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Traumatic brachial artery and nerve injuries around the elbow: Diagnostic challenges, multidisciplinary reconstruction, and early limb salvage outcomes in a single-centre tertiary hospital in India

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Abstract

Background: Traumatic brachial artery injuries around the elbow, often associated with median and ulnar nerve injuries, are limb-threatening emergencies. Extensive collateral circulation may preserve distal pulses, masking significant vascular disruption and delaying diagnosis. **Aim:** To describe our institutional experience, emphasising diagnostic pitfalls, the role of computed tomography angiography (CTA) and multidisciplinary reconstruction in limb salvage. **Methods:** A retrospective review included four consecutive patients with traumatic brachial artery injury or suspected vascular compromise around the elbow treated at a tertiary trauma centre in Eastern India between January 2022 and December 2023. Clinical, radiological, operative, and outcome data were analysed. CTA assessed vascular integrity, and management involved plastic surgery, orthopaedics, and intensive care teams. **Results:** Four male patients (mean age 46.5 years; range 24–60 years) were included. Three injuries resulted from high-energy road traffic accidents and one from a glass laceration. CTA accurately identified vascular pathology in all imaged patients ($n = 2$). Two patients underwent autologous vein bypass grafting, while two required sural nerve grafting for median and/or ulnar nerve defects. Limb salvage was achieved in three patients (75%). One patient developed delayed arterial thrombosis despite an initially patent artery, resulting in irreversible limb ischaemia requiring above-elbow amputation. **Conclusion:** High clinical suspicion, early CTA, prompt revascularisation, and coordinated multidisciplinary management are essential for optimising limb salvage following complex brachial artery injuries. **Relevance for patients:** Early diagnosis and integrated specialist care can improve limb salvage and functional recovery, even in delayed presentations of complex upper-extremity trauma.

Keywords: Brachial artery; Vascular system injuries; Computed tomography angiography; Limb salvage; Soft-tissue injuries; Soft-tissue surgery; Patient care team; Elbow injuries

1. Introduction

Traumatic injuries to the brachial artery in the region of the elbow represent a relatively uncommon yet highly consequential form of peripheral vascular trauma. Although upper extremity vascular injuries constitute only a small percentage of all traumatic arterial lesions, damage to the brachial artery can profoundly affect limb viability, hand function, and overall quality of life. The brachial artery serves as the primary conduit supplying the forearm and hand. Its relatively superficial course, combined with its close anatomical relationship to the distal humerus, elbow joint, and major peripheral nerves, makes it particularly susceptible to both direct and indirect trauma.[1]

In recent decades, the epidemiology of these injuries has shifted. While penetrating trauma from knives or firearms historically predominated, rapid urbanisation, increased motorisation, and industrial growth—especially in low- and middle-income countries such as India—have led to a rise in high-energy blunt trauma from road traffic accidents and crush injuries.[2–5] These mechanisms often produce complex injury patterns involving not only the artery and nerves but also fractures, joint dislocations, extensive soft-tissue loss, venous injury, and compartment syndrome, dramatically increasing the technical difficulty of reconstruction.[6] Such injuries frequently require staged reconstructive procedures, meticulous debridement, and coordinated multidisciplinary decision-making to restore both limb perfusion and function.

A particularly deceptive feature of elbow-region vascular trauma is the rich collateral circulation. Anastomoses between the profunda brachii, recurrent radial and ulnar arteries, and interosseous vessels can maintain distal perfusion even after complete disruption or occlusion of the main brachial trunk. Consequently, palpable radial or ulnar pulses do not reliably exclude significant arterial injury. This phenomenon often contributes to diagnostic delay, with reports of missed injuries in elbow dislocations and supracondylar fractures leading to thrombosis and irreversible ischaemia.[7–9] Delayed recognition may also permit progression of intimal injury or thrombosis despite an initially well-perfused extremity, underscoring the importance of repeated neurovascular assessment in high-risk patients.

Clinical evaluation, therefore, remains the foundation of management. Hard signs of vascular injury—such as active bleeding, expanding haematoma, absent distal pulses, bruit, thrill, or overt ischaemia—warrant immediate surgical exploration. However, many patients present with subtler "soft signs," including diminished pulses, progressive swelling, neurological deficits, or high-energy mechanisms of injury, necessitating further investigation and intervention.[10]

Multidetector computed tomography angiography (CTA) has revolutionised the assessment of extremity vascular trauma. CTA offers rapid, non-invasive, high-resolution imaging that simultaneously evaluates vascular integrity and associated skeletal and soft-tissue injuries. Its diagnostic accuracy for occlusion, intimal tears, pseudoaneurysms, and extrinsic compression is excellent, often guiding precise operative planning.[11–13] The increasing availability of CTA in emergency settings has also reduced reliance on conventional catheter angiography, facilitating faster diagnosis and shortening the interval to definitive revascularisation in haemodynamically stable patients.

