Pediatric Vascular Injuries, Patterns of Injury and Outcome

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ABSTRACT
Background: Paediatric vascular injuries differ from adult subjects in that significant injuries are more challenging to be detected since they are asymptomatic, are associated with spasm, or have other more serious life-threatening injuries which take priority in the resuscitation.
Objective: This study was carried out to review the pattern of vascular injury in pediatrics, and its effect in outcome.
Methods: This work was prospective observational clinical study that was carried out on pediatric trauma patients presented at Emergency Department (ED) in Mansoura University Emergency Hospital over period of one year, from September 2021 to August, 2022. The study included 103 patients.
Results: The current study demonstrated that the majority of injuries were penetrating (62.1%), while 37.9% were blunt. Most of injuries were in the upper extremities, involving mostly brachial artery (28.3%), brachial vein (21.7%), and ulnar and radial vessels (23.3%). Regarding operative management lines, primary repair was performed in the majority of the cases (31.6%), followed by repair with vein patch (26.3%), and ligation (24.6%). The majority of the cases were admitted in ward (69.9%), while 30.1% were admitted in ICU. A statistically significant association was detected between injuries of the upper extremities and median duration of hospital stay among the studied cases.
Conclusion: It can be concluded that optimal management of vascular injuries in children necessitates expedient diagnosis and treatment, with readily available access to a multidisciplinary team who have experience in paediatric trauma. The selective usage of arteriography is beneficial in injury diagnosis and subsequent surgical or non- surgical management. Computed tomography angiography can be a significant tool for initial evaluation.
Keywords: Pediatric extremity vascular injuries, Pediatric Trauma Society, Blunt trauma, Penetrating trauma.

INTRODUCTION

Non-iatrogenic vascular injuries in children are not common. It was estimated that major trauma centers treat less than 5 patients every year **(1)**. Rapid diagnosis is essential, with a 97% recovery rate in children in whom proper diagnosis was made. The treatment of this population is complex. Paediatric trauma cases might present with undiagnosed vascular injuries which are masked by vasospasm and the existence of associated multi-system injuries. Additionally, vascular injuries are often associated with other life threatening, and therefore distracting, conditions. Lastly, there are no yet available guidelines for the management of paediatric trauma patients **(2)**.

In children, vascular trauma of extremities are uncommon with an incidence of < 1%. Though vascular injuries in paediatric population are linked to lower mortality compared to in adults, the incidence of limb loss and poor functional outcomes are similar. In the previous decade, guidelines for managing extremity vascular injuries in adult patients have been developed. However, there are no yet available guidelines for the management of paediatric trauma patients, and adult guidelines might not be appropriate for children **(3)**.

Due to their smaller vessels and the associated spasm, children present distinct management-related challenges **(4)**. Moreover, endovascular techniques is usually difficult because of vessel size and is usually discouraged due to children's increased life span and further vessel growth **(5)**. Open vascular exposures are rarely encountered in surgical training, highlighting the significance of familiarity with such techniques for effective management **(6)**.

Vascular surgeon staffing is most commonly responsible for managing complex vascular injuries and a previous study showed that free-standing children's hospitals were less likely than dual-certified centers to have vascular surgeons staff or immediate availability **(7)**. Blunt trauma is responsible for the majority of MVIs in trauma patients of all ages; however, a penetrating mechanism of injury occurs with more frequency (almost 50%) in children **(8)**. Paediatric Trauma Society demonstrated a decrease in mortality with tourniquet use in pediatric combat casualties **(9)**.

AIM OF WORK

The current study was done to review the pattern of vascular injury in pediatrics, and its effect in outcome.

PATIENTS AND METHODS

This was prospective observational clinical study carried out on pediatric trauma patients presented to Emergency department (ED) in emergency Mansoura university hospital over a period of one year from September 2021 to August 2022.

The study included pediatric trauma patients aged less than 16-years old arrived to ED with vascular injury and treated by members of ED. But we excluded patients aged more than 16 years old & less than one year and with no vascular injury can be detected.

