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Arterial Trauma of Limbs in Patients under 18 Years Old at the Joseph Ravoahangy Andrianavalona University Hospital Center: Epidemioclinical Aspects and Management

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Abstract

Introduction: This study aims to determine the epidemiological, clinical, etiological, diagnostic, therapeutic, and prognostic aspects of limb arterial trauma in patients under 18 years old. **Methods:** This is a retrospective descriptive study conducted over 20 years, from January 2002 to December 2022, in the Department of Vascular Surgery at Joseph Ravoahangy Andrianavalona University Hospital Center (CHUJRA). It included all patients under 18 treated for limb vascular trauma. Frequency, age distribution, and several other parameters were analyzed. **Results:** Forty-six (46) cases were recorded. Young males (mean age = 13.17 years) accounted for 91.30% of the cases. The most common etiology was civil responsibility accidents (65.22%). The emergency clinical presentation was dominated by hemorrhagic syndromes, present in all patients, with the brachial artery being the most affected (26.08%). Surgical intervention mainly involved vascular repair through direct sutures and end-to-end anastomosis. **Conclusion:** The management of vascular trauma remains a multidisciplinary challenge, particularly in resource-limited settings. Nevertheless, rapid and appropriate intervention can yield satisfactory outcomes.

Keywords

Pediatrics, Revascularization, Surgery, Trauma, Vessels, Wounds

1. Introduction

Vascular injuries in children are rare, accounting for approximately 0.6% to 1.4% of pediatric trauma cases [1]. Managing these injuries is particularly challenging due to the specific characteristics of pediatric anatomy, including more fragile vessels, a marked tendency for vascular spasms, and a lower blood volume, making hemorrhages especially severe [2]. Without prompt and adequate intervention, complications can include limb ischemia, functional loss, or, in severe cases, death [1].

Although the incidence of pediatric vascular injuries is low, their impact on morbidity is significant, primarily due to delayed diagnosis or inappropriate management. This issue is further compounded in developing countries, where access to specialized care is often limited. Addressing vascular trauma in these settings presents a considerable challenge for vascular surgeons, who must contend with inadequate infrastructure and limited medical resources.

This study aims to examine arterial injuries of the limbs in children under 18 years of age treated at the Joseph Ravoahangy Andrianavalona University Hospital Center (CHUJRA) in Madagascar. It analyzes the epidemiological aspects, diagnostic methods, and therapeutic interventions implemented to provide data that may help optimize the management of such cases in resource-limited settings.

2. Patients and Methods

This is an observational, retrospective, descriptive study conducted in the Vascular Surgery Department of CHU-JRA over a 20-year period, from January 2002 to December 2022. It includes 46 patients under the age of 18 with limb arterial trauma who underwent surgical management in this department. The inclusion criteria comprised all children treated for traumatic arterial injuries, while patients with poorly documented or incomplete medical records, as well as those with limb trauma without suspected or associated vascular injury, were excluded. The diagnostic tools and criteria used to assess the extent of the injuries were primarily clinical, including Doppler ultrasound, with CT angiography rarely performed. The most commonly assessed signs included pain, coldness, skin discoloration, diminished or variable blood flow, and structural abnormalities.

Data were extracted from medical records and analyzed using Microsoft Excel and SPSS software. The variables analyzed included demographic characteristics (age, sex), circumstances of the trauma, the time to management (time elapsed from the accident to specific treatment), types of injuries, surgical management, and short-term postoperative outcomes.

3. Results

Among the 5455 admissions to vascular surgery at our study site, 46 cases involved pediatric arterial trauma, representing a frequency of 0.84%. The patients' average age was 13.17 years, with the most affected age group being 13 to 18 years (76%), and a predominance of boys at 91.30% (n = 42). The general characteristics of the

patients and arterial injuries are summarized in Table 1. Civil liability accidents were the primary cause of trauma at 65.22% (n = 30), followed by domestic accidents (n = 8) and road traffic accidents (n = 8) (Figure 1). The leading causes of trauma were stab wounds (77%).

Table 1. General characteristics of parameters.

PARAMETERS	CASES (n = 46)	PROPORTION (%)
CIRCUMSTANCES OF THE ACCIDENT		
Civil liability accident	30	65.22
Domestic accident	8	17.29
Road traffic accident	8	17.29
ETIOLOGIES		
Sharp object injury	23	76.67
Gunshot wound	3	10.00
Glass bottle injury	4	13.33
AFFECTED ARTERIES		
Axillary artery	5	10.87
Femoral artery	6	13.04
Posterior tibial artery	6	13.04
Dorsalis pedis artery	1	2
Radial artery	5	11
Ulnar artery	4	9
Brachial artery	12	26
Subclavian artery	7	15
TYPE OF VASCULAR REPAIR		
Direct lateral suture	35	76.09
End-to-end anastomosis	11	23.91

Figure 1. Image showing a soft tissue injury with hemorrhagic injury to the right brachial artery caused by a road traffic accident. Source: USFR Vascular Surgery, CHUJRA.

The most frequently affected arteries were in the upper limbs, particularly the brachial artery at 26% (n = 12) and the subclavian artery at 15% (n = 7) (Figure 2). The nature of vascular injuries varied according to the trauma mechanism, with lateral wounds in 35 patients (76.09%) and complete transections in 11 patients (23.91%).

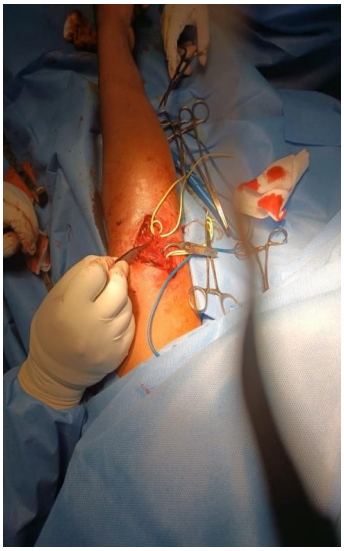

Figure 2. Intraoperative image of a left brachial artery injury. Source: USFR Vascular Surgery, CHUJRA.

