

Limb Salvage In Orthopaedic Trauma With Vascular Injury

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Abstract

Background: Management of Orthopaedic Trauma with vascular injury (OTWVI) can be quite challenging as there could be threat to life in addition to limb loss. Timely recognition of vascular injury in orthopaedic trauma is critical to limb salvage. The greatest risk of limb loss in any peripheral vascular injury is associated with popliteal artery injury.

Objectives: To determine the success rate of limb salvage following OTWVI after limb stabilization and vascular repair.

Materials and Methods: This was a descriptive prospective study that was conducted between April 1, 2017 and March 31, 2023 at a public and two private medical facilities in Port Harcourt. The study assessed the success rate of limb salvage in patients with OTWVI who had limb stabilization and vascular repair. The variables obtained were Patients' demography, mechanism of injury, the vessel(s) involved, time of presentation, surgical approach and outcome after obtaining an informed written consent. The level of significance was set at ≤ 0.05 .

Results: During the period under review, 23 patients were managed. Of these, 20 (86.96%) were males, and 3 (13.04%) were female, with a mean age of 33.5 ± 9.9 years. The mechanisms of injury were Gunshots 9 (39.13%), Machete cuts 6 (26.09%), motor vehicle accidents (MVAs) 5 (21.74%) and industrial accidents 3 (13.04%). Sixteen patients (69.57%) presented within 6 hours, 5 within 12 hours (21.74%) and 2 after 48 hours (8.70%). The vessels involved were 1 (0.04%) Deep Femoral Artery alone, 3 (0.14%) Superficial Femoral artery alone, 5 (0.22) Popliteal artery alone, 2 (0.10%) Anterior tibial artery alone, 2 (0.10%) Anterior tibial + posterior tibial arteries, 1 (0.04%) Anterior tibial and peroneal arteries, 1 (0.04%) Axillary artery alone, 4 (0.17%) Brachial artery alone, 1 (0.04%) Radial artery alone, 1 (0.04) Ulnar artery alone, 1 (0.04%) Radial + Ulnar arteries and 1 (0.04%) lateral digital artery of the thumb alone. All the patients had external fixation and thrombectomy. Seventeen (74%) had repair with interposition venous graft, mainly using reversed Great Saphenous Vein (R-GSV) as a result of arterial length deficit from gunshot or crush injuries, while 6 (26%) cases, especially related to machete cuts, had direct vascular end-to-end repair. Repairs were successful in 20 (86.96%) patients who presented relatively early while 3 (13.04%) were unsuccessful (including 2 patients with popliteal artery injuries that presented late and 1 with the lateral digital artery of the thumb injury) and ended

up with limbs amputations. One patient died immediately after axillary artery repair from multiple injuries and massive blood loss.

Conclusion: Orthopaedic Trauma with Vascular Injury (OTWVI) could be quite challenging and may be associated with limb loss without timely intervention.

Keywords: Great saphenous vein, Limbsalvage, Popliteal artery, Orthopaedic trauma, Vascular injury, Vascular repair.

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I. Introduction

Vascular injury due to orthopaedic trauma is both a limb-threatening and life-ending situation, which poses a major challenge to orthopaedic and vascular surgeons with other managing clinicians charged with the primary care of trauma patients¹. Hence, a prompt and accurate diagnosis, coupled with adequate management skills is necessary in successfully salvaging limbs of orthopaedic trauma with vascular injury (OTWVI) patients². Irrespective of mechanism of injury, early detection of vascular injury is pertinent in preventing irreparable and permanent damage to the tissues³.

The incidences of vascular injury associated with extremity trauma differs according to population, geographic location, and also mechanism of injury which could be blunt or penetrating trauma^{4,5}. According to the National Trauma Data Bank analysis, OTWVI among adults is about 1.6%, while it accounts for 0.6% in paediatric patients but ranges from 6-12% for military personnels¹. Over 70% of these injuries are most common among younger males with average age of 30 years⁶. However, increasing prevalence is now being observed in the older generation⁷. Among patients that had orthopaedic trauma with vascular injury (OTWVI) in the military settings, the superficial femoral artery is the most commonly injured vessel with 33-37%, while the popliteal and tibial arteries each account for 25%⁸⁻¹⁰. In civilian settings, the most commonly injured vessels are femoral or popliteal arteries with about 50-60%, while the brachial artery accounts for 30%¹¹.