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METHODS

Primary survey included full history taking that included allergies, medications and mechanism of injury. Removing the clothes for examination with keeping the patients warm were the first to be done, cervical spine was stabilized, airway was checked, chest movement were inspected, air movement were checked, pulse and blood pressure were assessed, and neurological status were also assessed.

Secondary survey included full set of vital signs (heart rate, pupil condition [dilated or constricted], breathing, degree of conscious level, and skin color), and head to toe assessment was done

Laboratory tests included complete blood count (CBC) and cross matching, arterial blood gas, liver and kidney function tests as well as coagulation tests.

Radiological investigations included doppler US, fast, duplex study, chest X-ray, CT-angio and other CT (if needed)

Management included surgery or conservative treatment.

Outcomes

- Patient admitted to word or ICU.
- Mortality or survival within 7 days.
- Length of hospital Stay.
- Number of operations.

Ethical consideration:

Study protocol was submitted for approval by Institutional Review Board (IRB) Mansoura University. Informed written consents were taken from parents of each participant. Confidentiality as well as privacy were respected. Data weren't be used for any different purposes. The Declaration of Helsinki for human beings, which is the international medical association's code of ethics, was followed during the conduct of this study.

Statistical analysis

Data were analysed using SPSS software, v25. Qualitative data were described as numbers and precents. Quantitative data were defined as medians (interquartile range) for non-normally distributed data and means± SDs for normally distributed data following testing normality by utilizing Kolmogrov-Smirnov test. Chi-Square, MC tests were utilized for comparison between qualitative data between groups as appropriate. Kruskal Wallis and Mann Whitney U test were utilized for comparison between 2 studied groups and more than 2 studied groups, respectively for non-normally distributed data.

RESULTS

Our study enrolled 103 children's cases. Their mean age was 8.18±3.52 years. Most of subjects were males (78.6%), whereas females represented 21.4% of the cases, 62.1% of the patients had penetrating injuries while 37.9% had blunt trauma. The majority of penetrating injuries were caused by glass (42.2%), followed by knife (39.1%), and gunshot in only 6.2%. Most of the blunt injuries were due to motor vehicle crash (43.6%), followed by pedestrian vs. automobile trauma (23.1%), and fall (23.1%). Most of injuries were in the upper extremities, involving mostly brachial artery (28.3%), brachial vein (21.7%), and ulnar and radial vessels (23.3%). The second largest patient group was cases with torso injuries, in which the 2 most common structures with an injury were aorta (37.5%) and the vena cava (12.5%) (table 1).

Table (1): Location of vascular injuries among the studied cases.

Location	n=103	%
Head & neck:	n=12	
• Carotid arteries	1	8.3
• Jugular veins	2	16.7
• Vertebral arteries	1	8.3
• Extracranial arteries	4	33.3
• Intracranial arteries	3	25.0
• Intracranial veins	1	8.3
Torso:	n=16	
• Aorta	6	37.5
• Vena cava	2	12.5
• Iliac artery	1	6.2
• Iliac vein	1	6.2
• Subclavian artery	1	6.2
• Subclavian artery and vein	1	6.2
• Portal vein	1	6.2
• Short gastric arteries	1	6.2
• Intercostal artery	1	6.2
• Inferior phrenic vein	1	6.2
Upper extremities:	n=60	
• Brachial arteries	17	28.3
• Brachial veins	13	21.7
• Traumatic	1	1.7
• Axillary veins	4	6.7
• Cephalic veins	1	1.7
• Ulnar arteries	7	11.7
• Radial arteries	3	5.0
• Ulnar & radial	14	23.3
Lower extremities:	n=15	
• Femoral arteries	1	6.7
• Femoral veins	1	6.7
• Superficial femoral artery	2	13.3
• Superficial femoral vein	1	6.7
• Popliteal arteries	2	13.3
• Saphenous veins	1	6.7
• Anterior or posterior tibial artery	3	20.0
• Posterior tibial vein	3	20.0
• Geniculate artery	1	6.7
Causes of injury		
Penetrating	n=64	62.1
• Gunshot	4	6.2
• Glass	27	42.2
• Scissors	2	3.1
• Propeller	2	3.1
• Knife	25	39.1
• Saw	2	3.1
• Other	2	3.1
Blunt trauma	n=39	37.9
• Motor vehicle accident	17	43.6
• Pedestrian vs automobile	9	23.1
• Falls	9	23.1
• Battered	1	2.6
• Other blunt	1	2.6