Contemporary management has moved beyond simple arterial repair. Optimal outcomes require a holistic "orthoplastic" approach that addresses skeletal stability, compartment decompression, nerve reconstruction, serial debridement, and timely durable soft-tissue coverage. Autologous vein grafting remains the gold standard for segmental arterial defects due to its durability, resistance to infection, and long-term patency.[14,15] Early collaboration among vascular, plastic, orthopaedic, anaesthesia, and critical care teams is increasingly recognised as a key determinant of successful limb salvage and functional recovery in these complex injuries.

Despite global advances, data from the Indian subcontinent on multidisciplinary management of complex brachial artery trauma remain limited. Delayed presentation, resource constraints, and fragmented care pathways are common challenges. This retrospective case series describes our experience in managing four patients with traumatic brachial artery injuries around the elbow at a tertiary trauma centre in Eastern India. It highlights practical diagnostic pitfalls, the utility of CTA, reconstructive strategies, and the critical role of coordinated multidisciplinary care in achieving limb salvage.

2. Materials and methods

This retrospective observational study was conducted at a high-volume tertiary referral hospital with a Trauma Centre in Eastern India. All patients who presented with traumatic injury around the elbow associated with brachial artery injury or clinical suspicion of vascular compromise were included and managed between January 2022 and December 2023 (a two-year period). The study protocol was reviewed and approved by the Institutional Ethics Committee. Patient confidentiality was maintained throughout the study, and all data were anonymised prior to analysis.

Four consecutive male patients aged 24–60 years satisfied the inclusion criteria, which required either radiological evidence of brachial artery disruption

or intraoperative confirmation of vascular injury necessitating specialist intervention. Patients with isolated distal forearm arterial injuries, pre-existing peripheral vascular disease, or incomplete documentation were excluded. Patients who had undergone definitive vascular intervention elsewhere before referral were also excluded to ensure uniform assessment of diagnostic evaluation and operative management at our institution.

Upon arrival, all patients underwent systematic evaluation according to Advanced Trauma Life Support principles. Vascular assessment included palpation of radial and ulnar pulses, capillary refill time, skin colour and temperature, pulse oximetry on the affected digit, and handheld Doppler signals. Neurological examination focused on median, ulnar, and radial nerve function. Compartment syndromes were assessed clinically. Plain radiographs were obtained to evaluate associated fractures and dislocations. CTA was performed selectively in haemodynamically stable patients with equivocal clinical findings or when detailed anatomical mapping was required for surgical planning. The decision to proceed directly to surgery or obtain advanced imaging was based on the presence of hard or soft signs of vascular injury, overall haemodynamic status, and associated musculoskeletal trauma following multidisciplinary discussion.

Management was individualised and delivered by a multidisciplinary team comprising plastic and reconstructive surgeons and orthopaedic surgeons, along with a dedicated intensive care team. Vascular procedures included exploration, thrombectomy, primary repair when feasible, or interposition grafting using autologous vessel grafts. Orthopaedic interventions involved fracture stabilisation with external fixation or internal devices as appropriate. Soft-tissue management followed a staged approach: aggressive serial debridement, fasciotomy for compartment syndrome, nerve reconstruction with autologous grafts when indicated, and eventual coverage using local or regional flaps and split-thickness skin grafts augmented with negative-pressure wound therapy (NPWT). Postoperative care included serial neurovascular examinations, monitoring of distal limb perfusion, anticoagulation or antiplatelet therapy when indicated, infection surveillance, and supervised physiotherapy to facilitate early functional recovery.

Data collected included patient demographics, injury mechanism and timing, clinical presentation, imaging findings, operative details, postoperative complications, second-stage and subsequent procedures, limb-salvage status, and short-term functional outcomes. Medical records, operative notes, anaesthesia records, radiological images, and follow-up documentation were independently reviewed to ensure completeness and consistency of the collected data. Due to the small sample size and descriptive nature of the study, results are presented using means, ranges, and percentages.

3. Results

During the study period, four male patients with a mean age of 46.5 years (range 24–60 years) were treated. The patient demographics, injury characteristics, management, and outcomes have been depicted in Table 1. High-energy blunt trauma from road traffic accidents accounted for three cases (75%), while one case resulted from penetrating glass injury (25%). The mean time from injury to presentation at our centre was 27.5 ± 21.1 hours.

