



## Experience in Surgical Treatment of Damage to the Great Vessels of the Lower Extremities in Case of Industrial Injury

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### Abstract

**The Purpose of the Study:** To conduct a retrospective analysis of the structure of the combined industrial bone and vascular injury of the lower extremities and to analyze the results of surgical treatment.

**Materials and Methods:** Data from 147 patients with industrial combined bone and vascular trauma of the lower extremities were analyzed. All patients are male, aged 19 to 48 years, with an average age of 30.2 years. Of the 123 observations, mine injury prevailed (102; 82.9%) with damage to the femur and/or tibia and popliteal artery damage - 116 (78.9%). 92 two-stage interventions were performed in conjunction with traumatologists.

**Results:** A positive result of surgical treatment was noted in 73 (79%) cases. The duration from injury to the start of surgery in this group ranged from 2 to 5 hours, the degree of acute arterial ischemia according to V.S. Savelyev (1974) was IIa - IIb. The duration of the operation is from 3 to 4 hours, patients were in shock of the II century. Preoperative blood loss - from 1 to 2.5 liters. This group was dominated by damage to the popliteal artery (43; 54.4%). In 6 (6.5%) cases, after reconstructive intervention, the limb was amputated.

**Conclusions:** The most favorable outcome is indicated in the early delivery of the injured (up to 2 hours) to specialized hospitals with anti-shock therapy at the preoperative stage.

**Keywords:** Combined Musculoskeletal Occupational Injury; Lower Extremities; Two-Stage Surgical Treatment

According to the WHO, injuries today ranks third in a number of causes of total mortality, and in the group of people under 45 years old firmly holds the first place. Injuries over the past few years have increased significantly and reached epidemic characteristics. In the world, about 12 million people are injured annually. persons of whom die - up to 350 thousand [1-7].

Today in Ukraine, as almost all over the world, there is a significant increase in the level and severity of traumatic injuries of a person, which enabled some authors to introduce the concept of «epidemic of injuries» [8-10]. The level of injuries in the regions of Ukraine is steadily growing and significantly exceeds sanitary losses in local military conflicts of the last century. In particular,

in 2001, 2.3 million people were injured in the state. people, died from injuries about 40 thousand. According to the State Statistics Committee of Ukraine, mortality due to accidents, poisonings and injuries ranks third, and due to injuries alone - fourth among all other causes [11,12].

Polytrauma with damage to the musculoskeletal system is one of the most common and difficult to treat, as well as life-threatening, so the study of clinical and organizational problems of treating victims with such an injury is relevant and necessary [13,14]. Of particular importance, both in terms of complexity and in view of the threat to life, are the combination of injuries, which is a very complex problem for world medical science and health care [15,16].

Despite the achievements of modern medicine, mortality and disability due to polytrauma with a skeletal component remain quite high, due not only to the severity of injuries, but also to the presence of various complications of a general and local nature, which are observed both in the early and in the remote period after injury [17].

The largest proportion of deaths and complications is observed in the acute period of polytrauma, which is associated with massive blood loss, traumatic shock and other complications. In particular, there is an increase in the proportion of complications (30-60%), disability (12-45%) and mortality (8085%), as well as dissatisfaction of practitioners with the results and quality of treatment of this pathology [18].

Occupational injury with vascular damage is one of the most dangerous and serious types of injury, often entailing disability of victims and death. As a result of the developed traumatic disease, mainly people of young working age suffer: the average age of the dead is 23-34 years. Among surviving patients, the frequency of disability is 40-60%, so the problem of combined osteovascular trauma in peacetime acquires special social significance [1-6].

The frequency of amputations of limbs in vascular injuries is 8% [6]. Popliteal artery injury occurs in 15.5% of cases; The clinical picture is not much different from damage to the vessels of the thigh. If trauma to the popliteal artery very rarely leads to fatal blood loss, then the ligation of this vessel ends with gangrene in 26.3%

of observations, so an attempt to restore its integrity is relevant. Injuries of the vessels of the lower leg in peacetime account for about 3.8% of all vascular injuries. Most often, the posterior tibial artery is injured - the largest artery of the lower leg [6].

The overall mortality rate in vascular injury is still high (about 18%), reaching 62% in case of damage to large vessels of the chest and abdominal cavity, 35% - with combined injuries, 20.5% - with injuries of neck vessels. In case of damage to the vessels of the extremities, about 5% of peacetime victims die [4-6].