Regarding the management lines of the studied cases, the majority of the studied cases were subjected to operative management (55.3%), 21.4% underwent diagnostic arteriography, 15.5% had computed tomography, while 7.8% carried out diagnostic venography. **Table (2)** reveals lines of operative management of the studied cases. Primary repair was performed in the majority of the cases (31.6%), followed by repair with vein patch (26.3%), and ligation (24.6%). Amputation was performed in 5.3% of the cases.

Table (2): Lines of operative management of the studied cases.

Operative management line	n=57	%
Primary repair	18	31.6
Resection and anastomosis	2	3.5
Ligation	14	24.6
Repair using vein patch	15	26.3
Synthetic replacement	2	3.5
Extra-anatomic bypass	3	5.3
Amputation	3	5.3

Table (3) displays the outcome of the studied children. The majority of the cases were admitted in ward (69.9%), while 30.1% were admitted in ICU. Within one week, the percentage of mortality among the studied cases was 8.7%. The median duration of hospital stay was 15 days.

Table (3): Outcome of the studied cases

Outcome	n=103	%
Ward	72	69.9
ICU	31	30.1
Mortality within one week		
Alive	94	91.3
Dead	9	8.7
Hospital stay /days		
Median (min-max)	15.0(1-150)	

Table (4) displays the relation between type of injury and mortality of the studied cases. There was no significant correlation between type of injury and mortality of the studied cases **($p>0.05$)** and shows the relation between site of vascular injury and mortality of the studied cases.

According to these results, no significant association was found between site of vascular injury and mortality of the studied cases ($p>0.05$), also table (4) displays the relation between operative and non-operative management and mortality of the studied cases. The percentage of mortality was higher among patients who underwent non-operative management (88.9%), compared to those having operative management (11.1%).

Accordingly, a significant association existed between operative and non-operative management and mortality of the studied cases ($p<0.05$).

Table (4): Relation between type of injury, site of vascular injury, operative and non-operative management and mortality of the studied cases.

Type of injury	Alive n=94(%)	Died n=9(%)	Test of significance
Penetrating **Blunt**	60(63.8) 34(36.2)	4(44.4) 5(55.6)	χ^2=1.31 p=0.252
Site of vascular injury			
Head & neck: • **Carotid arteries** • **Jugular veins** • **Vertebral arteries** • **Extracranial arteries** • **Intracranial arteries** • **Intracranial veins**	n=4 1(25) 1(25) 1(25) 0 1(25) 0	n=8 0 1(12.5) 0 4(50) 2(25) 1(12.5)	MC=6.75 p=0.240
Torso: • **Aorta** • **Vena cava** • **Iliac artery** • **Iliac vein** • **Iliac vein** • **Subclavian artery** • **Subclavian artery and vein** • **Portal vein** • **Short gastric arteries**	6(37.5) 2(12.5) 1(6.2) 1(6.2) 1(6.2) 1(6.2) 1(6.2) 1(6.2) 1(6.2)	0 0 0 0 0 0 0 0 0	
Upper extremities: • **Brachial arteries** • **Brachial veins** • **Traumatic** • **Axillary veins** • **Cephalic veins** • **Ulnar arteries** • **Radial arteries** • **Ulnar & Radial**	17(28.3) 13(21.7) 1(1.7) 4(6.7) 1(1.7) 7(11.7) 3(5.0) 14(23.3)	0 0 0 0 0 0 0 0	
Lower extremities: • **Femoral artery** • **Femoral vein** • **Superficial femoral artery** • **Superficial femoral vein** • **Popliteal artery** • **Saphenous vein** • **Anterior or posterior tibial artery** • **Posterior tibial vein** • **Geniculate artery**	1(7.1) 1(7.1) 2(14.3) 1(7.1) 2(14.3) 0 3(21.4) 3(21.4) 1(7.1)	0 0 0 0 0 1(100) 0 0 0	MC=15.0 p=0.06
Management			
• **Non-operative** • **Operative**	38(40.4) 56(59.6)	8(88.9) 1(11.1)	χ^2=7.81 p=0.005*

Z: Mann Whitney U test, χ2: Chi-Square test.

