

Peripheral Arterial Injuries in Pediatric Age Group

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Purpose: Arterial injury in children is a challenging problem for its special characteristics. It is rare even during warfare. This review described a personal experience in the management and outcome of acute pediatric arterial injuries of extremities.

Methods: Thirty-six children below age of 13 years were studied during period from 2004 through 2014 in Iraq.

Results: Male patients were 27 (75%) and female were 9 (25%). Seven to twelve years old was the most affected age group. The incidence of iatrogenic injuries was greater in infants and toddlers while penetrating injuries were the most common in older children. Upper limbs arteries were affected in 17 (47.2%) and lower limb in 19 (52.8%) patients. Hard signs were the commonest mode of presentation (83.3%). Lateral wall tear and complete transection were the most frequent types of arterial injury (36.1% and 27.8% respectively). The most frequent procedures performed were end-to-end anastomosis and lateral arteriorrhaphy. Surgical outcome was good. In 27 cases distal pulsations were regained. Seven cases had impalpable distal pulses but still viable limbs. Limb length discrepancy was detected in one case. One case was complicated with limb loss. No death was recorded.

Conclusion: Arterial injuries in children are age related. The proper treatment of arterial injuries in children requires high index of suspicion, early operative intervention and continuous postoperative follow-up throughout years of active growth. Angiogram has a limited role as a diagnostic tool in acute arterial injuries. [J Trauma Inj 2016; 29: 37-42]

Key Words: Pediatrics, Vascular system injuries, War-related injuries.

I. Introduction

Arterial injury is an important cause of mortality and morbidity in both adult and children.

Pediatric peripheral arterial injuries fall into three principal categories: injuries incurred in the course of diagnostic procedures, affecting primarily infants and toddlers, blunt trauma from falls and vehicular accidents, and penetrating trauma, which was the particular injuries encounter in Iraq during the study period.

Pediatric peripheral arterial injuries differ from those in adults, by being considerably less common,

even in warfare, and affecting smaller, atherosclerosis-free, spasm-prone vessels, small intravascular volume and polycythemia in newborn, in addition to diagnostic difficulties.(1-4) It needs more than just patency-preserving flow to support adequate limb growth.

Fewer resources and insufficient reporting are ascribed to the management of pediatric arterial trauma than adult injury.

The aim of this review is to describe a personal experience in the management and outcome of 36 children with acute peripheral arterial injuries.

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II. Patients and Methods

This is a cross-sectional study comprises 36 children (below age of 13 years), cared by a single vascular surgeon at Samawa General Hospital (2004–2008) and Ibn Al-Bitar Hospital (20012–2014) in Iraq.

Thirteen years old was considered as a highest pediatric age as an arbitrary cut-off point.

Thorough history was taken and proper physical examination was performed. The diagnosis depended mainly on clinical symptoms and signs. Early surgical exploration was considered in all cases.

The limbs were explored under general anesthesia using longitudinal incision to expose injured artery

and control bleeding followed by reconstruction. Polypropylene 6/0–8/0 (Ethicon Inc., Somerville, NJ) were used for arterial repair and anastomosis. Circumferential suturing was always interrupted in at least three places. Drain was not routinely used. Postoperative, heparin injections for five days followed by antiplatelet for three months were prescribed.

III. Results

Thirty-six children with arterial trauma were studied, 27 (75%) were male and 9 (25%) were female. The distribution of mechanisms of injury according to age groups is shown in (Table 1).

Table 1. Distribution of peripheral arterial injury mechanisms according to age group in 36 children.

Age group	Mechanism of injury			Total (%)
	Penetrating	Blunt	Iatrogenic	
< 2 years	1	-	5	6 (16.7%)
2-7	2	4	4	10 (27.8%)
7-12	17	3	-	20 (55.5%)
Total	20	7	9	36 (100%)

Table 2. Mechanisms of peripheral arterial injuries in 36 children.

Mechanism	Type	Number	Total (%)
Penetrating	Shell/missile	9	20 (55.6%)
	Gunshot	8	
	Stab wound	3	
Blunt	Road traffic accident	3	7 (19.4%)
	Bicycle falling	2	
	Falling from height	2	
Iatrogenic	Catheterization	7	9 (25%)
	Cannula puncture	2	

Table 3. Distribution of peripheral arterial injuries in 36 children.