The clinical details of the four patients are as follows. In the first case (Figure 1), a 52-year-old man presented three hours after a crush injury to the left upper limb. Examination revealed a pulseless, stony-hard limb with absent capillary refill. The radiograph showed humero-ulnar joint subluxation. Surgical exploration demonstrated segmental brachial artery loss, which was bridged with an 8-cm reversed saphenous vein graft. Forearm fasciotomy was performed. Postoperatively, skin necrosis developed over the cubital fossa. He underwent staged debridement, transposition flap coverage, split-thickness skin grafting, and elbow stabilisation with external fixators. The limb was successfully salvaged with acceptable outcomes at early and late follow-up.

In the second case (Figure 2), a 60-year-old man presented six hours after a right upper limb crush injury. Radial pulses were present with maintained capillary refill, but ulnar neuropathy and impending compartment syndrome were noted. Radiograph revealed humero-ulnar subluxation with olecranon fracture. Exploration showed the brachial artery compressed but intact; flow improved after decompression. A 6-cm ulnar nerve segmental avulsion was reconstructed using two sural nerve cable grafts. The elbow was stabilised with external fixators. The limb was salvaged, with a satisfactory appearance at 6-week follow-up.

In the third case (Figure 3), a 24-year-old man presented 48 hours after a glass laceration on the proximal right forearm. The previously sutured wound dehisced. Clinical findings included absent radial pulse, a cold limb, and early compartment syndrome. Radiography showed a mid-shaft humeral fracture, while CTA demonstrated an abrupt cutoff of the brachial artery. Exploration revealed necrotic muscles, 6-cm brachial artery loss, and a 5-cm median nerve defect. Reconstruction was performed using a 6-cm radial artery graft harvested from the injured limb to bypass the defect, anastomosed proximally to the brachial

Table 1. Patient demographics, injury characteristics, management, and outcomes

Age (years)	Mechanism	Presentation	Imaging	Neurovascular intervention	Orthopaedic/Soft-tissue management	Outcomes
52	Crush injury: road traffic accident (RTA)	Pulseless, cold limb, absent capillary refill	X-ray: humero-ulnar subluxation	Great saphenous vein graft for brachial artery repair	Fasciotomy, debridement, transposition flap and skin graft; elbow stabilised with an external fixator	Limb salvaged; good functional improvement of wrist and digits
60	Crush injury (RTA)	Radial pulse present, ulnar neuropathy, impending compartment syndrome	X-ray: humero-ulnar subluxation + olecranon fracture	Ulnar nerve gap repair with sural nerve cable grafts	Debridement, negative-pressure wound therapy, skin graft, and external fixation for a subluxated humero-ulnar joint	Limb salvaged; good functional improvement of wrist and digits
24	Sharp glass laceration	Absent radial pulse, cold limb, compartment syndrome	Computed tomography angiography: brachial artery cutoff distal to fracture	Radial artery graft for brachio-ulnar bypass and median nerve gap repair with sural nerve cable grafts	Debridement of necrotic muscles, external fixation for a humeral shaft fracture	Limb salvaged; suboptimal function of the wrist and fingers
50	Crush injury (RTA)	Radial and ulnar pulsations reduced in volume, suspected compartment syndrome	Computed tomography angiography: brachial artery cutoff	None (artery intact); median nerve in continuity	Radial fracture stabilisation with external fixation	Limb ischaemia → amputation

artery and distally to the ulnar artery. This approach restored inline flow while utilising a readily available autologous arterial conduit of suitable calibre and length, without the need to further harvest a saphenous vein graft. Sural nerve cable grafts were used for the median nerve defect. Staged debridement, NPWT, split-thickness skin grafting, and humeral stabilisation with external fixators followed. Repeat CTA confirmed revascularisation, and a fair but suboptimal functional outcome was noted at three months. The use of the radial artery as an interposition graft in this context is supported in the trauma literature as a viable autologous option when a vein is unavailable, or an arterial tissue match is preferred.[15]

In the fourth case (Figure 4), a 50-year-old man presented 36 hours after a crush injury to the right upper limb. CTA suggested a segmental cutoff of the brachial artery. Intraoperatively, the artery was decompressed and found intact with distal flow and pulsations. However, progressive ischaemia developed within 72 hours, necessitating amputation. Intraoperative findings during amputation revealed distal segmental thrombus. The unusual feature of this case was that, despite an intact vessel, intravascular compression and subsequent thrombosis probably occurred because of intimal trauma. This finding was difficult to recognise during the early postoperative period (24–48 h), when near-normal digital oxygen saturation was detected by pulse oximetry. Once the ischaemia was detected between 48 and 72 hours, it was too late for effective intervention. This patient also had a history of a cerebrovascular accident (without supporting documentation), for which systemic heparinisation was initially avoided.

