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Treatment Approaches to Combined Orthopedic and Vascular Traumas: A Single-Center Experience

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Abstract

Background: Orthopedic and vascular trauma can be clinically observed and have negative consequences if not treated appropriately.
Objectives: This study aimed to present the clinical experiences of the authors regarding vascular traumas in combination with extremity fractures or dislocations.
Methods: In total, 95 patients (78 males, 17 females, with the mean age of 34.7±5.6 years old) who underwent surgical treatment for combined orthopedic and vascular trauma between November 2012 and February 2020 were included in the study. Patients were retrospectively evaluated according to their clinical properties, treatment strategies, and results.
Results: Traffic accidents were the most common reason for trauma with a rate of 36.8% (n=35). The most common orthopedic injury was seen in the femur, whereas the most common vascular injury was on the superficial femoral artery. The most commonly performed treatment methods for vascular and orthopedic trauma were primary repair and external fixation, respectively. Based on findings, the mortality and amputation rates were 2.1% (n=2) and 15.7% (n=15), respectively.
Conclusion: Combined orthopedic vascular traumas are less frequent than isolated vascular traumas, but they have higher mortality and amputation rates. In order to decrease mortality and amputation rates, communication should be perfectly coordinated between the emergency department and orthopedic and cardiovascular surgery clinics; moreover, urgent intervention is crucial.

Keywords: Bone fracture, Joint dislocation, Vascular trauma

1. Background

Vascular traumas can be divided into two main groups as penetrating and blunt traumas according to the etiology and mechanism of injury. The penetrating trauma usually results in lacerations or transection of the vessel without contusion. Gunshot injuries cause more serious tissue damage due to high energy, compared to penetrating trauma. Blunt traumas can lead to extensive tissue defects due to concomitant fractures or dislocations. They may cause thrombosis or bleeding as a result of damage to the vessel wall ranging from the intimal flap to rupture (1).

Extremity vascular injuries are usually more common in young age and male gender (2). Since the lower limb has more axial length and exposed parts, the incidence rate of lower limb vascular traumas is twice as much as that of upper limb vascular traumas (3). Vascular trauma constitutes 3% of all traumatic injuries (4). Combined orthopedic vascular injuries are rarer than isolated vascular injuries; however, their mortality and morbidity rates are higher due to the accompanying bone, nerve, soft tissue, and/or crush injuries. Early diagnosis and treatment are very important for these injuries as a delay in the intervention may cause limb and/or life-threatening consequences. Improved diagnostic methods and the introduction of endovascular treatment options offer alternative modalities to traditional surgical management.

2. Objectives

In this study, the authors present their clinical experience regarding the treatment of combined orthopedic vascular trauma.

3. Methods

In total, 95 patients (78 men, 17 women with a mean age of 34.7±5.6 and a range of 3-82 years old) who were treated in Necmettin Erbakan University Meram Medical Faculty Hospital, Konya, Turkey for combined orthopedic vascular trauma between November 2012 and February 2020, were included in the study. Institutional Ethics Committee of the clinical studies approved the study in 2020 with the decision no of 2791-114. The demographic data, clinical features, treatment methods, and results were collected from the hospital database. It should be mentioned that the patients who underwent primary amputation were excluded from the study.

The patients who referred to the emergency department were cared for by the relevant trauma clinics. Moreover, patients with unstable hemodynamics, crush injuries, active bleeding, or signs of major vascular injuries were taken into operation immediately. Besides, patients with stable hemodynamics were cared for by both clinics in the emergency department and their treatment managements were planned. In blunt traumas, patients with stable hemodynamics were cared for by the relevant clinics for accompanying abdominal, thorax, or head trauma while in the emergency department. Patients who were immediately taken into operation were cared for by the relevant clinics during the operation.