	Upper limb		Lower Limb
Axillary	1	Common femoral	9
Brachial	13	Superficial femoral	5
Radial	3	Profunda femoris	1
		Popliteal	3
		Anterior tibial	1
Total (%)	17 (47.2%)	Total (%)	19 (52.8%)

Table 4. Clinical presentations of children with peripheral arterial injuries.

Hard signs		Soft signs	
Sign of ischemia	11	Small hematoma	3
Active bleeding	9	Track missile adjacent to major artery or nerve injury	2
Expanding or pulsatile hematoma	8	History of bleeding or hypotension	1
Bruit	1		
Gangrene	1		
Total (%)	30 (83.3%)	Total (%)	6 (16.7%)

Table 5. Associated injuries in children with peripheral arterial injuries.

Associated injury	Number (%)
Soft tissue	21 (58.3%)
Vein	16 (44.4%)
Bone	9 (25%)
Nerve	4 (11.1%)
Multiple injured patient	1 (2.8%)

Table 7. Methods of pediatric peripheral arterial injury treatment.

Method of repair/treatment	Number (%)
End-to-end anastomosis	10 (27.8%)
Lateral arteriorrhaphy	9 (25%)
Ligation	6 (16.7%)
Saphenous vein graft interposition	4 (11.1%)
Venous patch	2 (5.6%)
Amputation	1 (2.8%)
Conservative management	4 (11.1%)
Total (%)	36 (100%)

Iatrogenic injury was occurred in 5 out of 6 children below age of 2 years. Blunt and iatrogenic mechanisms had same incidence and were the commonest in age group 2–7. Penetrating injuries were the commonest in 17 out of 20 children in age group 7–12. (Table 2).

The lower limbs were injured in 19 cases (52.8%) while the upper limbs were involved in 17 cases (47.2%) (Table 3).

The clinical presentation of the children with arterial injuries shows in (Table 4). Hard signs were the commonest mode of presentation in 30 cases (83.3%). Six cases (16.7%) had soft signs.

Table 6. Types of peripheral arterial injury in 36 children.

Type of arterial injury	Number (%)
Lateral wall tear	13 (36.1%)
Complete transection	10 (27.8%)
Pseudoaneurysm	8 (22.2%)
Contusion	5 (13.9%)
Total (%)	36 (100%)

Table 8. Outcome of operative and nonoperative managements of peripheral arterial injuries in 36 children.

Viable limb	Positive pulses	27 (75%)
	Negative pulses	7 (19.4)
	Limb length discrepancy	1 (2.8%)
	Lost limb	1 (2.8%)

The soft tissue disruption was the most frequent associated injury and was encountered in 58.3%.

Vein injuries were encountered in 44.4%. Bone fractures were occurred in 25%. Nerve injuries were occurred in 11.1%. In one case (2.8%) the patient was multiply injured (Table 5).

The types of arterial injuries shows in (Table 6), lateral wall tear was the most frequent type that was occurred in 13 cases (36.1%). Complete transection was occurred in 10 cases (27.8%). Pseudoaneurysm was occurred in 8 (22.2%) and contusion was encountered in 5 cases (13.9%)

The end-to-end anastomosis and lateral arteriorrhaphy were the commonest procedures performed, in 10 and 9 cases respectively. Ligation was carried out in 6 cases, saphenous vein graft interposition in 4 cases, usage of venous patch in 2 cases and ampu-

tation (above the knee) in one case. Conservative management was still applicable in 4 cases (Table 7).

The outcome of the management is shown in (Table 8). In viable limb, positive distal pulse was regained in 27 cases, while in 7 cases had impalpable pulse. Limb length discrepancy was described in one case. One limb was lost and amputated. Fortunately, no death was recorded.

IV. Discussion

Non-iatrogenic peripheral arterial injuries in infants and children comprise nearly 1% of all pediatric trauma admissions, despite higher incidence during wartime.(5-7) Thromboses, hematomas, and pseudoaneurysms following diagnostic procedures are largely unreported.(4) As a consequence, the literature consists entirely of small, short follow-up, retrospective series with the singular exception of long-term prospective study of revascularization to lessen post-traumatic limb length discrepancies.