Overall, CTA (performed in two patients) accurately delineated vascular pathology in all cases and guided operative planning. Vascular reconstruction with autologous grafts was required in two patients. Additional procedures included fasciotomy, extensive debridement, external fixation, nerve grafting, and staged soft-tissue coverage. The staged reconstructive strategy enabled the sequential optimisation of vascular patency, skeletal stability, soft-tissue viability, and wound-bed preparation before definitive coverage. Close postoperative surveillance with serial neurovascular assessment facilitated early detection of complications and timely secondary interventions when required. Limb salvage was achieved in three patients (75%). No graft-related complications occurred in salvaged limbs. The salvaged patients demonstrated satisfactory distal perfusion and maintained viable soft-tissue coverage during the early follow-up. The single amputation case highlighted the risk of delayed thrombosis despite initial arterial continuity.

4. Discussion

Traumatic brachial artery and associated median and ulnar nerve injuries around the elbow represent some of the most complex and limb-threatening conditions



Figure 1. Brachial artery reconstruction with saphenous vein graft, staged soft-tissue coverage, and successful limb salvage in a crush injury of the right forearm. (a, b) A 52-year-old man presented three hours after a crush injury to the left upper limb. Examination revealed a pulseless, stony-hard limb with absent capillary refill. (c) The radiograph showed humero-ulnar joint subluxation. (d) Surgical exploration demonstrated segmental brachial artery loss, bridged with an 8-cm saphenous vein graft. Forearm fasciotomy was performed. (e) An operative image intensifier was used to confirm joint subluxation. (f) Postoperatively, skin necrosis over the cubital fossa was observed. (g–i) Second-stage debridement and coverage with a transposition flap and skin graft, and elbow joint stabilisation with external fixators. (j, k) Early and late follow-up of the salvaged limb.

encountered in upper extremity trauma surgery. Despite advances in trauma systems, diagnostic imaging, and microsurgical techniques, these injuries continue to challenge even experienced multidisciplinary teams due to the intricate anatomy of the region. The brachial artery lies in close proximity to the distal humerus, elbow joint, and major peripheral nerves, making concomitant neurovascular damage common, particularly in high-energy blunt trauma.[16] Beyond the immediate threat of limb ischaemia, these injuries have important functional implications because disruption of the brachial artery is frequently accompanied by damage to the median and ulnar nerves, flexor musculature, and periarticular soft tissues. Consequently, restoration of arterial continuity alone does not guarantee satisfactory limb function. Successful treatment requires simultaneous preservation of skeletal stability, neural integrity, and durable soft-tissue coverage, highlighting the need for coordinated reconstructive planning from the earliest stages of care. This evolving concept of functional limb salvage, rather than simple limb preservation, is increasingly recognised in contemporary trauma reconstruction.

Our series reflects the evolving epidemiology of vascular trauma in India and similar low- and middle-income countries. While penetrating trauma historically predominated in civilian series, high-energy blunt mechanisms from road traffic accidents now constitute the majority of cases.[3,6,17] This shift has substantially increased reconstructive complexity because blunt trauma frequently produces extensive intimal injury, segmental arterial loss, severe soft-tissue crushing, contamination, fracture-dislocations, and compartment syndrome. The mean presentation delay of 27.5 hours in our patients is typical of many Indian trauma systems, where initial