Diagnosis of acute arterial occlusion was based on clinical manifestations (i.e., pain, pallor, poikilothermia, pulselessness, paresthesia, and paralysis) and ankle-brachial index (ABI). In some patients with suspected vascular injury, imaging methods were used to confirm the diagnosis, localize the injury site, and plan the surgery. Most of the patients were operated under general anesthesia; however, some cases who were recommended for follow-up by the orthopedics team and underwent embolectomy or primary vascular repair were operated under local anesthesia. In the operation, first, hemodynamics was stabilized and the bleeding was controlled.

The vascular repair was primarily performed for patients with ischemia time longer than 3 h and without collateral blood flow source for the extremity (e.g., femoral, popliteal, and brachial artery injuries). Damaged vascular structures were found and bleeding was controlled. When the vascular segments were thrombosed, the flow was achieved by applying embolectomy. Vascular clamps were placed after 100 IU/kg heparin. It must be noted that heparin was not used for patients with coagulopathy or head trauma. Primary repair methods were used in partial vascular injuries without tissue loss.

For patients with vascular injuries with full-thickness incision and/or tissue defect, interposition was performed with a venous or rarely synthetic graft. Venous injuries for which collateral venous return was not possible (e.g., popliteal, femoral, or brachial vein) were absolutely repaired. Small venous structures and some superficial veins accompanying arterial injury were ligated. Some patients underwent endovascular intervention in the hybrid operating room of our clinic. Fractionated heparin and acetylsalicylic acid were given to patients without bleeding problems as anticoagulants for graft patency in the postoperative period. Fractionated heparin was discontinued at discharge while anticoagulation was continued with acetylsalicylic acid.

In open fractures, first, bone stabilization was achieved when bone mobility was excessive or one of the arteries (forearm or pedal) providing collateral circulation in the extremity was intact. Similarly, the joint reduction was performed primarily in patients with knee or elbow dislocation. The circulation was re-evaluated for iatrogenic vascular injury after orthopedic stabilization in patients for whom vascular repair was performed primarily. The accompanying nerve or soft tissue injuries were absolutely repaired by the orthopedics team. In cases with severe skin and soft tissue defects, plastic surgery consultation was requested during the intraoperative period and necessary repairs were performed.

It should be mentioned that all patients received tetanus prophylaxis. Antibiotic prophylaxis with 1 g of cefazolin sodium was administrated to all patients after the induction of anesthesia. Ornidazole was added as a second antibiotic to the treatment of patients with open fractures, dirty wounds, and crush injuries. In dirty wounds, bone fragments and foreign bodies were removed and irrigated with saline. In the postoperative period, antibiotic treatment was revised in consultation with the infectious disease clinic to adjust the infection parameters.

Fasciotomy was performed to prevent the development of compartment syndrome in patients with fragmented bone fracture and extensive tissue defect accompanied by severe venous injury. In some patients, due to the development of compartment syndrome, fasciotomy was performed during the early postoperative follow-up. Negative pressure wound care systems were used for wound care, especially in patients undergoing fasciotomy and vein ligation. Some patients underwent amputation below the knee due to crush injury and multiple open fractures despite successful revascularization.

Statistical analysis of the study was performed using computerized techniques. Continuous variables in the study are shown as mean±standard deviation values while categorical variables are represented as frequency and percentage.

4. Results

The demographic characteristics of the patients are shown in Table 1. Based on the results, the most common cause of trauma was traffic accident with the rate of 36.8% (n=35). In total, 67 (70.5%) patients had stable hemodynamics during admission while 28 (29.5%) patients had shock. The mean ischemia time between trauma and surgical intervention was 2.1±3.5 h (ranging from 30 min to 14 h). The mean Mangled Extremity Severity Score (MESS) was 5.7±8.6, and the MESS value was ≥7 in 32 cases.