Timely and accurate evaluation is required for patients with limb injuries, especially due to the involvement of the skin, soft tissue and vascular structures present in the limb¹². Vascular examinations such as capillary assessment, colour and temperature of extremity, standard documentation of palpable pulse, and use of Doppler, should be done, followed by physical examinations to ascertain the type of vascular injury (soft or hard signs)¹. Patients with hard signs are majorly indicated for immediate surgeries, while those with soft signs could have surgical exploration after further assessment to determine the degree of vascular injuries¹³. Imaging techniques such as computed tomography angiography (CTA) and Duplex ultrasound (DUS) could be done to effectively diagnose soft signs injury¹.

Early detection of vascular injury and the immediate surgical intervention are two major factors that influence limb salvage^{14,15}. The duration from presentation of injured limb to when repair is done is regarded as the ischaemic time. The ideal ischaemic time should not exceed 6 hours at presentation, as time exceeding this would only compromise the limb's chances of survival.¹³ Furthermore, ischaemic time less than eight hours increases limb salvage rate and lower amputation rates by 10%¹⁵, while ischaemic time more than 8 hours increases amputation rates by 80%⁵. Although there are standard lower extremity injury scores that assist surgeons in making the amputation decision, however, amputation of the limb must be made based on the patients' extremity wound, age, other associated injuries and socioeconomic factors of the patients¹⁶. A failed limb repair could have negative physical and psychological effects on the patients, hence the need to choose between any of the interventions with best success rate and little morbidity¹⁶.

Within the sub-region, there is paucity of data on the outcome of limb salvage among patients with OTWVI. Hence, the study sought to assess the success rate of limb salvage following OTWVI after limb stabilization and vascular repair.

II. Materials And Methods

Study Area

This was a multicentre study conducted at the University of Port Harcourt Teaching Hospital, Sterling Specialist Hospital and Morning Star Hospital, all in Port Harcourt, Rivers State, among patients presenting with OTWVI for limb salvage.

Methods

This was a descriptive cross-sectional study conducted between April 1, 2017 and March 31, 2023. The success rate of limb salvage in patients with OTWVI who had limb stabilization and vascular repair was evaluated. A pre-designed semi-structured questionnaire was used to collect information after obtaining informed written consent. The parameters collated were Patients' demography, mechanism of injury, the

vessel(s) involved, time of presentation, surgical approach and outcome. The level of significance was set at p value of ≤ 0.05 .

Statistical Analysis

The data were collated using pre-designed semi-structured pro-forma which were entered into an excel spreadsheet. Data were analyzed using statistical packages for social sciences (SPSS) version 25, with demographic data and medical information summarized using descriptive statistics (mean, median, frequency percentage and standard deviation) as appropriate.

III. Results

The demographic characteristics in table 1 showed that there were 20 males (86.96%) and 3 females (13.04%), with a mean age of 33.5 ± 9.9 years. The time at presentation as presented in table 2 showed that 16 (69.57%) patients presented within 6 hours, 5 (21.74%) within 12hours and 2 (8.70%) after 48hours. The mechanisms of injury in the patients as presented in figure 1 were 9 (39.13%) gunshot patients, 6 (26.09%) machete cut patients, motor vehicle accidents (MVAs) 5 (21.74%) and industrial accidents 3 (13.04%) patients.

Figure 2 showed the artery of injury. The vessels involved were 1 (0.04%) Deep Femoral Artery injury, 3 (0.14%) isolated Superficial Femoral Artery injury, 5 (0.22) isolated Popliteal Artery injury, 2 (0.10%) isolated Anterior Tibial Artery injury, 2 (0.10%)Anterior Tibial + Posterior Tibial Arteries injuries, 1 (0.04%) isolated Anterior Tibial and Peroneal Arteries injuries, 1 (0.04%) isolated Axillary Artery injury, 4 (0.17%) isolated Brachial Artery injury, 1 (0.04%) isolated Radial artery injury, 1 (0.04) isolated Ulnar artery injury, 1 (0.04%) Radial + Ulnar arteries injuries and 1 (0.04%) isolated lateral digital artery of the thumb injury.

Figure 3 presented the surgical intervention received by the patients. All the patients had external fixation and thrombectomy. 17 (74%) had repair with interposition venous graft, mainly using reversed Great Saphenous Vein (R-GSV) as a result arterial length defect from gunshot or crush injuries, while 6 (26%) cases especially those related to machete cuts had direct end-to-end vascular repair.

