

Original Research Article

Brachial artery injury in pediatric patients: review of management and outcome in 29 patients

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ABSTRACT

Background: The brachial artery is the most frequently injured artery in the upper extremity due to its vulnerability and commonly it is associated with road traffic accidents and occupational injuries. But brachial artery injury in pediatric age group is not very frequent as in adults and commonly associated with supracondylar fracture of humerus. They may present with or without features of ischemia. Prompt diagnosis and treatment is essential for salvage of limb in established ischemia. Obscure presentation of arterial injury poses challenge in early diagnosis and treatment. Repair of the injured artery in these cases is not clearly recommended. We are presenting a series of 29 pediatric brachial artery injuries and their outcome in our institute over the last 5 years.

Methods: Twenty nine pediatric patients with brachial artery injury managed in our institute between 2014 to 2018 are assessed retrospectively for operative procedure and outcome.

Results: Supracondylar fracture was the most common cause (55.17%). Ischemic and non-ischemic presentation was noted in 41.37% and 69.63% cases respectively. Artery repair was done in 17 (58.62%) cases. Primary repair and interposition vein graft repair was done 8 and 9 cases respectively. Among the 17 repaired artery good functional outcome with Grade 5/5 muscle power noted in 14 cases. Amputation was done in two cases.

Conclusions: Good functional recovery may be achieved in segmental injury repair with a vein graft. Though in closed injury without ischemic features artery may not be repaired, full functional recovery is possible due to collateral circulations. Obscure presentation detected and repaired early also has a satisfactory result.

Keywords: Brachial artery injury, Pediatric, Vein graft, Obscure

INTRODUCTION

The brachial artery is the most frequently injured artery in the upper extremity due to its vulnerability.¹ Its injury accounts for approximately 28% of all vascular injuries. Commonly it is associated with road traffic accidents and occupational injuries. Brachial artery injury in pediatric age group is not very common as in adults and the reported incidence is 0.3 to 1.7%.² Brachial artery injury in pediatric age group is commonly associated with

supracondylar fracture of humerus.³ Incidence of other aetiology is very infrequent and includes posterior dislocation of elbow or closed elbow injury.⁴

They may present with or without features of ischemia.^{1,5} Prompt diagnosis and treatment is essential for salvage of limb in established ischemia. Obscure presentation poses challenge in early diagnosis and treatment. Repair of the injured artery in this situation is not clearly recommended.

We are presenting a series of 29 pediatric brachial artery injuries and their outcome in our institute over the last 5 years.

Aims and objectives

The aims and objectives of the study were to assess the outcome of brachial artery injury management in children and also to assess operative outcome in absence of ischemic features in these cases.

METHODS

This is a retrospective study with pediatric patients attending emergency department with arm injury and brachial artery injury was noted after clinical examination and investigations. The patients were included between 2014-2018 and followed up till writing of this paper. The study was done at Sri Ram Murti Smarak Institute of Medical Sciences, which is a tertiary referral and multi-speciality health care providing centre.

Inclusion criteria:

Inclusion criteria were patients aged between 1-16 years with arm and Brachial artery injury.

Exclusion criteria were <1 year, >16 year, patients with life threatening injury needed intervention apart from limb injury.

All pediatric patients attending the emergency with arm and brachial artery injury are included in this study. Patients related variables are collected from hospital database and reviewed for management and outcome.

All pediatric patients who had arm injury and presented to emergency are assessed clinically and with investigations. On arrival patients are managed with ATLS protocol and severe life threatening injury apart from arm injury are excluded from the study. Stable patients with suspected brachial artery injury are assessed for distal radial and ulnar pulsation, digital saturation and capillary refill. The presentation with suspected brachial artery injury is categorized as hard signs and soft signs.¹ Patients with hard signs i.e. cool extremity, delayed capillary filling time, pale limb, expanding hematoma are taken to OT and explored under tourniquet control to assess the extent of injury. Patients with soft signs i.e. weak pulsation but well perfused limb are subjected to colour Doppler assessment. Open injury with Colour Doppler suggestive of brachial artery injury are taken for exploration. Colour Doppler negative patients and closed injury are kept on close observation for development of ischemic features and in such cases a CT angiography was done. Patients with open and evident nerve injury are also explored to detect an arterial injury for possible repair in same sitting.