Vascular injury was diagnosed in most cases by physical examination and ABI measurement. Nevertheless, in some cases with stable

Table 1. Demographic characteristics of patients

Variable	n	%	Mean±SD	Range
Total number of Patients	95	100		
Age (years)			34.7 ± 5.6	
Mechanism of trauma	78	82.1		
Blunt (e.g., traffic accident and fall)	59 36			
Penetrating (e.g., stab and gunshot)			2.1±3.5 5.7±8.6 7.4±8.7	0.5-14 2-11 1-37
Ischemia time (h)		62.1 37.8		
MESS value	18	18.9		
Hospital stay (days)	15	15.7		
Fasciotomy	2	2.1		
Amputation				
Mortality				

MESS: Mangled extremity severity score

Table 2. Vascular injury localization and treatment methods

Arterial Injury	N	Venous ınjury	N	Treatment methods	N
Subclavian	3	Subclavian	2	Non-operative	5
Axilary	4	Axillary	3	Embolectomy	11
Brachial	25	Brachial	14	Ligation	13*
Ulnar	9	Cephalic	9	Simple suture	31
Radial	13	Basilic	5	End-to-end repair	28
CFA	3	Femoral	21	Patch plasty	5
SFA	32	Popliteal	13	Venous graft	25
DFA	4	Tibial	7	Synthetic graft	4
Popliteal	19	Saphenous	9	Endovascular	5
PTA	12				
ATA	9				

Note: One patient may have arterial and/or venous injuries at more than one location. ATA: Anterior tibial artery, CFA: Common femoral artery, DFA: Deep femoral artery, PTA: Posterior tibial artery, SFA: Superficial femoral artery. *Most commonly superficial or small venous injury.

hemodynamics, duplex ultrasonography (DUSG), computed tomography angiography (CTA), or magnetic resonance angiography (MRA) was requested to confirm the diagnosis and surgical planning. Preoperative angiography was performed in 25 (26.3%) patients in the present research. Table 2 summarizes the data on vascular injuries. Based on the findings, 78.9% (n=75), 54.8% (n=52), 38.9% (n=37), and 6.3% (n=6) of the vascular injuries were in the lower extremities, isolated arterial, both arterial and venous, and isolated venous injuries, respectively. The most common vascular injury was in the superficial femoral artery with the rate of 33.7% (n=32).

Skeletal stabilization was performed primarily in cases with dislocation and closed fractures. Spontaneous revascularization was observed in five (5.2%) cases, three of whom were children. In 90 patients, 122 vascular repair procedures were performed for a total of 105 extremities. The most common vascular repair method was the primary suture technique which was used in 31 (32.6%) patients. Revascularization was achieved in 11 (11.6%) patients with brachial or femoral embolectomy who had closed femur, humerus fractures, or knee or elbow dislocations.

In this study, polytetrafluoroethylene grafts were used in four (4.2%) patients. The saphenous vein could not be used due to the diameter mismatch in two subclavian and one common femoral artery injuries. In another patient, the saphenous vein was unavailable due to multi-trauma and crush injury in the bilateral lower extremity. All arterial injuries were repaired as much as possible. However, in some cases of multi-trauma, if one of the pedal or forearm arteries was intact, the other was ligated. Moreover, the accompanying truncal vein (e.g., brachial, femoral, and popliteal vein) injuries were absolutely repaired, and ligation was performed in some small and superficial veins.

In total, five (5.2%) patients with stable hemodynamics were treated in the hybrid operation room of our clinic. The hybrid procedure was performed on four patients by surgical embolectomy after imaging and balloon dilatation. Moreover, in the case of one patient with concomitant thoracic aortic injury, the lower limb vascular injury was surgically treated while an endovascular stent was applied for aortic injury. One patient had signs of swelling and tension in the thigh for 1 week after the discharge. On control angiography, pseudoaneurysm was detected in the lateral branch of the deep femoral artery and was treated by coil embolization (Figure 1). Data on orthopedic injuries are tabulated in Table 3.