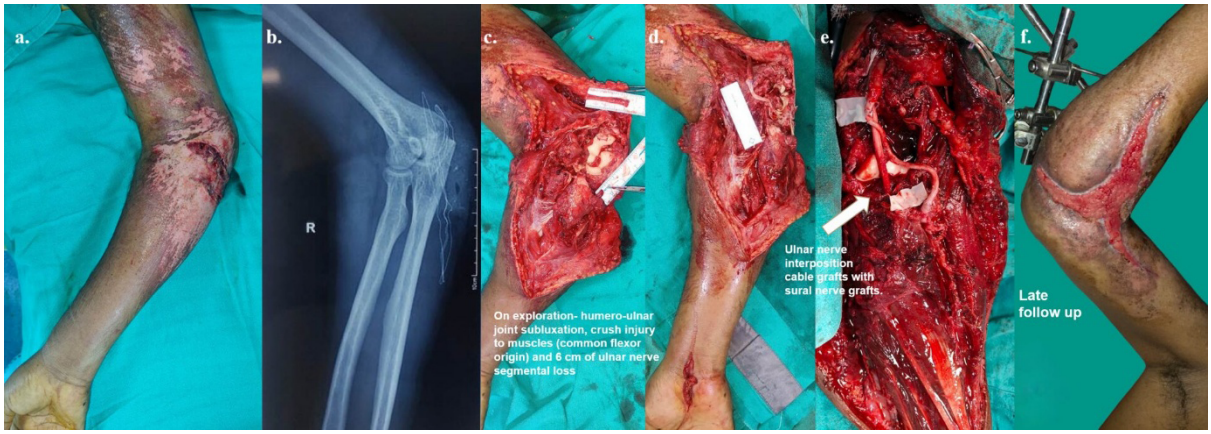


Figure 2. Brachial artery decompression, ulnar nerve cable grafting, muscle debridement, and external fixation performed following a crush injury of the right upper limb for limb salvage. (a) A 60-year-old man presented six hours after a right upper limb crush injury. Radial pulses were present, capillary refill was maintained, and ulnar neuropathy with impending compartment syndrome was noted. (b) The radiograph revealed humero-ulnar joint subluxation with olecranon fracture. (c–e) On exploration, the brachial artery was found compressed but intact, with distal flow on decompression. A 6-cm ulnar nerve segmental avulsion, along with crushed forearm muscles, was debrided, and the forearm was reconstructed using two sural nerve cable grafts, anteriorly interposed. The elbow was subsequently stabilised with external fixators, and the limb was salvaged. (f) 6-week follow-up image.

care at peripheral facilities often leads to delayed referral and more advanced tissue compromise.[17,18] Such delays not only worsen ischaemia–reperfusion injury but also complicate nerve repair, as prolonged denervation reduces the potential for meaningful functional recovery.[19] The referral pattern observed in our cohort also reflects the disparities in trauma care delivery between peripheral and tertiary healthcare facilities. Delays frequently arise from initial haemodynamic stabilisation, limited access to advanced vascular imaging, long-distance transportation, and delayed recognition of occult vascular injury. Such systemic factors may adversely influence both limb salvage and neurological recovery, emphasising that improvements in trauma networks and early referral pathways are as important as advances in operative technique.

This study highlights a major diagnostic challenge: the unreliability of clinical pulse examination. Rich collateral circulation around the elbow frequently maintains distal perfusion despite significant proximal arterial injury.[7–9,13] Case 2 clearly demonstrated this phenomenon, in which preserved radial pulses coexisted with arterial compression and ulnar nerve injury. This diagnostic pitfall has been repeatedly associated with delayed recognition and higher amputation rates.[7,8] Our experience strongly supports the recommendation for liberal use of CTA in high-energy elbow trauma, even when distal pulses are detectable.[11] However, clinical vigilance remains indispensable despite technological advances. Serial neurovascular examinations performed by experienced clinicians may identify evolving vascular compromise before irreversible ischaemia develops. Changes in pain severity, increasing forearm swelling, deterioration in neurological function, or progressive reduction in Doppler signals should prompt immediate reassessment, even when initial clinical findings appear reassuring. Repeated assessments are especially valuable after fracture reduction or external fixation, when vascular status can change rapidly.

Computed tomography angiography proved highly valuable in our stable patients. It delineated the exact site and nature of vascular injury and simultaneously assessed skeletal and soft-tissue damage, enabling better operative planning.[11–13] In Case 3, CTA accurately identified the arterial cutoff, while in Case 4, it revealed compression despite arterial continuity. However, as demonstrated in Case 4, CTA has limitations in detecting occult intimal injuries that may progress to delayed thrombosis.[20,21] CTA should therefore be interpreted within the broader clinical context rather than as an isolated diagnostic investigation. Radiological findings must be correlated with the mechanism of injury, serial clinical examinations, and intraoperative observations whenever uncertainty persists. In selected cases with persistent clinical suspicion despite equivocal imaging, early surgical exploration may remain justified to prevent catastrophic limb loss.

Revascularisation strategies must be highly individualised. Autologous great saphenous vein grafts remain the gold standard for segmental defects.[14,22] In Case 3, using a radial artery graft as a flow-through conduit from the brachial to the ulnar artery was a pragmatic, effective choice, especially because it minimised additional donor-site morbidity. This technique is supported by the



Figure 3. Brachial artery and median nerve reconstruction, serial debridement, skin grafting, and external fixation in stages were performed following a glass laceration of the right forearm for limb salvage. (a) A 24-year-old man presented 48 hours after a glass laceration on the proximal right forearm, with a sutured wound (performed elsewhere) and a humeral fracture. The wound dehisced, with dusky muscles protruding. Clinical examination revealed an absent radial pulse and a cold, stony limb, with early compartment syndrome. (b) The radiograph revealed a mid-shaft humeral fracture, and computed tomography (CT) angiography showed an abrupt brachial artery cutoff distal to the fracture fragments. (c–f) Surgical exploration revealed necrotic volar forearm muscles, segmental losses measuring 6 cm of the brachial artery distal to the bifurcation and 5 cm of median nerve, which were reconstructed using a 6-cm radial artery graft with distal anastomosis to the ulnar artery, while the median nerve was reconstructed with sural nerve cable grafts (shown in the inset of (e)). (g, h) Serial debridement and split-thickness skin grafting were performed after 72 hours in the second stage, along with humeral fracture reduction and stabilisation with external fixators. (i) The limb was kept immobilised with a dressing for the next 5 days. (j) Repeat CT angiography showed revascularised brachio-ulnar flow. (k, l) show the late postoperative images at 3 months.