Surgical outcome in figure 4 showed that repairs were successful in 20 (86.96%) patients who presented early while 3 (13.04%) were unsuccessful, including 2 patients with popliteal artery injuries that presented late and 1 with the lateral digital artery of the thumb injury, who ended up with limbs and thumb amputations. One death was recorded in a patient who died immediately after axillary artery repair from multiple injuries and massive blood loss.

Figure 5 showed completely transected Right Anterior Tibial Artery, showing the proximal and distal segments associated with Distal Tibia Fracture.

Figure 6 showed external fixation and thrombectomy session.

Figure 7 showed direct vascular repair session of the right anterior tibia artery.

Figure 8 presented post vascular repair with continuity of the right anterior tibia artery restored.

Table 1: Demographic Characteristics

Parameter	Frequency (N)	Percent (%)
Age Group (Years)		
≤ 15	1	4.35
16-25	1	4.35
26-35	13	56.52
36-45	2	8.70
46-55	4	17.39
56-65	-	-
66-75	1	4.35
76-85	1	4.35
Mean	33.5 ± 9.9 Years	
Gender		
Male	20	86.96
Female	3	13.04

Table 2: Time Of Presentation

Hours	Frequency (N)	Percent (%)
0-6	16	69.57
7-12	5	21.74
>48	2	8.70

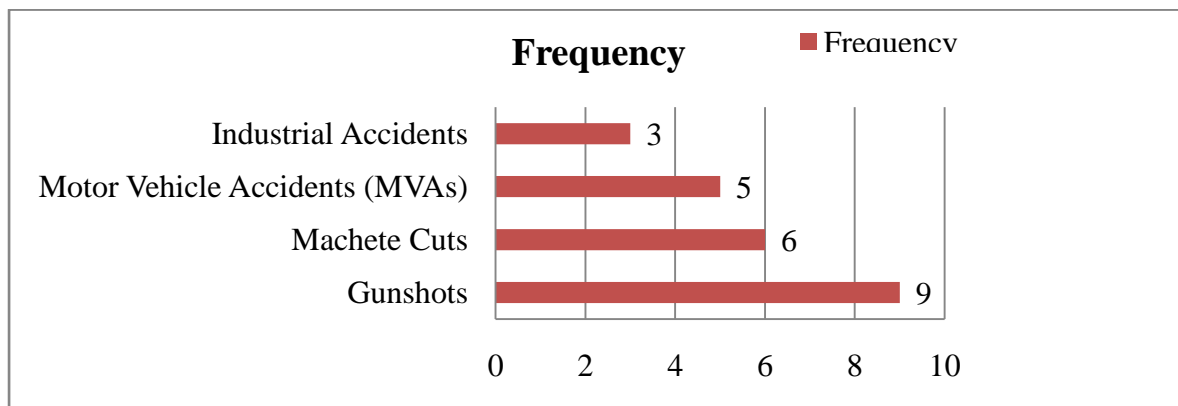


Figure 1: Mechanisms Of Injury

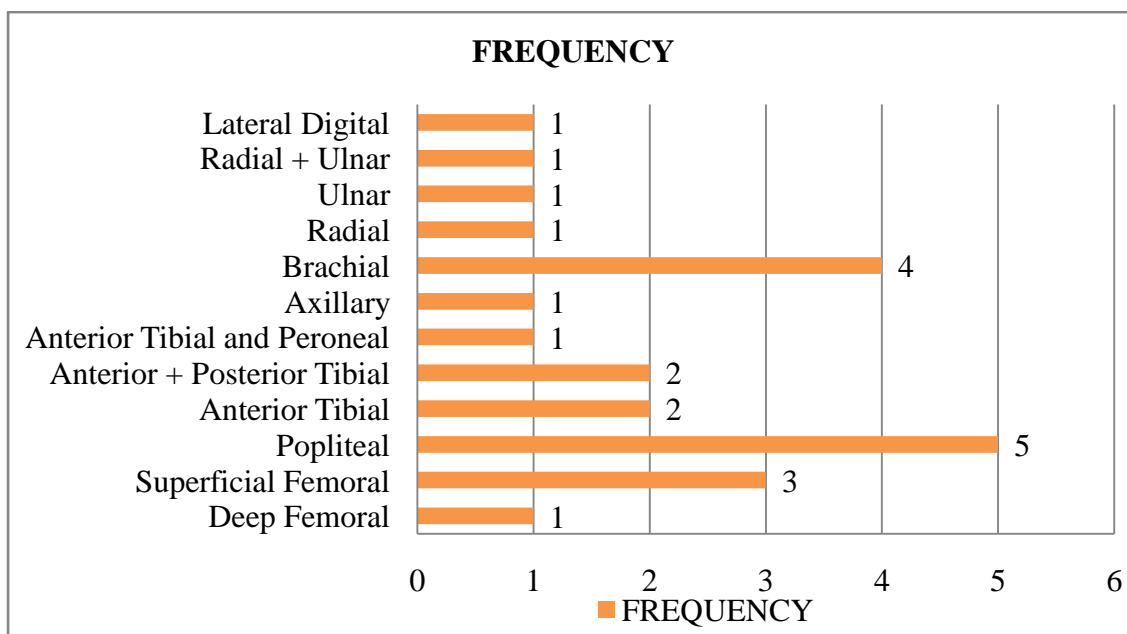


Figure 2: Artery Of Injury

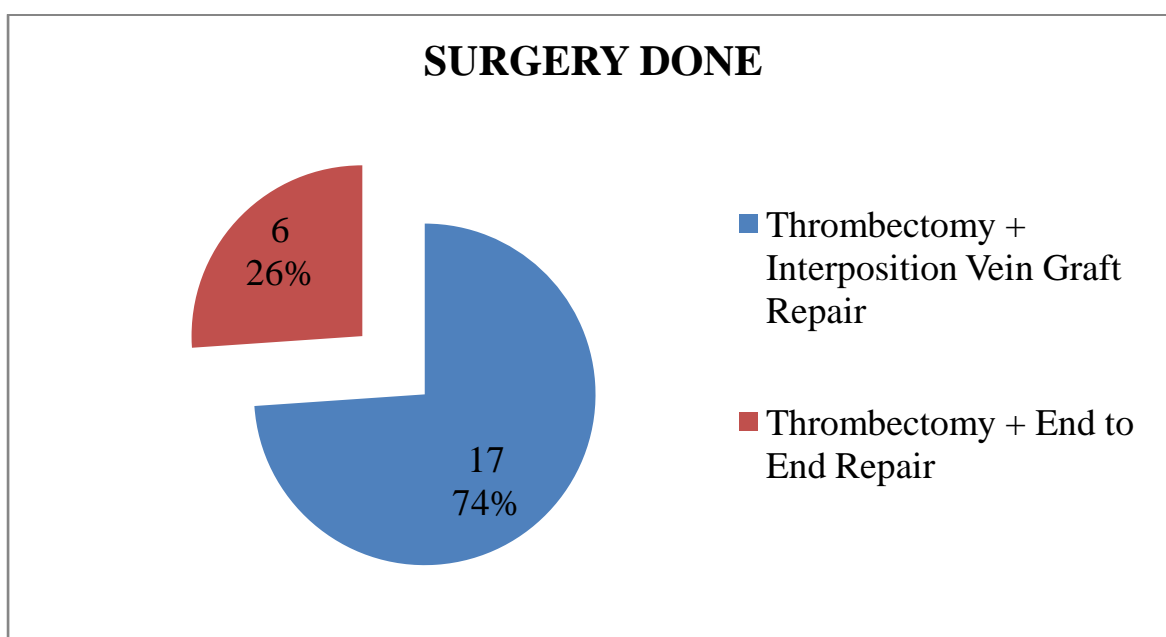


Figure 3: Surgical Interventions

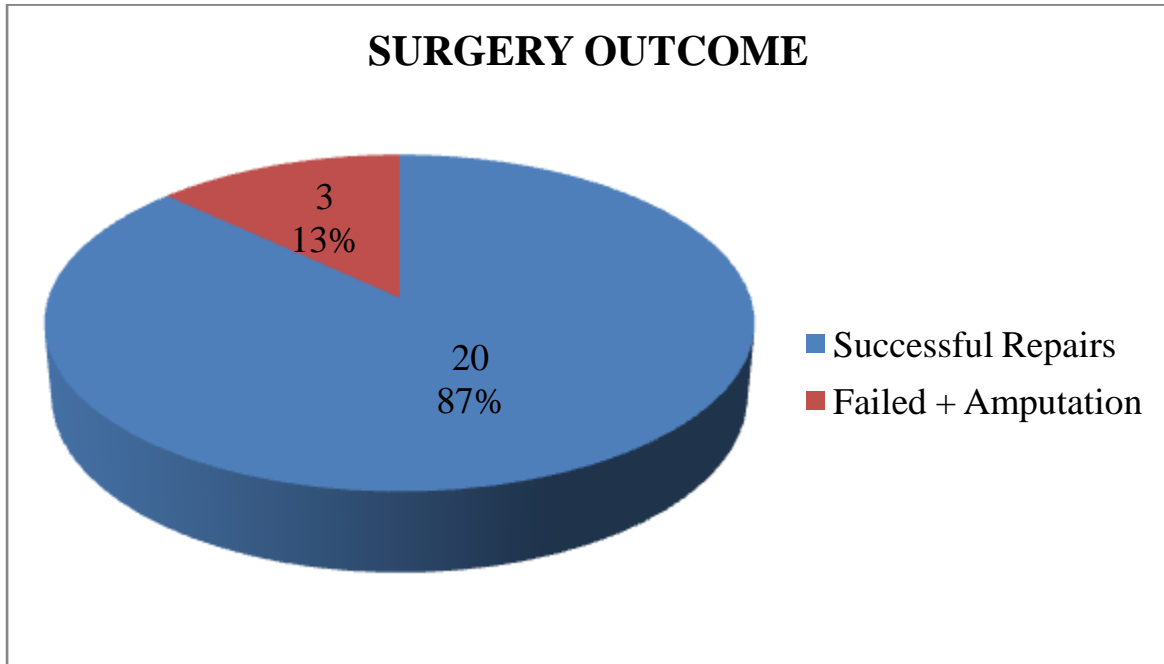


Figure 4: Surgical Outcome



Figure 5: Completely Transected Right Anterior Tibial Artery Showing The Proximal And Distal Segments Associated With Distal Tibia Fracture.



Figure 6: External Fixation And Thrombectomy Session

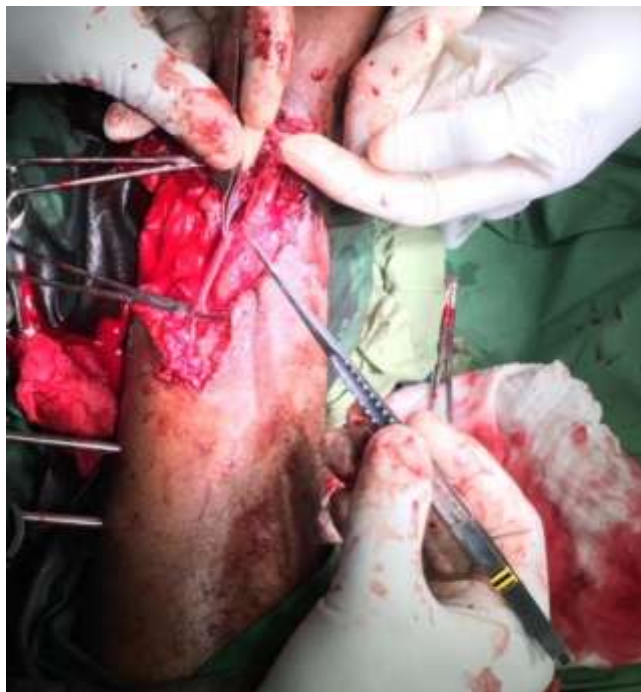


Figure 7: Direct Vascular Repair Session Of The Right Anterior Tibia Artery



Figure 8: Post Vascular Repair Session With Continuity Of The Right Anterior Tibia Artery Restored.

IV. Discussion

The predominance of the male gender in this study was expected, as several studies have shown males to be predominant patients in orthopaedic trauma with vascular injury (OTWVI). This result is consistent with previous studies who had reported at least 70% males in patient populations with OTWVI.^{13,17-21} Furthermore, mean ages of 32 years, 34 years and 37 years, had also been documented,^{13,18,20,21} which is similar to the 33.5 years obtained in this study. Thus, an indication that OTWVI is most common among the younger population.

The most frequent mechanism of injury in this study was gun shot, followed by machete cuts, motor vehicle accidents and industrial accidents. Although the incidence of gun shots and machete cuts as mechanisms of injury have not been specifically categorised in the civilian settings, however other titles such as violent activities or criminal events do tend towards these areas. Moreover, D'Alessio et al¹⁸ had reported about 32% of OTWVI due to criminal events, while 17% was attributed to violent events by Sun et al²⁰. The high incidence of gunshots and machete cuts as major mechanisms of injury in our study, might be due to the militancy and insurgency that characterize the oil producing Niger Delta area of Nigeria, to which Port Harcourt belongs.