Table (5) demonstrates the relation between demographic characteristics and ICU admission. No statistically significant correlations were found between age, sex, or type of injury and ICU admission **(p>0.05)** and shows the relation between anatomic location of injury and ICU admission of the studied cases. According to these results, no significant correlation existed between anatomical location of injury and ICU admission of the studied cases (p>0.05). Also, **table (5)** demonstrates the correlation between operative and non-operative management and ICU admission of the studied cases. The percentage of ICU admission was higher among patients who underwent operative management (67.7%), compared to those having non-operative management (32.3%). However, a non-significant association existed between operative and non-operative management and ICU admission of the studied cases **(p<0.05)**.

Table (5): Relationship between demographics, anatomic location of injury, operative and non-operative management and ICU admission of the studied cases.

	Ward n=72	ICU n=31	Test of significance
Age/years			
• **Mean±SD**	8.01±3.58	8.58±3.40	Z=0.830
• **Median (Min-Max)**	8(2-15)	9(3-15)	p=0.407
Sex			
• **Male**	55(76.4)	26(83.9)	χ^2=0.722
• **Female**	17(23.6)	5(16.1)	p=0.395
Type of injury			
• **Penetrating**	47(65.3)	17(54.8)	χ^2=1.004
• **Blunt**	25(34.7)	14(45.2)	p=0.316
Site of Vascular Injury			
Head & neck:	n=3	n=9	
• **Carotid arteries**	0	1(11.1)	MC=5.33
• **Jugular veins**	1(33.3)	1(11.1)	p=0.377
• **Vertebral arteries**	1(33.3)	0	
• **Extracranial arteries**	1(33.3)	3(33.3)	
• **Intracranial arteries**	0	3(33.3)	
• **Intracranial veins**	0	1(11.1)	
Torso:	N=9	N=7	
• **Aorta**	3(33.3)	3(42.9)	MC=9.91
• **Vena cava**	0	2(28.6)	p=0.358
• **Iliac artery**	0	1(14.3)	
• **Iliac vein**	1(11.1)	0	
• **Subclavian artery**	1(11.1)	0	
• **Subclavian artery and vein**	1(11.1)	0	
• **Portal vein**	1(11.1)	0	
• **Short gastric arteries**	1(11.1)	0	
• **Intercostal artery**	0	1(14.3)	
• **Inferior phrenic vein**	1(11.1)	0	
Upper extremities:	N=52	N=8	
• **Brachial arteries**	16(30.8)	1(12.5)	MC=7.49
• **Brachial veins**	9(17.3)	4(50.0)	p=0.379
• **Traumatic**	1(1.9)	0	
• **Axillary veins**	4(7.7)	0	
• **Cephalic veins**	1(1.9)	0	
• **Ulnar arteries**	7(13.5)	0	
• **Radial arteries**	3(5.8)	0	
• **Ulnar & Radial**	11(21.2)	3(37.5)	
Lower extremities:	N=8	N=7	
• **Femoral arteries**	1(12.5)	0	MC=9.64
• **Femoral veins**	0	1(14.3)	p=0.291
• **Superficial femoral artery**	2(25.0)	0	
• **Superficial femoral vein**	0	1(4.3)	
• **Popliteal arteries**	2(25.0)	0	
• **Saphenous veins**	0	1(14.3)	
• **Anterior or posterior tibial artery**	1(12.5)	2(28.6)	
• **Posterior tibial vein**	2(25.0)	1(14.3)	
• **Geniculate artery**	0	1(14.3)	
Management			
• **Non-operative**	36(50.0)	10(32.3)	χ2=2.76
• **Operative**	36(50.0)	21(67.7)	p=0.097

Z: Mann Whitney U test, χ^2: Chi-Square test.