literature, which shows good patency rates when suitable autologous arterial conduits are available.[15,23,24] Autologous conduits consistently outperform prosthetic grafts in contaminated traumatic fields due to superior infection resistance and long-term durability.[14] Meticulous vascular technique remains equally important irrespective of the conduit selected. Adequate debridement of devitalised arterial segments, tension-free anastomosis, avoidance of graft kinking, and restoration of satisfactory distal runoff are fundamental principles that maximise graft patency. Equally important is protecting reconstructed vessels from subsequent soft-tissue desiccation, infection, or external compression by providing timely definitive coverage.

Concomitant nerve injuries significantly influence long-term functional outcomes. In two of our cases, segmental defects of the median and ulnar nerves required sural nerve cable grafting. Early nerve reconstruction is crucial because prolonged denervation leads to irreversible motor end-plate degeneration and muscle atrophy.[19,25] The suboptimal functional recovery observed in Case 3 underscores the challenge of achieving excellent sensorimotor return in delayed, high-energy injuries despite technically successful repairs. The timing of nerve reconstruction should always be considered alongside vascular repair, skeletal stabilisation, and soft-tissue management. In

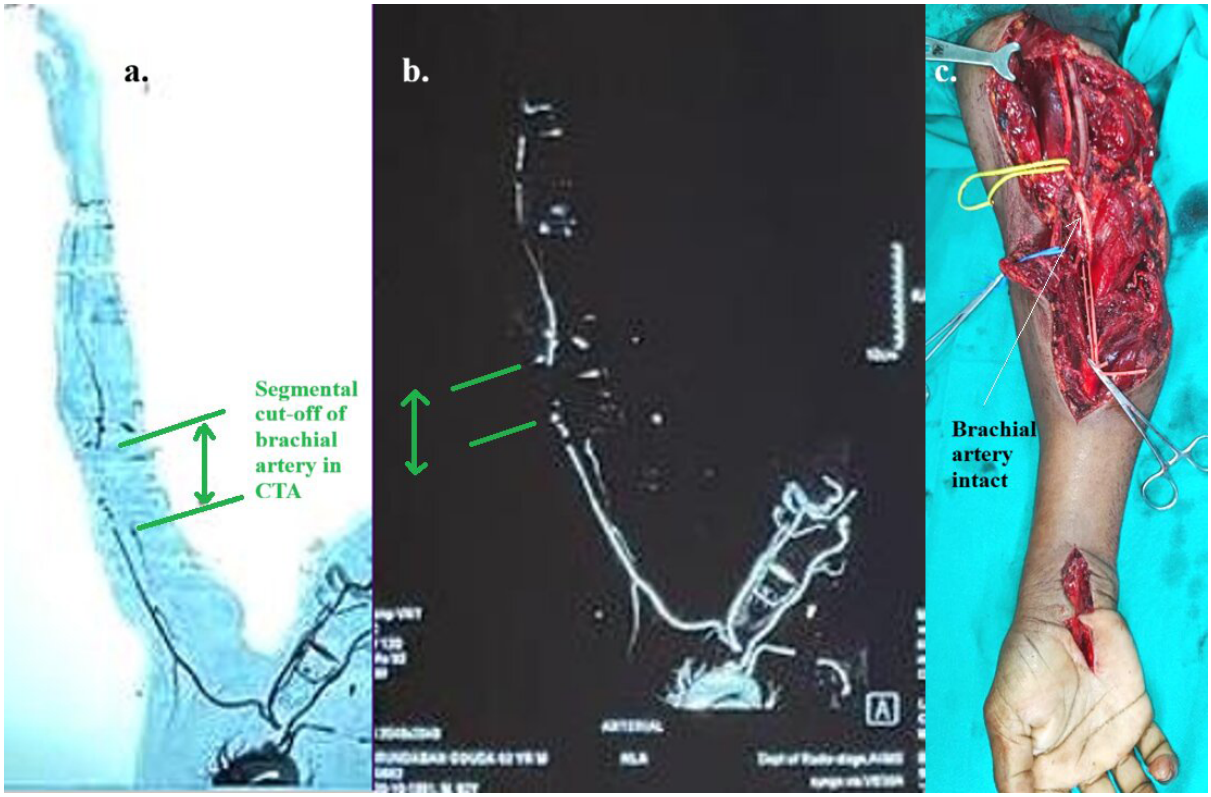


Figure 4. A 50-year-old man presented after 36 hours of sustaining a crush injury to the right upper limb. (a, b) Computed tomography angiography suggested a segmental cutoff of the brachial artery. (c) Intraoperatively, the artery was decompressed and found intact in continuity proximally and distally, with pulsatile radial and ulnar arteries; therefore, no arterial repair was needed. Despite restoration of flow intraoperatively, the patient developed limb ischaemia within the next 72 hours, necessitating subsequent amputation during which a segmental thrombus was found occluding distal blood flow.