Lower extremity cases, similar to vascular injuries, had a high prevalence. There were a large number of cases with multiple limb injuries, especially in blunt traumas. Moreover, the most

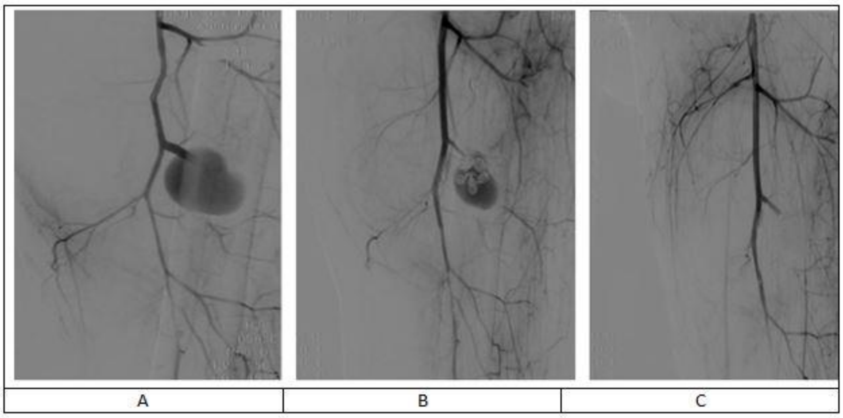

Figure 1. (A) Pseudoaneurysm in the lateral branch of the deep femoral artery; (B) Endovascular intervention to the pseudoaneurysm; (C) Treated pseudoaneurysm with coil embolization.

Table 3. Orthopedic traumas

Fractures	N	Dislocations	N
Clavicle	3	Shoulder	4
Humerus	21	Elbow	9
Radius	13	Wrist	3
Ulna	7	Hip	5
Femur	32	Knee	13
Tibia	17	Ankle	4
Fibula	9		

Note: One patient may have fractures and/or dislocations in more than one location.

Table 4. Mangled extremity severity score

Variable	Score
A. Skeletal/soft tissue injury	
1. Low energy (stab, simple fracture, 'civilian' gunshot wound)	1
2. Medium energy (open or multiple fractures, dislocation)	2
3. High energy (close-range shotgun or 'military' gunshot wound, crush injury)	3
4. Very high energy (above+gross contamination, soft tissue avulsion)	4
B. Limb ischemia (score doubled for ischemia>6 hs)	
1. Pulse reduced or absent but normal perfusion	1
2. Pulseless; paresthesias, diminished capillary refill	2
3. Cool, paralyzed, insensate, numb	3
C. Shock	
1. Systolic blood pressure always >90 mmHg	0
2. Hypotensive transiently	1
3. Persistent hypotension	2
D. Age (years)	
1. <30	0
2. 30-50	1
3. 50<	2

common orthopedic injury was in the femur. Orthopedic stabilization was performed before the vascular treatment in 42 (44.2%) patients. External fixation in fractures and closed reduction in dislocations were most commonly used for orthopedic stabilization. In some cases, splints were applied with internal fixation or traction. In total, 25 (26.3%) patients had accompanying nerve, tendon, and soft tissue damage which were repaired by orthopedics and/or plastic surgery teams.

It should be mentioned that in this study, the fasciotomy rate was 18.9% (n=18). Fasciotomy was performed to prevent the development of compartment syndrome in 15 patients with crush injury, fragmented bone fracture, extensive tissue defect, severe venous injury, and long-term ischemia (>6 h). For three patients, fasciotomy was performed in the postoperative period due to the development of compartment syndrome.

The most common complication in the postoperative period was wound problem. The vascular evaluation was continued until the discharge time. In the early postoperative period, three (3.1%) patients whose ischemia findings were available underwent embolectomy, and re-flow was achieved. Neurological deficits due to nerve damage were observed in nine (9.4%) cases. There was no amputation in the upper limb while 15 (15.7%) patients underwent amputation below the knee in the lower limb despite successful revascularization. Amputation decision was made according to MESS (Table 5). The mean hospital stay of the patients was

7.4±8.7 days but it was longer for those undergoing fasciotomy and amputation. According to the results, the mortality rate was 2.1% (n=2) in this study.