Though, motor vehicle accidents alone accounted for 22% in this study, it is one of the most widely reported mechanisms of OTWVI. A previous study by Udosen et al²¹ in Calabar reported that 100% of the patients were involved in road traffic accidents. Similarly, several forms of road traffic accidents have accounted for 48%-80% of OTWVI according to different studies^{13,18-20}. Industrial accidents leading to OTWVI was the least mechanism of injury in this study. This is consistent with the findings of Jagdish et al¹⁹ and

Barnard et al¹³, who had also reported few incidences of industrial accidents as a mechanism. Conversely, Sun et al²⁰, reported industrial accidents as the second major mechanism of OTWVI at a study in China. The paucity of industries in our geographical location might be responsible for the low incidence of industrial accidents in OTWVI patients in this study.

The ischaemic time in our study ranged from 6hrs to over 48hrs, with most presenting within 6 hours. This is in agreement with Barnard et al¹³, who also reported that most patients reported under 6hrs, while. However, aside from the ischaemic time, other criteria such as background diseased conditions, funding for treatment and injury severity, might affect the limb salvage of the patients²². The early presentation observed in most patients in this study is quite impressive as quick presentation to health care facilities following OTWVI in both emergency and non-emergency situations helps to improve chances of limb salvage.

The most widely injured arteries in this study were isolated popliteal artery and brachial artery injuries. This is in concert with Jagdish et al¹⁹, Cakir et al¹⁷, Barnard et al¹³ and Yu et al²³, who had all reported popliteal artery as the most injured arterial vessel. Similarly, injuries to the brachial artery and superficial femoral artery have also been reported in some other studies^{17,19}, while femoral artery as the most injured in OTWVI was documented by Sun et al²⁰. The injuries could affect 2 arteries at the same time, as observed in the cases of anterior tibial + posterior tibial arteries in 2 patients, anterior tibial and peroneal arteries in 1 patient and Radial + Ulnar arteries in 1 patient as well. The incidence of having at least 2 arteries injured together had been previously reported by Cakir et al¹⁷ and Barnard et al¹³.

All the patients in this study received thrombectomy, while 74% had interposition venous graft, mainly using reversed Great Saphenous Vein (R-GSV) and 26% had direct vascular end to end repair. The R-GSV was majorly used in patients with arterial length deficit from gunshot or crush injuries, while the end-to-end vascular repairs were majorly indicated in patients with machete cuts. The use of great saphenous vein in OTWVI have been widely reported. Barnard et al¹³, Yu et al²³, Sun et al²⁰ and Jagdish et al¹⁹, respectively reported that 50%, 60%, 69% and 89% of patients had R-GSV interventions, which is consistent with this study. The frequent usage of great saphenous vein in our study may be attributed to the type of injuries it was indicated for (gun shot and crush injuries) which precludes end to end repairs. Similarly, the end-to-end repair used in our study have also been previously reported by Sun et al²⁰ and Yu et al²³ in 21% and 40% respectively among OTWVI patients.

The surgical outcome in this study showed that the limb salvage rate was 87% and only 13% failure with consequent amputation was recorded. The surgical repairs in this study were successful in 20 patients that presented relatively early, while the 3 failed repairs included 2 patients with popliteal artery injuries that presented late and 1 with the lateral digital artery of the thumb injury, therefore these 3 patients ended up with limb and thumb amputations. However, 1 patient died immediately after axillary artery repair from multiple injuries and massive blood loss. The limb salvage rate in this study was higher than the 83% and 84% achieved by Sun et al²⁰ and Benard et al¹³ respectively, but comparatively lower than the 88%, 89% and 90% documented by Cakir et al¹⁷, Jagdish et al¹⁹ and D'Alessio et al¹⁸ respectively.

V. Conclusion

Orthopaedic Trauma with Vascular Injury (OTWVI) could be quite challenging and may be associated with limb loss or even death. However, early presentation, recognition and intervention by a multidisciplinary team, including the orthopaedic and vascular surgeons, are pivotal to limb salvage.

Compliance with ethical standards

Acknowledgement

The authors would like to acknowledge all the patients who despite the discomfort agreed to take part in the study.

Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of ethical approval

Ethical approval for the study was obtained from the ethics and review board of the University of Port Harcourt Teaching Hospital, Port Harcourt and the Medical Directors of the private medical facilities that participated in the study.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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