contaminated wounds or severely crushed extremities, staged reconstruction may occasionally be necessary; however, unnecessary delay should be avoided because functional recovery declines progressively with prolonged denervation. Early rehabilitation, sensory re-education, and structured physiotherapy remain integral components of postoperative recovery following successful nerve reconstruction.

Emerging nerve conduit technologies, including natural polymer-based and conductive nanofiber guidance conduits, represent promising alternatives to autologous nerve grafting. Recent advances in biomaterial design aim to provide a supportive microenvironment for axonal regeneration while reducing donor-site morbidity and overcoming limitations in the availability of autologous nerve. Natural polymers such as collagen, chitosan, alginate, gelatin, silk fibroin, and hyaluronic acid have been investigated for their biocompatibility and ability to support nerve regeneration, while conductive nanofiber conduits incorporate electrical and topographical cues to enhance neural cell function and axonal growth. These technologies remain an emerging area of peripheral nerve reconstruction and require further preclinical and clinical validation before they can routinely replace autologous nerve grafting in complex traumatic nerve defects.[26,27]

Management of compartment syndrome was critical in three patients. Early fasciotomy, combined with NPWT, helped preserve viable muscle and support subsequent soft-tissue coverage.[22,28] NPWT not only reduced oedema and bacterial load but also promoted granulation tissue formation, facilitating later flap coverage and skin grafting. Our experience also reinforces the concept that compartment decompression should not be delayed when clinical suspicion exists. The threshold for fasciotomy should remain low in patients with prolonged ischaemia, crush injury, or reperfusion following vascular repair, as delayed decompression may negate the benefits of successful revascularisation by permitting progressive muscle necrosis and irreversible neurological injury.

Staged soft-tissue reconstruction protects vascular and nerve repairs.[29–31] Exposed grafts are highly susceptible to

infection and desiccation; therefore, early coverage with local flaps and skin grafts after adequate debridement remains a cornerstone of modern limb salvage.[32,33] Integrating plastic and reconstructive surgeons from the initial phase reflects best-practice multidisciplinary care that has demonstrably improved outcomes in complex extremity trauma. The orthoplastic philosophy has transformed the management of complex extremity trauma by promoting simultaneous decision-making between reconstructive and orthopaedic teams rather than sequential interventions. Such collaboration minimises repeated anaesthesia, shortens the interval to definitive reconstruction, reduces wound complications, and facilitates earlier mobilisation. Although this integrated approach has been widely adopted in lower-limb trauma, our findings support its equally important role in complex elbow injuries.

The amputation in Case 4, despite an initially intact artery, provides important insights into occult intimal injury and delayed thrombosis in blunt trauma. Even with apparently restored flow and normal distal oxygen saturation on pulse oximetry, progressive distal thrombosis occurred. This case also highlights the dilemma of anticoagulation in patients with previous cerebrovascular accidents.[20,21] It reinforces the need for intensive postoperative monitoring, serial Doppler assessment, and a low threshold for repeat imaging in the first 72 hours. This observation further suggests that imaging evidence of restored arterial continuity should not be interpreted as definitive proof of vascular stability after high-energy blunt trauma. Intimal disruption may develop despite initially satisfactory distal perfusion, underscoring the importance of vigilant postoperative surveillance in limb-salvage protocols. Repeated clinical examination with handheld Doppler assessment may enable earlier recognition of evolving thrombosis before irreversible tissue loss occurs.

Successful vascular reconstruction extends beyond restoration of arterial continuity and requires structured postoperative surveillance, particularly during the first 72 hours when the risk of early graft thrombosis, reperfusion injury, and compartment syndrome is greatest. We advocate intensive neurovascular monitoring with assessment of radial and ulnar pulses, capillary refill time, skin colour and temperature, pulse oximetry, pain, motor and sensory function, and handheld Doppler signals hourly during the first 24 hours, every 2 hours for the subsequent 24 hours (24–48 hours), and every 4 hours during the third postoperative day (48–72 hours), with additional assessments whenever clinical deterioration is suspected. Any reduction in Doppler signals, prolonged capillary refill time, worsening pain or swelling, deterioration in neurological status, or decline in digital oxygen saturation should prompt urgent reassessment with duplex ultrasonography or repeat computed tomography angiography, and consideration of immediate re-exploration. Such protocol-based surveillance is increasingly recognised as an essential component of successful extremity vascular trauma management, particularly following blunt arterial injuries with potential occult intimal damage.[16,22,25]