Surgeons caring for these injuries are therefore obliged to comb interference from a limited knowledge base near bottom of the evidentiary hierarchy.

Interpreting the results of our personal experience suggests that the cause of arterial injuries in children is age related.(1,3) The incidence of iatrogenic etiology was more frequently affected infants and toddlers less than 2 years old. Penetrating etiology was higher among ages 7-12 years. In children with 2-7 years old, the blunt and iatrogenic were more frequent than penetrating injuries. The relation between various etiological types of injuries varies in published series. However, the incidence of iatrogenic injuries is greater in younger children.(1,8-10)

The main cause of iatrogenic etiology was femoral artery catheterization, whether diagnostic or therapeutic.(11,12) The small vessels are vulnerable to spasm. Prolong ischemia can lead to discoloration and cyanosis of the skin. Thereafter, frank gangrene and irreversible tissue loss may result. Inadvertent cannula puncture of radial and brachial arteries may also lead to arterial spasm and eventually ischemia. In addition, thrombi or emboli can obstruct the blood flow.

The main cause of penetrating arterial injuries

was shells or missiles and gunshot injuries.

Road traffic accident, falling from height and bicycle falling were the most common mechanisms of blunt injuries. Supracondylar fractures of humerus and dislocations of the elbow lead particularly to brachial artery injuries. However, the incidence of ischemia after proper fracture reduction is rare.(13,14)

The clinical presentation of blunt arterial injuries is usually less apparent than penetrating and some of iatrogenic injuries. Hard signs of arterial injury were the commonest, a result which was comparable with that of Rozycki and his colleagues.(15)

Noninvasive method, duplex scanning, is applicable in questionable clinical presentation or iatrogenic cases. Non-severed arterial injuries can be diagnosed by this modality.

Arteriography must be retained for more complex and multilevel arterial injuries.(2,3,16) However, it is not routinely available in emergency unit and was not performed in this study.

The brachial and common femoral arteries were the most frequently involved arteries in this study. Meagher and his associates reported brachial and superficial femoral arteries as the most frequent.(17) Mommsen et al reported that the femoral artery, common and superficial, was the commonest followed by the brachial artery.(18)

Soft tissue disruption plays a major role in outcome of surgical intervention and it requires extensive debridement then primary or delayed primary skin closure. High velocity missiles are more likely to be associated with bone, nerve and other soft tissue damages owing to more kinetic energy that missiles have.

Bone fracture should be treated at the same operative session. Orthopedic fixation was performed before and, in number of cases, after arterial anastomosis to save the time for revascularization.

Nerve injury can be repaired at same time if the wound is sufficiently cleaned otherwise it should be postponed for few weeks.

Venous injuries should be repaired for more satisfactory outcome(19) but it is not uncommon to ligate the vein especially in life-threatening situation.

Fasciotomy distal to site of arterial reconstruction

should be carried out in acute compartment syndrome. It was performed in one case of arterial and venous injuries with a bone fracture and major crush injury.

Type of arterial injuries and extent of damage determined the line of treatment that was performed.(1,2)

The most frequent procedure carried out, in this series, was end-to-end anastomosis and lateral arteriorrhaphy.

Single injury of the radial, ulnar, and anterior or posterior tibial arteries with preserved collaterals can be ligated with satisfactory result.(20) Ligation of axillary artery was performed in one case with life-threatening situation. No specific consequence was recorded during short- and long-term follow-up. Different studies mentioned different percents for performed procedures owing to diverse sampling.(5,21)

In this review, nonoperative management was still possible in 11.1%. It was preferred in arterial spasm after inadvertent cannula puncture and arterial injury that associated with malalignment of fractured bone with audible Doppler pulsation and no overt signs of ischemia.(22,23)

Surgical outcome was generally good in this review. In 27 cases distal pulsation was regained. Seven cases had impalpable distal pulse but limb was viable. Limb length or circumference discrepancy was detected in one case. Amputation, above the knee, was urged in one case with established gangrene due to delayed referral.

V. Conclusion

Arterial injuries in children are age related. The proper treatment of arterial injuries in children requires high index of suspicion, early operative intervention and continuous postoperative follow-up through out years of active growth. Angiography has a limited role as a diagnostic tool in acute arterial injuries. However, Duplex scanning can be helpful.

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