Thus, severe trauma is one of the leading causes of disability and mortality in all age groups. Fractures of the long bones of the lower extremities, in particular the femur, carry an increased risk of complications, and the choice of surgical treatment tactics, timing and methods of fixing fractures of the long bones of the lower extremities in patients with severe combined trauma is a topical and controversial issue.

### The Purpose of the Study

To conduct a retrospective analysis of the structure of the combined industrial bone and vascular injury of the lower extremities and to analyze the results of surgical treatment.

### Materials and Methods

For the period from 2008 to 2013 along the line of air ambulance by the brigade of the State Institution «Institute of Emergency and Reconstructive Surgery. V. K. Husak NAMS of Ukraine», 147 visits were made in Donetsk region to patients with industrial trauma of the lower extremities. All patients were male, the age of patients ranged from 19 to 48 years, the average age was 30.2 years.

Given the specifics of the work, all patients did not have concomitant pathology. According to the nature of the occupational injury (123 observations), the cause was mine injury in 102 (82.9%) cases (rock collapse - compression, tissue contusion, fractures, vascular trauma); influence of mechanisms and mine transport (fractures, thawing, limb detachments, vascular trauma) - 27 (21.9%) cases; In 5 (4.1%) cases, the injury was caused by rupture of the cargo cable (bruise, rupture of muscles, ligamentous apparatus, vascular injury), in 13 (10.6%) cases - the impact of sawing mechanisms (damage to muscles, bones, vascular injury).

The structure of occupational trauma of the lower extremities is presented in Table 1, the degree of acute arterial ischemia of the lower extremities according to V.S. Savelyev (1973) IIa to IIIb.

The nature of the occupational injury	Number of cases	
	Abs.	Rest. (%)
Open multi-fragmentation fracture of the lower third (n/3) of the femur, upper third (in/3) of the bones of the lower leg with damage to the ligamentous apparatus of the knee joint, popliteal artery, muscle contusion, large hematoma	49	33%
Open multi-fragmentation bone fracture in/3 of the lower leg with popliteal artery injury	43	29,2%
Posterior dislocation of the lower leg, rupture of the popliteal artery, large intermuscular hematoma	24	16,3%
Open multi-fragmentation fracture of the lower leg bones with damage to the tibial arteries, muscle contusion, extensive intermuscular hematoma	18	12,2%
Damage to the bones of the c/3-n/3 lower leg with damage to muscles, tibial arteries	13	8,8%
JUST	147	100%

**Table 1:** The structure of combined occupational trauma of the lower extremities.

The frequency of concomitant trauma was as follows: detachment of fingers and feet - 55 (37.5%); contusion of organs (without compromising the integrity of the organ) of the abdominal and chest - 37 (25%) cases, brain contusion - 37 (25%), contusion of the abdominal organs - 13 (9%) cases.

All patients at the time of admission to district hospitals were in a state of shock (combined shock II-III). Anti-shock measures were carried out at work after injury, during transportation - by teams of the paramilitary mountain rescue unit and resuscitation teams, as well as in intensive care units and urgent operating rooms in specialized medical institutions. Delivery times from production to district departments of surgery, traumatology ranged from 2 to 4 hours, the average time is 3 hours, the long duration is due to the remoteness of production from specialized medical institutions, a feature of the production process (miners). The delivery time of a vascular surgeon to specialized medical institutions depended on the distance from Donetsk and ranged from 30 minutes to 2 hours; average time 1 hour 30 min. Terms from injury to the start of surgery from 4 hours to 6 hours, the average time is 5 hours.

Out of 147 visits, 92 (62.6%) reconstructive surgeries were performed together with traumatologists. Surgical interventions were carried out in two stages: the first stage - the restoration of the integrity of the bones and fixation of the joints, the second stage - the restoration of blood flow through the main arteries.

The structure of reconstructive vascular operations was dominated by interventions in the popliteal artery basin (autovenous prosthetics), which were necessarily combined with fasciotomy of the lower leg muscles: external percutaneous compression-distraction osteosynthesis (CHCDO) of the knee joint, autovenous popliteal artery prosthetics, open fasciotomy of the lower leg muscles - 31 (33.7%) patients; CHCDO, autovenous prosthetics of the tibioperoneal trunk, open fasciotomy of the muscles of the lower leg - 19 (20.6%); CHCDO, autovenous prosthetics of the posterior tibial artery and anterior tibial artery, open fasciotomy of the lower leg muscles - 8 (8.7%).