The main vascular reconstruction surgeries included lateral suturing performed in 35 patients (76.09%) and end-to-end anastomosis in 11 patients (23.91%). In 82% cases, treatment was initiated within 6 hours of the accident. Postoperative management of vascular injuries involved analgesics, antibiotic prophylaxis, and thromboprophylaxis with either unfractionated heparin or low molecular weight heparin, such as Enoxaparin (Lovenox*), at preventive doses. Broad-spectrum antibiotic prophylaxis was typically prescribed for a short duration to prevent surgical site infections, with an average course of 7 days. Thromboembolic prophylactic treatments were systematically administered during the few days of postoperative bed rest, accompanied by motor physiotherapy for patients with associated nerve injuries. Prescriptions were discontinued once patients could mobilize adequately.

Short-term outcomes were favorable for all patients, with a low amputation rate (2%). The average hospital stay was 4 days.

4. Discussion

Vascular injuries in children, though rare, carry significant morbidity due to complications such as ischemia, amputation, and neurological sequelae. This study, conducted at CHU-JRA, demonstrates a low but noteworthy prevalence of pediatric vascular trauma over a 20-year period. Here, we compare our findings with international and regional data.

Our series confirms the rarity of vascular trauma in children, with a frequency of 0.84%. This prevalence aligns with the literature, where the incidence of vascular injuries in children ranges between 0.6% and 1.4% of pediatric trauma hospitalizations [3]. In the United States, a study by R. Shah in 2009 from major trauma centers identified 42 cases over six years [4]. Similarly, the Swedish registry of pediatric vascular injuries reported 34 cases over 10 years [5]. These figures are comparable to our annual average of 2 cases, underscoring the infrequency of these injuries, even in specialized centers. Moraes Silva's study in Brazil reported 37 cases over a decade [6], further highlighting the consistency of these frequencies across different geographic contexts.

In our series, the patients' mean age was 13.17 years, with a predominance among adolescents aged 13 to 18 years (76%). This age distribution is consistent with Shah's findings, which also reported most cases within this age group [4]. The male predominance observed in our study (91% boys) is well-documented in the literature, with similar ratios in most studies, potentially reflecting behavioral differences between genders, as boys are more frequently involved in high-risk activities [7].

Civil liability accidents (CLAs) were the leading cause in our series, accounting for 65% of cases, followed by domestic accidents (17%) and road traffic accidents (17%). This distribution is similar to findings from Debeugny's study in Europe, which also highlighted the prevalence of CLAs among children with vascular trauma [8]. However, in regions like India, road traffic accidents have been reported as the primary cause, accounting for up to 40% of cases [9]. Thus, the distribution of causes varies depending on the local context and social behaviors.

The most frequently affected arteries in our study were the brachial artery (26%), subclavian artery (15%), and tibial artery (13%). These findings align with studies by Shah and Huber, which also noted a predominance of upper-limb injuries [4] [10]. The brachial artery is particularly vulnerable due to its superficial location and exposure to sharp-object injuries, which were the leading cause in our study (77%) [8].

In our study, 82% of patients received treatment within 6 hours of injury a critical factor in reducing severe complications such as amputation and nerve damage. This timely intervention aligns with the findings of Ricco and Fébrer, who emphasized the importance of rapid surgical intervention to minimize prolonged ischemia and amputation risks [3]. Debeugny's European study reported an amputation rate of 15% in patients with delayed treatment, compared to only 5% when intervention occurred within 6 hours [8]. Our study's low amputation rate may reflect the efficiency of early intervention in most cases. This study enabled us to develop standardized protocols in our center for managing children with limb trauma and suspected vascular injury. The goal was to reduce the risk of complications and accelerate treatment. In the future, we aim to expand our study nationwide across all centers managing vascular surgical conditions to establish a national protocol.

The surgical techniques employed in our series included lateral suturing (76% of cases) and end-to-end anastomosis (24%). These outcomes align with standard practices in vascular surgery, where lateral suturing is preferred for simple lateral wounds without substance loss, while end-to-end anastomosis is reserved for complete transections without tension [11].

Immediate postoperative outcomes were favorable, with positive recovery in the majority of patients and no major short-term complications observed. A similar study in Sweden reported high success rates in pediatric vascular repair, with complete recovery in 90% of cases [7]. Postoperative complications in our study were rare, due to rigorous clinical monitoring and ultrasound follow-up combined with Doppler assessment at 6 months and 1 year. This approach allowed us to evaluate the effectiveness of our management in the medium and long term.

However, it is worth noting that long-term follow-up of vascular injuries in children is underreported, particularly regarding the effects on growth and limb development. Ricco and Fébrer highlight the need for additional studies to assess the long-term impacts of vascular trauma on young patients, especially concerning growth abnormalities [3]. To prevent these accidents and reduce the incidence of pediatric vascular injuries, multi-component educational interventions can be effective in improving knowledge, attitudes, and safety behaviors among school-aged children [12]. These include the use of appropriate protective gear during sports activities, the implementation of safe play structures, close supervision of children, and early education on road safety.

5. Conclusion

Our study, although monocentric, highlights the critical importance of early surgical management in pediatric vascular trauma. The results, characterized by a low rate of severe complications, underscore the effectiveness of the therapeutic strategies implemented at CHU-JRA. However, it remains essential to continue strengthening the capacities of medical teams while improving access to care in remote areas to minimize delays in management.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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