Table (6) reveals the relationship between length of hospital stay and type of injury among the studied cases. There was no significant correlation between type of injury and median duration of hospital stay among the studied cases **($p>0.05$)** and reveals the relationship between length of hospital stay and anatomical location of injury among the studied cases. On the other hand, there was a significant correlation between injuries of the upper extremities and median duration of hospital stay among the studied cases ($p<0.05$). Also, **table (6)** demonstrates the relation between length of hospital stay and operative and non-operative management of the studied cases. The median duration of hospital stay was longer among patients who underwent operative management (19 days), compared to those having non-operative management (10 days). Accordingly, there was a significant association between length of hospital stay and operative and non-operative management of the studied cases **($p<0.05$)**.

Table (6): Relationship between length of hospital stay and type of injury, anatomic location of injury, and operative and non-operative management among the studied cases.

Type of injury	LOS (Days) Median (min-max)	Test of significance
• **Penetrating** • **Blunt**	15(1-150) 12(1-50)	Z=0.848 p=0.397
Anatomical location of injury		
Head & neck: • **Carotid arteries** • **Jugular veins** • **Vertebral arteries** • **Extracranial arteries** • **Intracranial arteries** • **Intracranial veins**	9(9-9) 6(2-10) 18(18-18) 2(2-7) 6(1-8) 1(1-1)	KW=6.16 p=0.291
Torso: • **aorta** • **vena cava** • **iliac. artery** • **iliac vein** • **Subclavian artery** • **Subclavian artery and vein** • **Portal vein** • **Short gastric arteries** • **Intercostal artery** • **Inferior phrenic vein**	24.5(18-50) 15.5(11-20) 14(14-14) 20(20-20) 15(15-15) 30(30-30) 29(29-29) 15(15-15) 10(10-10) 15(15-15)	KW=10.06 p=0.346
Upper extremities: • **Brachial artery** • **Brachial veins** • **Traumatic** • **Axillary veins** • **Cephalic veins** • **Ulnar arteries** • **Radial arteries** • **Ulnar & Radial**	13(7-19) 21(17-29) 11(11-11) 8.5(8-9) 18(18-18) 17(11-30) 8(6-9) 16.5(11-44)	KW=26.80 p<0.001*
Lower extremities: • **Femoral arteries** • **Femoral veins** • **Superficial femoral artery** • **Superficial femoral vein** • **Popliteal arteries** • **Saphenous veins** • **Anterior or posterior tibial artery** • **Posterior tibial vein** • **Geniculate artery**	8(8-8) 26(26-26) 11(9-13) 13(13-13) 11.5(10-13) 3(3-3) 20(12-30) 49(10-150) 30(30-30)	KW=8.57 p=0.379
Management		
• **Non-operative** • **Operative**	10(1-150) 19(3-50)	Z=6.01 p<0.001*

Z: Mann Whitney U test. KW: Kruskal Wallis test.

Table (7) reveals the relationship between length of hospital stay and lines of operative management among the studied cases. There was no significant association was found between median duration of hospital stay and different lines of operative management among the studied cases **(p>0.05)**.

Table (7): Relation between length of hospital stay and lines of operative management among the studied cases.

Operative management line	LOS (Days) Median (min-max)	Test of significance
Primary repair	18.5(11-49)	KW=6.26 p=0.395
Resection and anastomosis	21.5(13-30)	
Ligation	20.5(12-29)	
Repair using vein patch	15(10-30)	
Synthetic replacement	34.5(19-50)	
Extra-anatomic bypass	19(18-32)	
Amputation	15(3-18)	

DISCUSSION

Paediatric vascular injuries often present a unique challenge because of a relatively low incidence even in busy paediatric trauma centers. Though such injuries are relatively rare, they are associated with high morbidity and mortality [(2)].

In fact, most of accepted diagnostic and therapeutic modalities utilized in pediatric vascular injuries were developed through adult vascular injury experience. For that, a continual re-evaluation of encountered paediatric vascular trauma can provide important information in the proper diagnosis and treatment of such injuries [(10)].

