distal and proximal segments before final restoration of arterial flow. Distal and proximal segments of the artery were flushed with 0.1% heparin solution to prevent fresh thrombus formation.

Systemic heparin anticoagulation was administered postoperatively to patients who had severe soft tissue injuries and had undergone venous repair with reverse autologous saphenous vein interposition grafts.

All patients were treated with tetanus antitoxin preoperatively. All patients were also given preoperative and postoperative antibiotic therapy to reduce the high risk of infection related to contamination of the penetrating injuries or the presence of foreign bodies in the wounds.

Figure1: [A]Crush injuryof right upper limb by cutting saw [B]Completely transected brachial artery,vein and median nerve.



Results

Fifteen patients were male and five were female (age range, 20 to 45 years; mean, 30 years). Twelve of the patients had penetrating injuries (2 had stab wounds; 2, window glass injuries; and 8, industrial accidents), 8 had blunt trauma injuries (traffic accidents). Five patients had peripheral nerve injury. Of 20 patients were in hypovolemic hypotensive shock, and 34 (59.6%) were actively bleeding.

Physical examination and Doppler ultrasonography revealed the absence of arterial pulses in 18 patients and weak arterial pulses in 2. For brachial artery injuries, the average brachial-brachial Doppler pressure index was 0.42 ± 0.08 (range, 0.25 to 0.5) preoperatively, and 0.88 ± 0.02 (range, 0.8 to 0.9) postoperatively. Eighteen patients underwent preoperative angiography in order to confirm the vascular injury.

Repair of the 20 arterial injuries required end-to-end anastomosis for 8 of the injuries; reverse, autologous, saphenous-vein interposition grafts [Figure 2A] for 8; and primary repair for 4.

In 12 patients, serious venous injuries were associated with arterial injuries. In 8 of these patients, venous continuity was restored with saphenous vein interposition grafts [Figure 2A], end-to-end anastomosis, and primary repair. Four severely injured brachial veins were ligated.

Two of the 20 patients had injuries to soft tissues and bony structures. Fractures occurred most frequently among patients with blunt trauma. Eight patients (17.5%) had tendinous injuries that were repaired perioperatively by plastic surgeons.

Nine of the 20 patients required primary fasciotomy of the forearm [Figure 2B]. All patients who underwent venous repair procedures or ligation experienced edema in the upper extremity. This edema decreased with elevation of the extremity and resolved in all patients during the follow-up period (approximately 10 to 30 days). Five of 20 patients had peripheral nerve injury: 3 had injuries to the median and

ulnar nerves, 1 had injuries to the median nerve alone, and 1 had injuries to the ulnar nerve alone. Two of the 5 patients with penetrating trauma had nerve injuries that were treated perioperatively by plastic surgeon [Figure 2A]. The remaining 3 patients with nerve injury underwent electromyography for evaluation of injuries and were followed up in neurosurgery and rehabilitation clinics. During the follow-up period, functional recovery was achieved in 2 of the 3 patients with nerve injury. In the other 1 patient, disability was clearly evident throughout follow-up. In some cases plastic surgeon help was taken to close the wound [Figure 3A and 3B].

Two patients experienced early postoperative thrombosis. In these patients, arterial reperfusion was achieved with embolectomy.

The mean hospitalization period was 10 days (range, 2–20 days). The hospitalization time was longer for the patients who underwent fasciotomy because of compartmental syndrome, venous repair, musculoskeletal injury, or nerve injury. The average follow-up period was 16 months (range, 6–24 months); follow-up visits were usually necessary for orthopaedic or neurologic examinations.

Figure 2: [A] Interposition grafting of brachial artery, vein by saphenous vein graft and median nerve by sural nerve graft [B] Fasciotomy to prevent compartment syndrome.

[A]

[B]



Figure 3: [A] Closure of wound done by plastic surgeon [B] Completely healed wound

[A]

[B]



Discussion

The morbidity and mortality rates associated with brachial artery injuries depend on the cause of the injury itself, which vein or tendon is injured, and whether musculoskeletal and nerve injuries are also present.

Patients with obvious clinical symptoms of brachial artery injuries as detected by physical examination and those in whom Doppler ultrasonography demonstrates a substantial difference in pressure between the right and left brachial arteries should undergo surgical repair without further angiographic examination. Doppler ultrasonography of the upper extremity has been shown to be as specific and sensitive as arteriography in detecting brachial artery injuries[2,5 - 7]. Normally, the average brachial-brachial Doppler pressure index between the 2 upper extremities is approximately 0.95; it is rarely less than 0.85[8]. In our patients, this measurement was significantly lower than normal). If uncertainty remains regarding vascular injuries after physical examination and Doppler ultrasonography, angiography may be used to confirm the vascular injury. Eighteen of our patients required preoperative angiography.

Four patients exhibited pulse insufficiency. The pulses of those patients were not palpable on manual examination but were detected on Doppler examination. Surgical exploration revealed partial injury to the brachial artery. These findings may be explained by collateral flow or by the flow bypassing the partially injured brachial artery[9].

Thorough tissue debridement must be performed to avoid bacterial infection. After proximal and distal control of the bleeding artery has been achieved, the artery should be explored until the uninjured arterial wall is apparent. Both segments of the brachial artery can be mobilized by ligation of the immediate minor branches; this procedure provides additional length and reduces the tension at the anastomosis.

End-to-end anastomosis is preferable if it can be performed without tension or damage to major collateral vessels. Otherwise, the saphenous-vein interposition graft is the next best choice, because it has better patency rates and better resistance to infection compared with synthetic grafts[4].

Although the rate of thrombosis associated with venous repair ranges from 39% to 59%, the injured major veins must be repaired so that arterial flow can be restored[10, 11]. We were able to restore venous continuity in 8 of 12 patients with major venous injuries.

Three patients had early postoperative thrombosis; arterial reperfusion was achieved in 2 of these patients by embolectomy.

Compartmental edema or contusion can impair venous drainage and arterial flow and can cause pressure injuries to the nerves[12,13]. Nine of our patients underwent primary fasciotomy of the forearm, and 2 had bone fractures. In the patients with musculoskeletal injuries, arterial revascularization was performed before skeletal injury stabilization so that ischemia time could be kept to a minimum.

Neurologic injury continues to destroy the function of the upper extremity even after a successful arterial repair. Major venous injuries, fractures, and widespread tissue destruction may also influence the long-term function of the extremity[14]. Whether primary and secondary nerve repair procedures are helpful is a point of controversy[15]. The rate of functional disability ranges from 27% to 44% when injury to the upper extremity includes nerve injuries[16].

In our series, the outcomes of our five patients with nerve injuries were similar to those of patients discussed in other reports[14, 16]. One patient with nerve injury experienced severe, long-term disability. This patient was followed up in neurosurgery and rehabilitation clinics.

During the last 20 years, amputation associated with upper extremity arterial injuries has decreased to a rate of 3.1% to 3.4% because of advances in the treatment of shock, the use of antibiotic therapy, and increased surgical experience[16]. None of our patients required amputation. None of our patients died.

Conclusion

In an upper extremity that is severely endangered by ischemia, it is essential that arterial and major venous exploration and vascular repair be performed, in conjunction with debridement of damaged tissues, if viability is to be restored. Careful clinical examination, Doppler ultrasonography, and pressure measurements are as important as angiography in the diagnosis of vascular injuries. Traumatic neurologic injury may significantly affect the degree of long-term disability after upper extremity injuries so it should be repaired primarily by plastic surgeon.

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