Patients with open injury are explored under general anesthesia or brachial plexus block as per anaesthetist preference and under tourniquet control. Bone fracture is fixed first followed by artery, nerve and muscle repair. If any evidence of ischemia is there a fasciotomy was done in both aspects of arm. Both ends of artery are trimmed to remove traumatic segments after placing haemostatic clamps. Segmental defect more than 1cm is repaired with an interposition great saphenous vein graft. We preferred to remove all injured part to get rid of any thrombogenic potential than a primary repair. Artery repair was done with a 7-0 prolene suture. 2500 unit heparin given slow intravenously after arterial repair. Nerve is preferably repaired primarily and sural nerve graft was used if segmental defect more than 2 cm (Figure 1 and 2).

Postoperative back slab in elbow flexion applied for 2 weeks if there is no bone injury. Patients were reviewed for return of distal pulse, improved volume and ischemic features after repair. A colour Doppler assessment was done to check patency of repair. Return of nerve sensation assessed periodically with progression of Tinel's sign. Bone union assessed with plain X-ray. Muscle power, range of motion and functional recovery were assessed periodically.

RESULTS

Twenty nine pediatric patients were included in the study. Mean age of the patients was 9.17 with SD 2.64 and SE 0.49. Among them 27 were male and 2 were female.

Aetiology of the injuries were supracondylar fracture, glass cut injury, avulsion injury after RTA, thorn wire injury and seen in 16 (55.17%), 6 (20.68%), 6 (20.68%) and 1 (3.44%) patients respectively. Hard signs were noted in 14 (48.27%) and soft signs in 15 (51.72%) patients. Associated nerve injury was detected in 13 patients (44.82%).

Twelve supracondylar fracture was treated with fracture reduction and bone fixation without artery repair. Artery is not repaired in them as to avoid collateral circulation damage. Four supracondylar fracture treated with simultaneous artery repair. Two of them were partial injury and the other two were complete transection. Six Glass cut injuries are repaired primarily. RTA and avulsion injuries are repaired with vein graft in 6 patients. Overall artery was repaired in 17 patients. Among the repaired artery segmental gap after refreshing margin was seen 12 patient and they were repaired with a vein graft. Mean vein graft length was 3.16, SD 1.11). Fasciotomy was done in 11 (37.93). Limb was salvaged in 27/29 and total distal amputation was done in 2 patients. Among the salvaged patients grade 5/5 power was noted in 21 and grade 4/5 power was seen in 4 patients. Among the repaired artery grade 5 and 4 power was seen in 14 and 1 cases respectively. In repaired nerve injury cases sensory and motor recovery was noted in all.

Operative outcome is summarised in Table 1.

Table 1: Summary of surgical outcome.

Management	Outcome	No.	Total
Artery repaired	Amputation	0	8
	Grade 5	7	
	Grade 4	1	
	Grade 3 or less	0	
	Amputation	2	9
	Grade 5	7	
	Grade 4	0	
	Grade 3 or less	0	
Artery not repaired	Amputation	0	12
	Grade 5	8	
	Grade 4	4	
	Grade 3 or less	0	

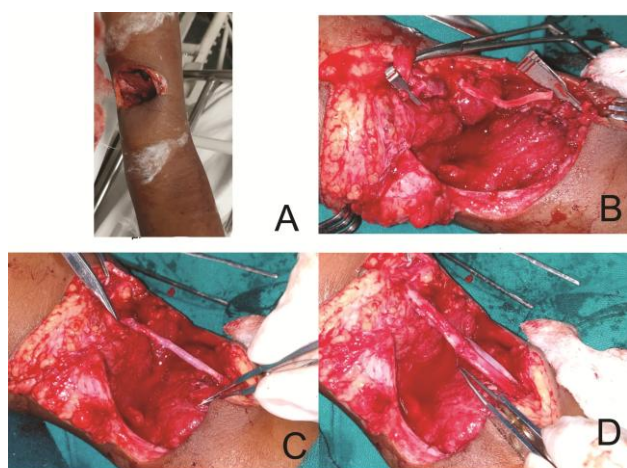


Figure 1: Brachial artery injury in a 12 year boy from thorn wire. (A) Patient presented without any manifestation of major bleeding and perfused distal limb; (B) a 4cm segmental defect noted after clearing the injured end and GSV Graft harvested and placed; (C) artery repaired with interpositional vein graft; (D) median nerve is also repaired.