5. Discussion

There are some gray areas in the management of concomitant orthopedic and vascular traumas. The gray area to avoid during the evaluation of patients in the emergency department is a missed diagnosis (5). The signs of the vascular trauma of the limb are generally divided into two groups, namely hard and soft signs. Hard signs include active hemorrhage, loss of pulse, expanding hematoma, bruit or thrill, and limb ischemia signs. Soft signs include blood loss anamnesis before admission, diminished pulse, moderate hematoma, proximity to a large vessel or bone injury, and ipsilateral neurologic deficit. (5).

However, there are some pitfalls to be considered in the vascular examination. While palpable pulse does not exclude vascular trauma, the nonpalpable pulse may not confirm the diagnosis of vascular trauma. Pulses can be palpable even if there is trauma due to collateral circulation or incomplete vascular damage (6). On the contrary, pulses may be nonpalpable even if there is no trauma due to current peripheral artery disease or hypotensive shock. These patients should be monitored closely and re-evaluated after hemodynamic stabilization. If ischemia or bleeding signs are observed during follow-up, emergency exploration can be performed (7). In the presence of active hemorrhage, external compression or tourniquet can be applied to control the bleeding but long-term tourniquet should be avoided as it negatively affects collateral circulation and urgent revascularization should be provided (7).

In vascular trauma, the ABI measurement is an important auxiliary examination method. In the presence of abnormal ABI (<0.9), imaging methods should be used to avoid diagnostic pitfalls (5). The DUSG is a safe, repeatable, cheap, and noninvasive method, but it is operator-dependent and has access difficulties, especially in crush or open injuries (1,8). In vascular trauma, CTA or MRA can be used as non-invasive imaging methods to confirm the diagnosis. Arterial angiography is considered the gold standard for the diagnosis of vascular injury, but it is an invasive method and requires special equipment (1).

In an epidemiological study, 28.8%, 38.9%, 3.1%, and 10.7% of the surgical exploration, CTA, DUSG, and arteriography, respectively, were reported for the diagnosis of vascular injury (9). In the present study, most cases had hard signs of vascular injury and were taken to the surgery room urgently. Arteriography and CTA were performed on five (5.2%) and 25 (26.3%) patients, respectively.

The ischemic time that muscles and nerves can tolerate is only 6-8 h, and longer ischemic times cause irreversible damage associated with limb dysfunction or amputation (10). Patterson et al. evaluated cases requiring vascular repair due to dislocation in the knee joint and reported a relationship between prolonged ischemia and high amputation rates. Therefore, rapid transport and early diagnosis are very important for ischemia time and outcome (11). In this study, the mean ischemia time was 2.1±3.5 h.

Orthopedic stabilization or vascular repair priority is also another important and gray area. It depends on the ischemia time, hemodynamic status, and the type of injury (12). If there are signs of critical ischemia, revascularization should be achieved as soon as possible, otherwise, bone stabilization can be applied first or temporary intravascular shunts (TIS) may also be used during bone stabilization (12). In cases where vascular repair is performed first, an iatrogenic vascular injury may develop during orthopedic stabilization and close monitoring is required. Furthermore, vascular exploration may be difficult due to fixators and screws in the patients for whom bone stabilization is achieved first (13).

In a study in which skeletal stabilization was achieved first, long hospital stays and high fasciotomy rates were detected and revascularization was primarily suggested (13). In the present research, if the ischemia time was longer than 3 h and there was truncal arterial injury, revascularization was performed first. On the other hand, if bone mobility was excessive, ischemia time was less than 3 h or one of the forearm or pedal arteries was intact, skeletal stabilization was performed first.

