

## Original Research Article

# Operative management and outcomes of brachial artery revascularization following delayed presentation of traumatic brachial artery injury: surgical persistence rewarded

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### ABSTRACT

**Background:** Dearth of expertise to manage vascular trauma spiraled with delay in diagnosis and referral to tertiary care centers continue to plague a developing nation like India. The brachial artery is the commonest artery to be injured in extremity following trauma. Although the patients present late, revascularization to salvage the limb and to maintain its function is advocated. This retrospective study was done to evaluate the management and outcomes of brachial artery revascularization in patients with delayed presentation of traumatic brachial artery injury.

**Methods:** Twenty-six patients of traumatic brachial artery injury who met the inclusion criteria during 1-year study period (August 2019 to July 2020) were included. Patients with iatrogenic vascular injury, severe vascular injury associated with massive orthopaedic neuromuscular injury (i.e., crush injury), mottled upper limb and injury to neck, chest, abdomen, lower limbs or any pseudoaneurysm were excluded. Data were analysed.

**Results:** Amongst 26 patients studied, 24 (92.30%) patients had complete transection of the artery. Of these, 19 (79.16%) had primary repair in the form of end-to-end anastomosis and 7 (29.16%) underwent reverse interposition saphenous vein grafting. Two patients with partial laceration of brachial artery underwent primary (lateral) repair. Associated fracture of humerus was managed with internal fixation following revascularization. Four cases underwent end to end repair of median nerve. Majority, 22 (84.61%) had good functional outcome and 4 (15.38%) had satisfactory functional results. Limb salvage rates was 100%.

**Conclusions:** Revascularization beyond warm ischemia time is still desirable to prevent limb loss. Traumatic neurological injury affects the functional outcome.

**Keywords:** Brachial artery, Delayed revascularization, Trauma, Limb salvage

### INTRODUCTION

Patients face a great deal of distress following vascular injuries due to dearth of vascular surgeons.<sup>1</sup> Limited expertise to manage vascular trauma coupled with delays in diagnosis and referral to tertiary care centres, looms large with regard to optimum management of these injuries. Definitive care within 1 hour provides better outcomes.<sup>2</sup> Upper extremity vascular injury can significantly impact the outcome of trauma patients.<sup>3</sup>

Injury to superficially located brachial artery accounts for 28% of all vascular injuries.<sup>4</sup> Patients with traumatic brachial artery injury delayed referral to tertiary centres for arterial reconstruction in practice. Few studies have been conducted to evaluate outcomes of these patients.<sup>5</sup>

#### Objective

This retrospective study was done to evaluate the management and outcomes of brachial artery

revascularization in patients who presented late following brachial artery injury.

## METHODS

The retrospective study was conducted in the department of cardiothoracic and vascular surgery after institutional ethical approval. The data of all the patients with non-iatrogenic upper limb vascular trauma during one-year study period (August 2019 to July 2020) was retrieved from medical records department. Patients with iatrogenic vascular injury, severe vascular injury associated with massive orthopaedic neuromuscular injury (i.e., crush injury), mottled upper limb and injury to neck, chest, abdomen, lower limbs or any pseudoaneurysm were excluded. Patient demographic, clinical status on presentation, site and mechanism of injury, duration from injury to repair, associated venous/nerve/bone injury, additional procedure such as vein ligation, fasciotomy, pre-operative and post-operative doppler ultrasonography of the affected part as well as anti-coagulation, and the length of hospital stay were recorded and analysed.

All patients had undergone doppler ultrasonography pre and postoperatively. Systemic heparinization was administered. On exploration, proximal and distal ends of artery were identified. Thrombectomy was performed. Primary repair (lateral/end to end anastomosis) or interposition reverse saphenous vein graft was used depending on the injury. Radial pulsation was felt immediately post revascularization. All patients with fracture underwent reduction and internal fixation. At our institute, intravenous unfractionated heparin infusion was administered for 48 hours during intraoperative and postoperative period.

Primary outcomes of this study were limb salvage rates, functional outcomes and mortality. Secondary outcomes were vascular complications such as graft failure, re-explorations and fasciotomy rates. Good functional outcome was defined as no neurological deficit and finger movement. Satisfactory functional outcome was recorded as slight paraesthesia with reduced finger movement. Poor function was noted with significant paraesthesia and no finger movement.

### Statistical analysis

The data was entered in MS excel spreadsheet and analysis will be done using statistical package for social sciences (SPSS) version 21.0. Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean  $\pm$ SD and median.