DISCUSSION

Brachial artery injury commonly presents with accompanied major bone and soft tissue injuries. Signs and symptoms are categorised as soft sign and hard signs.¹ Hard signs include major haemorrhage and shock, loss of distal pulsations, no capillary filling, cold clammy limb and features of Impending gangrene. This situation risks major amputation of limb if timely intervention is not taken. Urgent exploration is necessary when distal pulsation is absent.⁶ The median nerve courses with the brachial artery throughout its length so median nerve injury is almost associated with brachial artery injury.^{5,7} But it may present with soft signs like weak pulsation, delayed capillary filling and absence of ischemic features.⁸⁻¹⁰ The upper limb has a rich collateral flow

through the profunda brachii, radial and ulnar collateral arteries which may mask the signs of the injury⁸.

Brachial artery injury in children is commonly seen with supracondylar fracture. Supracondylar fracture may lead to a distal pulseless but perfused limb. Management of this condition sometimes creates confusion and no intervention in spite of complete transection is considered to avoid iatrogenic injury to collateral circulation.^{3,11,12} Complete transection other than supracondylar fracture in pediatric age group is very infrequent. Closed injury and posterior dislocation of elbow was mentioned as isolated case reports.^{13,15} Transected or injured Brachial artery with soft signs is unusual but may obscure the detection and delay the management. Clinical presentation with soft signs needs high index of suspicion. Pulse oximetry may not be reliable and digital saturation found to be maintained. Colour Doppler study is most useful tool for early detection of an obscure presentation. It is inexpensive, could be done bedside and has high accuracy rate. Angiography is most confirmatory and is used in obscure presentation.¹⁶

A brachial artery with obscure presentation is believed to be due to rich collateral circulation around elbow joint.^{12,17} The Profunda Brachii artery carries the alternate pathway for blood flow which communicates with Radial and ulnar artery through radial and ulnar collateral arteries. Though distal limb avoids an ischemic event, pulse rate and capillary filling may be slow.

Management of Brachial artery injury calls for urgent exploration and repair to salvage an ischemic limb. Repair of the artery within 6 hours is the traditional norm to avoid ischemic damage to distal muscle mass. Delayed presentation risks to survival of the limb due to ischemic damage to muscle which may give to compartment syndrome, Myoglobinuria and Acute renal failure. There is chance of reperfusion injury also jeopardising the repair on late presentation.

Repair may pose major challenges in avulsion injury as there is chance of segmental damage and loss of the artery. An interposition venous conduit is commonly used in these situation.^{2,18} A great saphenous vein graft harvested from leg and reversely interposed usually bridges the gap with good caliber match. Basilic vein graft from the surroundings has also been reported.^{19,20}

Implication of obscure presentation

Implication of an obscure presentation and its management strategy is not very clearly mentioned. Though the distal circulation is usually maintained due to escaped collateral circulation, pulse and capillary filling remains slow. As conventional belief, distal muscle may face ischemia on demand of full functional activity. We believe a transected brachial artery should always be repaired even after late presentation. It is shown that limb salvage surgery could be done even in delayed

presentation after golden hours.^{21,22} There is no data pertaining the adequacy of collateral circulation for the full functional recovery. And again, Reperfusion injury is not expected due to maintained collateral circulation from injury. So upon the evidence we found delayed repair would not pose any harm upon repair if the presentation is obscure. But it may benefit towards functional recovery.

CONCLUSION

Good functional recovery may be achieved in segmental injury repair with a vein graft. Though in closed injury without ischemic features artery may not be repaired, full functional recovery is possible due to collateral circulations. Obscure presentation detected and repaired early also has a satisfactory result.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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