There are also different opinions regarding the use of TIS. If TIS is used, the total operation time is extended, and also thrombosis and vascular damage may develop during the placement or removal of the shunt. Therefore, there are hesitations regarding the use of TIS, and it is generally recommended for large tissue defects and some special multi-fragmented fractures (2,5). It must be mentioned that TIS was not used in the present study.

In this study, the most common vascular injury was in the superficial femoral artery, similar to the reviewed literature (14). Treatment options that can be applied in our department include embolectomy, ligation, simple repair, graft interposition, and endovascular procedures. Our approach in the clinic to vascular injuries is as follows: the first step in vascular repair is bleeding control and defect detection. After proximal and distal vascular control is achieved with bulldog clamps or Silastic vascular straps, the damaged vascular area is debrided. The next step is the urgent provision of distal flow. If the vascular ends are thrombosed or there is no flow, the flow is facilitated by embolectomy and washing with heparinized fluid. Vascular thrombosis may develop due to contusion or external compression in closed fractures or dislocations. In these cases, spontaneous recovery may occur with skeletal stabilization and skeletal stabilization should be a priority. In this study, spontaneous improvement was observed in five (5.2%) patients and revascularization was achieved with embolectomy in 11 (11.6%) patients.

In some serious injuries, if vascular repair is not possible, ligation may be an option, but it is rarely used today due to its high amputation rate (1,2). It is stated that when one of the forearm or pedal arteries is injured, revascularization is necessary if the palmar or pedal arches are insufficient for circulation. Moreover, ligation can be applied in cases where the palmar or pedal arch is considered sufficient (15). In this research, all arterial injuries were repaired as much as possible. However, in a few patients ligation was performed in distal radial and anterior tibial artery injury due to unstable hemodynamics and severe tissue defect associated with a crush injury.

Incomplete vascular defects can usually be repaired simply with primary sutures or end-to-end anastomosis, and primary repair is the most common treatment method (2,14). To achieve good results in primary repair techniques, they should not cause more than 50% narrowing in the lumen (16). Especially in penetrating traumas, smooth-edged partial or full-thickness incisions and vascular defects up to 2 cm can be repaired primarily (17). In gunshot injury, intact vascular margins should be well evaluated due to the corrosive effect, otherwise, secondary thrombosis may develop due to intimal damage. Approximately, 1-1.5 cm of the marginal zone should be left at both ends and a venous graft should be implanted in between (17). In this study, primary repair techniques were used more frequently, compared to other techniques.

If the vascular defect is large and primary repair is not possible, graft interposition is required for treatment. The great saphenous vein is considered the ideal graft (5). In this study, the great saphenous vein was used most frequently for graft interposition. The saphenous vein on the other leg was used to prevent the development of stasis and compartment syndrome. In four cases with concomitant humerus fracture and brachial artery injury, the basilic vein was used as it could be accessed without additional incision, shortened the operation time, and had a compatible diameter. The polytetrafluoroethylene graft was used for only four (4.2%) patients due to the diameter mismatch or lack of autogenous grafts.

The use of endovascular techniques is increasing in many centers for the treatment of vascular trauma. It has become an alternative to surgical treatment since it can be minimally invasive, easy, fast, and applied under local anesthesia. Therefore, ischemia and operation times are shortened and less blood is lost. High costs, equipment requirements, radiation exposure, and nephrotoxicity are negative aspects. It provides advantages especially in cases with difficult surgical access, high risk of iatrogenic injury, and complications, such as pseudoaneurysm and arteriovenous fistula (1,2,18). Uğur et al. performed a 19.7% hybrid procedure on 66 patients in their study and reported the necessity of classical surgical equipment in centers for the treatment of vascular trauma (19). Endovascular procedures were used in five (5.2%) patients in the present study.