The current study was conducted to review the pattern of vascular injury in pediatrics, and its effect in outcome. The present work was prospective observational clinical study that was carried out on pediatric trauma patients arrived to Emergency Department (ED) in Mansoura University Emergency Hospital during a period of one year, from September, 2021 to August, 2022. The current study also found that most of injuries among the studied cases were penetrating (62.1%), while 37.9% were blunt. As regards the mechanism of injury, most of penetrating injuries were caused by glass (42.2%), followed by knife (39.1%), and gunshot in only 6.2%. Most of the blunt injuries were due to motor vehicle crash (43.6%), followed by pedestrian vs. automobile trauma (23.1%), and fall (23.1%).

Shah *et al.* [(11)] demonstrated that the mean age of patients with a peripheral vascular injury was 9.8 years (range: 1-17 years), and most (64%) of such injuries involved male patients. The mechanism of injury was distributed between penetrating (55%) and blunt (45%) trauma.

In addition, **Shah *et al.*** [(11)] noted that trends in the distribution of mechanism of injury were also observed based on patient's age stratification. Younger children (1-10 years old) had vascular injuries which were more often due to blunt trauma (61%) rather than penetrating trauma (39%). This was significantly different from the mechanism of vascular injuries in older children (11–17 years old), which were more often due to penetrating trauma (74%) rather than blunt trauma (26%). Authors also found that the major cause of penetrating vascular injuries in all children were lacerations from glass, however blunt vascular injuries most frequently were due falling.

In consistence with the previously mentioned data is the study by **Corneille *et al.*** [(2)] that was carried out on 116 patients who sustained 138 vascular injuries (111 arterial and 27 venous), of which there were 14 deaths (12%). Among the 138 injuries, there were 118 injuries in survivors (102 arterial and 16 venous), and 20 injuries in non-survivors (9 arterial and 11 venous). There were more penetrating injuries (57.8%) than blunt injuries (42.2%). The mean injury severity score (ISS) was 17.3±16.4; which was lesser in those with penetrating injuries (12.3±11.7) than those with blunt injuries (24.1±19.3). Moreover, the study showed no statistically significant difference between blunt and penetrating mechanism groups as regards mortality of the studied cases.

The current work showed that most of injuries were located in the upper extremities, involving mostly brachial artery (28.3%), brachial vein (21.7%), and ulnar and radial vessels (23.3%). The second largest patient group included those with torso injuries, in which the 2 most frequently injured vascular structures were the aorta (37.5%) and the vena cava (12.5%). Concerning injuries of the lower extremities, below-knee vessels (anterior and posterior tibial arteries and posterior tibial vein) were the most frequently injured vessels (20.0% for each), followed by popliteal artery and superficial femoral artery (13.3% for each). Injuries to head and neck vessels were the smallest group in our study.

Several studies are in agreement with our results. They reported that vascular injuries commonly involved proximal and distal extremities irrespective of mechanism [(12, 13)].

In a study by **Klinkner *et al.*** [(14)] of 7553 cases admitted with blunt trauma, only one case had a thoracic aortic tear. Such result also obtained by **Tiao *et al.*** [(15)] signifying that great vessels injuries are rare in children after blunt trauma. Also, penetrating head and neck injuries uncommonly accompanied by vascular injuries, but mortalities in head and neck injuries were most closely associated with concurrent traumatic brain injuries, as revealed by other reports [16].

In agreement with the current study, **Corneille *et al.*** [2] also revealed that the highest percent of cases (36.8%) had injuries to the upper extremities. The most commonly injured arteries in the upper extremity were the ulnar artery (35.6%) and brachial artery (35.6%), followed by the radial artery (26.7%). There were no moralities in this subset of patients.

The next largest patient group in the study by **Corneille *et al.*** [2] included those with torso injuries (30.8%), representing 33.3% of all vascular injuries in the study population with more blunt injuries (52.8%) than penetrating (47.2%) were observed in this group. Injury to the torso showed a higher association with mortality compared with all other regions combined. The two most frequently injured vascular structures were the aorta (26.1%) and the vena cava (26.1%); half of cases with aortic injuries and 66.7% of patients with vena cava injuries died.