Current evidence suggests that postoperative antithrombotic therapy following traumatic arterial reconstruction should be individualised according to the mechanism of injury, type of vascular repair, associated injuries, and patient-specific bleeding risk rather than applied routinely.[25] Blunt vascular trauma is particularly susceptible to occult intimal disruption, endothelial dysfunction, and delayed thrombotic occlusion despite satisfactory intraoperative flow restoration. In contrast, concomitant intracranial pathology, recent cerebrovascular events, solid-organ injuries, or extensive soft-tissue trauma may substantially increase the risk of haemorrhagic complications from systemic anticoagulation. Consequently, the decision to administer therapeutic anticoagulation, antiplatelet therapy, or observation alone should be based on multidisciplinary risk stratification involving vascular, reconstructive, trauma, critical care, and neurological teams. Serial clinical examination, Doppler surveillance, and selective repeat CTA may provide a safer strategy for detecting evolving thrombosis in patients for whom full anticoagulation is contraindicated. Our patient exemplified this therapeutic dilemma, in which the competing risks of thrombotic occlusion and haemorrhagic complications required a carefully balanced, individualised approach rather than adherence to a uniform postoperative anticoagulation protocol.

This study offers practical translational value for trauma systems in resource-limited settings. Achieving a 75% limb salvage rate despite delayed presentations demonstrates that coordinated multidisciplinary protocols can deliver meaningful results even under challenging conditions. The selective use of CTA, preference for autologous conduits, staged orthoplastic reconstruction, and early use of NPWT provide an adaptable model for tertiary centres across India and other developing regions. These findings may help reduce amputation rates and long-term disability in young, economically productive patients. Future translational research should focus on cost-effectiveness analysis, point-of-care biomarkers for ischaemia–reperfusion injury, and optimised anticoagulation strategies in patients with comorbidities. Although limited by its retrospective design and small sample size, this case

series provides clinically relevant insights into uncommon but challenging injuries that are infrequently reported from the Indian subcontinent. The detailed description of diagnostic reasoning, staged reconstructive strategies, and multidisciplinary decision-making adds practical value beyond simple outcome reporting. These observations may assist clinicians practising in resource-limited environments where delayed presentation and limited vascular expertise continue to influence patient outcomes. Prospective multicentre studies with longer functional follow-up and patient-reported outcome measures are required to further refine evidence-based management algorithms for these complex injuries.

As a small retrospective case series from a single centre, this study has inherent limitations, including selection bias, lack of a control group, and limited statistical power. Individualised management introduced heterogeneity, and long-term functional outcomes measured with validated scores (e.g., Disabilities of the Arm, Shoulder and Hand) were not uniformly available. Moreover, because timely follow-up was not available as advised, validated outcome scores could not be obtained. The findings of this study, however, are hypothesis-generating and should not be used to guide clinical practice without larger confirmatory studies.

Larger multicentre prospective studies are needed to develop international guidelines. Priority areas include point-of-care ultrasound for vascular screening, advanced perfusion imaging, bioengineered nerve and vascular conduits, and structured orthoplastic training programmes.[34,35]

In summary, managing combined brachial artery and nerve injuries around the elbow requires a high index of clinical suspicion, timely advanced imaging, prompt revascularisation, meticulous nerve repair, and true multidisciplinary collaboration. Successful limb salvage should ultimately be judged not only by preservation of the extremity but also by restoration of useful function, pain-free mobility, and reintegration into daily activities and employment. Our experience reinforces that even in delayed and complex presentations, coordinated specialist care can achieve acceptable limb salvage and functional outcomes.

5. Conclusion

Traumatic brachial artery injuries around the elbow demand a high index of clinical suspicion, even when distal perfusion appears preserved. Prompt recognition, selective use of CTA, timely revascularisation, and comprehensive, multidisciplinary reconstruction that addresses all injured tissues are essential for successful limb salvage. Our experience demonstrates that, despite challenges of delayed presentation, coordinated specialist care can achieve meaningful functional preservation in most cases.

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Conflict of interest

The authors declare that they have no competing interests.

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Writing–review & editing: All authors

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and institutional ethical standards. Approval was obtained in accordance with the local institutional policy. All patients included in the study provided informed consent to participate in the study.

Consent for publication

Written informed consent was obtained from all patients for the publication of anonymised clinical information and images.

Availability of data

The datasets generated during the current study are available from the corresponding author on reasonable request.

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