One of the gray areas in vascular trauma is the treatment of accompanying venous injuries. Venous injuries are often ignored or neglected. Diagnosis of venous injury is difficult if there is extensive soft tissue damage, and in most cases, venous injury is detected during surgery (2). The treatment of accompanying venous injuries is controversial. Some advocate that venous repair leads to loss of time and has no advantage over ligation, while others advocate that venous repair prevents postoperative limb edema and compartment syndrome development and contributes to limb salvage (20,21). In this study, subclavian, axillary, brachial, femoral, and popliteal vein injuries were repaired as much as possible. In cases with superficial veins and distal tibial vein injuries, the primary repair was performed in partial defects, while ligation was performed in cases with complete defects.

In the related literature, the most common orthopedic trauma was femur fracture and the most common orthopedic repair method was external fixation which coincides with the present research (22). Accompanying nerve injuries are common and their treatment is important to prevent loss of function. Similarly, repair of accompanying muscle, tendon, and soft tissue defects is important for wound healing and rehabilitation (22). In this study, 25 (26.3%) patients had accompanying nerve, tendon, and soft tissue damages which were repaired by orthopedics and/or plastic surgery team.

Compartment syndrome refers to when the pressure in the closed space exceeds the capillary perfusion pressure level required for tissue viability. General risk factors for the development of compartment syndrome are hypotension, longe ischemia time (>4-6 h), crush injury, and the need for vascular ligation (5). Fasciotomy can be performed prophylactically during the operation or when it develops in the postoperative period. However, fasciotomy delays healing and prolongs hospital stay, and wound care is important here (23).

Kayalar et al. reported that fasciotomy should be applied without the development of motor deficits and that the fasciotomy threshold should be kept low (2). Fasciotomy was applied to 18 (18.9%) patients with signs of compartment syndrome. These patients had crush injury, multiple open fractures, long ischemia time, higher MESS value (≥7), and the injury site was usually popliteal trifurcation.

It is difficult to make a primary amputation or revascularization decision in the extremity severely affected by trauma. Some scoring systems have been developed for this purpose. One of the frequently used systems is MESS and it contains four different variables, namely skeletal and soft tissue injury, limb ischemia, shock, and patient age (24). Although scoring systems are easily applicable, it is recommended that the sensitivity be low and the clinical condition of the patient be evaluated (25). Patients undergoing primary amputation were not included in this study, but MESS was used for treatment decisions in critical patients. In the present study, 15 (15.7%) patients underwent amputation while two (2.1%) patients died. It must be mentioned that these patients had severe crush injury and accompanying abdomen, thorax, or head trauma.

Combined orthopedic and vascular traumas can result in delayed complications. In this study, patients were followed up daily by both clinics during the postoperative period. Signs of ischemia were detected in three patients and embolectomy was performed. Again, three patients developed compartment syndrome and fasciotomy was performed. Despite all the attempts, limbs could not be saved in 15 patients. The mean hospital stay of patients was 7.4±8.7 days, but long-term rehabilitation was required for patients with fasciotomy or amputation.

The main limitation of the study was its retrospective nature and that the data were based on the patient anamnesis and hospital registration system. In addition, late results are not exactly known since these patients could not be followed up regularly after the first postoperative control.

6. Conclusion

In conclusion, significant advances have been made in the management of vascular injuries in recent years. However, there are still some gray areas in its diagnosis and treatment. The main problems seem to be ischemia time and accompanying injuries. Therefore, early and accurate diagnosis and treatment are very important for limb salvage and survival. The creation of trauma centers, inclusion of vascular surgeons in trauma teams, and training of these teams will speed up first aid and transport. Installation of an equipped hybrid vascular trauma room will provide the opportunity for diagnosis and treatment in the same session. Moreover, close postoperative follow-up reduces the complication rate and the need for intervention. The best outcome can be achieved with a team approach during the perioperative period.

Footnotes

Conflicts of Interest: The authors declare no conflicts of interest related to this study.

Ethical Consideration: Informed consent was taken from all of the participants. The study protocol was prepared according to the ethical guidelines of the 1975 Declaration of Helsinki. Institutional Ethics Committee of the clinical studies approved the study in 2020 with the decision no of 2791-114.

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