Corneille *et al.* [2] also reported that lower extremity injuries represented 25.0% of the overall injuries among the studied population. Below-knee arteries (anterior tibial, posterior tibial, and peroneal) were the most frequently involved (30.6%), followed by femoral arteries (27.8%) and popliteal arteries (19.4%). Popliteal veins were the most frequently injured (62.5%). On the other hand, cerebrovascular injuries represented the smallest group (6.9%) in this study, also in agreement with our study.

Our study also revealed that the majority of the studied patients were subjected to operative management (55.3%), 21.4% underwent diagnostic arteriography, 15.5% had computed tomography, while 7.8% carried out diagnostic venography.

Arteriography has been utilized to assess vascular injuries in children. In the present study, selective utilization of arteriography in haemodynamically stable children was carried out depending upon clinical criteria and judgment. In general, arteriography helps administration of anticoagulants for carotid thrombosis and vertebral artery dissection [17]. In addition to arteriography, CT has been significantly used utilized for assessment of paediatric trauma. CT angiography is a safe technique in children and may become more commonly used in assessing vascular injuries [18].

Concerning lines of operative management, the current data displayed that primary repair was performed in the majority of our cases (31.6%), followed by repair with vein patch (26.3%), and then ligation in 24.6% of the studied cases. Amputation was performed in 5.3% of the cases.

In the study by **Corneille *et al.*** [2] primary repair was carried out more than twice as often for cases having penetrating injuries compared with those with blunt injuries, and vessel ligation demonstrated a similar pattern. Such findings were also found in other reports of non-iatrogenic vascular trauma in children [12, 13].

The differences in treatment might be because of how the mechanism of injury influences the affected artery or vein. Penetrating trauma often produce a clean, focal injuries which might make it more suitable to primary repair. Blunt injuries trauma more shear and traction-type injuries with injury to a higher vessel length making it amenable to primary repair [19].

Following surgery, according to the current results, the majority of cases were admitted in ward (69.9%), while 30.1% were admitted in ICU. the percentage of ICU admission was higher among patients who underwent operative management (67.7%), compared to those having non-operative management (32.3%). The overall median duration of hospital stay was 15 days. The median duration of hospital stay was longer among patients who underwent operative management (19 days), compared to those having non-operative management (10 days). The current data also revealed that the overall percentage of mortality within one week of admission was 8.7%. The percentage of mortality was higher among patients who underwent non-operative management (88.9%), compared to those having operative management (11.1%). No mortality occurred following operative management lines, except after amputation where only one of two patients died.

In consistence with the current results, **Klinkner *et al.*** [14] showed that the mean length of stay was 12.1±18.76 days, with 10.9±12.55 days for males, and 15.2±30.3 days for females. The mortality rate was 9.7%; 8 mortalities were in males (10.5%) and 2 mortalities were in females (7.4%). Five mortalities due to serious traumatic brain injuries. Two cases were pulseless/non-breathing at the scene, and one case necessities CPR in the field. One mortality was due to a gunshot wound involving the abdominal aorta. Lastly, one case with a blunt injury to the carotid artery had a massive stroke and died.

In general, vascular injuries in children are uncommon. When they occur, they commonly located on extremities and are due to penetrating trauma. Torso vascular injuries have greater mortality rates compared to those in other anatomical sites. Indeed, rapid diagnosis and management increases the likelihood of limb salvage and reduces subsequent complications. The majority of children having vascular injuries have good functional outcomes, and high limb salvage rates.

CONCLUSION

It can be concluded that optimal management of vascular injuries in children necessitates expedient diagnosis and treatment, with readily available access to a multidisciplinary team who have experience in paediatric trauma. The selective use of arteriography is beneficial in injury diagnosis and subsequent surgical or non- surgical management. Computed tomography angiography can be a significant tool for initial evaluation. In spite of the currently available diagnostic and therapeutic approaches at tertiary care paediatric trauma centers, pediatric vascular injuries are associated with high morbidity and mortality. It is thus recommended that institutions caring for pediatric populations have to develop and maintain plans for proper treatment of vascular injuries or to offer expedient transfer to definitive care centers.

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