## RESULTS

Amongst 26 patients studied, the mean age at the time of presentation was  $22.75 \pm 16.8$  (range, 1.5-52) years. Majority were male 20 (76.92%) with male to female

ratio 3:1. The study variables evaluated are shown in Table 1. In the study population, 8 fell from height and 18 suffered road traffic accident. Intraoperatively, 24 (92.30%) patients had complete transection of the artery. Of these, 19 (79.16%) had primary repair in the form of end-to-end anastomosis and 7 (29.16%) underwent reverse interposition saphenous vein grafting. Two patients with partial laceration of brachial artery underwent primary (lateral) repair. All brachial artery injuries were associated with supracondylar fracture of humerus. Major venous injuries were repaired. Four cases underwent end to end repair of median nerve. No mortality or re-explorations were noted in the study population. Majority, 22 (84.61%) had good functional outcome and 4 (15.38%) had satisfactory functional results. Limb salvage was universal.

**Table 1: Variables evaluated in the study population.**

Variables	N=26
Age (Mean $\pm$ SD)	22.75 $\pm$ 16.8
Finding on admission	
Pulse rate (beats/minute) (Mean $\pm$ SD)	104.2 $\pm$ 9.65
Systolic blood pressure (mmHg) (Mean $\pm$ SD)	116 $\pm$ 9.58
Diastolic blood pressure (mmHg) (Mean $\pm$ SD)	73.62 $\pm$ 6.31
Respiratory rate (minute) (Mean $\pm$ SD)	21.3 $\pm$ 1.94
Absent pulse, n (%)	26 (100)
Cold extremity, n (%)	26 (100)
Motor deficit: complete	0 (0)
Partial	10 (38.46)
Sensory deficit: complete	2 (7.69)
Partial	7 (26.92)
Mottling	0 (0)
<b>Mechanism, n (%)</b>	
Blunt	22 (84.61)
Penetrating	4 (15.38)
<b>Type of injury, n (%)</b>	
Complete transection	24 (92.30)
Partial laceration	2 (7.69)
<b>Concomitant injury, n (%)</b>	
Fracture	26 (100)
Nerve injury	4 (15.38)
Vein injury	6 (23.07)
Major soft tissue loss	8 (30.76)
<b>Technique of repair, n (%)</b>	
Primary repair	19 (73.07)
Interposition vein graft	7 (26.92)
<b>Time from injury to repair (hour) (Mean<math>\pm</math>SD)</b>	10.62 $\pm$ 2.28
<b>Length of hospital stay (days) (Mean<math>\pm</math>SD)</b>	
Complications n (%)	
Infection	6 (23.07)
Graft failure	0 (0)
Amputation	0 (0)

## DISCUSSION

Although, the outcome of brachial artery injury following trauma have improved, delayed presentation of these patients in developing nation like India is common.<sup>6</sup> Delayed recognition and referral to tertiary care hospital due to limited expertise in vascular repair at the primary health centre is one of the major reasons.<sup>7</sup> All the patients in our study had mean time to revascularization of 10.62±2.28 hours. Thus, delayed revascularization was treatment norm. Similar approach was adopted at other centers.<sup>8,9</sup> In our study, the limb salvage rate was 100%. This could be attributed to rich collateral circulation in the upper limb of most patients.<sup>4,10</sup> Simmon et al advocated that delayed presentation beyond 6 hours amongst other things were not predictive of amputation in brachial artery injuries.<sup>11</sup> Concomitant neurological injury dictates functional outcome even after successful repair.<sup>12</sup> Major venous injuries, fractures, and widespread tissue destruction may also influence the long-term function of the extremity.<sup>13</sup> Whether primary and secondary nerve repair procedures are helpful is a point of controversy.<sup>14</sup> The rate of functional disability ranges from 27% to 44% when injury to the upper extremity includes nerve injuries.<sup>15</sup> In our study, 4 (15.38%) patients with primary median nerve repair had satisfactory functional outcome. Six (23.07%) patients had simultaneous vein repair. Arterial revascularization was followed by the bone fixation. This approach prevented the effect of unstable limb over successful revascularization. In addition, it reduced the warm ischemia and proved to be convenient to vascular surgeon in terms of ease in patient position. Post application of external fixator, integrity of the repair was confirmed. Various techniques, including lateral repair, end-to-end anastomosis, or interposition grafting with a saphenous vein were employed for brachial artery repair.<sup>16</sup> End-to-end anastomosis is preferred in the absence of tension with additional advantage of preserving major collateral vessels. Large segment loss prompts saphenous vein interposition graft as a viable option, because of better patency rates and resistance to infection compared with synthetic grafts.<sup>17</sup>

None of the patient required fasciotomy as injury was below the profunda brachii and mottled limbs were excluded.

### Limitations

The present study is retrospective hence may suffer from information bias. Further, there was shortfall of long-term limb salvage and functional outcomes.

## CONCLUSION

Delayed presentation beyond warm ischemia time should not deter the need for brachial artery revascularization. Traumatic neurological injury affects the functional outcome.

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