31 (34%) patients were operated under general anesthesia, 21 (23%) - under spinal anesthesia. The duration of surgery ranged from 3 to 7 hours, the average duration was 5 hours. For autovenous

prosthetics, a reversed large saphenous vein of the leg, taken on the affected side, was used. Intraoperatively, during the revision of the wound, heparin solution, antispasmodics, protease inhibitors were

injected intraarterially (into the distal arterial beds) in order to prevent prolonged thrombosis of the distal vascular bed.

The nature of the injury	Total quantity		Operated patients		Unoperated Patients	
	Abs.	Rest. (%)	Abs.	Vidn. (%)	Abs.	Vidn. (%)
Open multi-fragmentation fracture n/3 of the femur, intravenous bone with popliteal artery injury	31	33,7%	8	8,3%	23	25,4%
Open multi-fragmentation bone fracture in/3 of the lower leg with popliteal artery injury	11	12%	8	8,3%	3	3,6%
Posterior dislocation of the lower leg, rupture of the popliteal artery	15	17%	15	17%	-	-
Open multi-shrapnel bone fracture in/3 of the lower leg with damage to the tibial arteries	27	29%	19	20,8%	8	8,3%
Damage to the bones of the c/3-n/3 lower leg with damage to muscles, tibial arteries	8	8,3%	8	8,3%	-	-
JUST	92	100%	58	62,7%	34	37,3%

**Table 2:** The frequency of surgical interventions depending on the nature of the limb injury.

\*Note. b/3 - upper third; C/3 – middle third; N/3 – lower third.

In the intraoperative period, the main areas of therapy were maintaining stable blood pressure figures, antishock therapy, blood transfusions, detoxification therapy.

In 55 (37.4%) cases, patients were considered inoperable, of which 7 (4.8%) were in critical condition (IV shock, unstable hemodynamics, anuria, massive blood loss, convulsive syndrome), 9 (6.1%) patients at the time of examination revealed critical limb ischemia, which led to irreversible changes in the lower limb, in 5 (3.4%) patients bone and joint reconstruction was impossible.

**Results**

After surgery, a positive result of treatment was noted in 73 (79%) cases. The duration from injury to the start of surgery in this group ranged from 2 to 5 hours. The duration of surgery ranged from 3 to 4 hours, patients were in combined shock II degree. Preoperative blood loss ranged from 1 to 2.5 liters. By the nature

of the injury: posterior dislocation of the lower leg; popliteal artery rupture - 25 (34.2%); open multi-fragmentation fracture of bones in/3 of the lower leg with damage to the tibial arteries -18 (24.6%); open multi-fragmentation fracture of the femur, intravenous bone of the lower leg with damage to the popliteal artery - 6 (8.2%); open multi-fragmentation fracture of the bones in/3 of the lower leg with damage to the popliteal artery - 12 (16.4%); damage to the bones of the c/3-n/3 lower leg with damage to the tibial arteries - 6 (8.2%). The degree of acute arterial ischemia according to V.S. Savelyev (1973) in this group of patients was IIa - IIb.

In 6 (6.5%) cases, after reconstructive intervention, amputation of the limb was performed due to prolonged thrombosis of the distal vascular bed (arterial arch of the foot), severe subfascial edema of the lower leg and foot, venous thrombosis on the first or second day. The duration from injury to the start of surgery in this group is up to 6 hours. The duration of surgery ranged from 4

to 7 hours, patients were shocked III. Preoperative blood loss from 3 to 4.5 l, degree of acute arterial limb ischemia according to V.S. Savelyev (1973) from IIb to IIIa. By the nature of the injury of the lower extremities, there were: open multi-fragmentation fracture n/3 of the femur, B/3 of the bones of the lower leg with damage to the popliteal artery - 1; open multi-fragmentation fracture of the bones in/3 of the lower leg with damage to the tibial arteries - 2; damage to the bones of the c/3-n/3 lower leg with damage to the tibial arteries - 3.

Subsequently, in 30 (33%) cases, patients underwent plastic surgery of skin defects, in 11 (12.5%) cases, osteomyelitis intervention was performed, in 8 (9%) cases, deep venous thrombosis developed, knee arthroplasty was performed in 11 (12.5%) cases one year after the injury, 34 (37.5%) patients in the remote postoperative period developed secondary lymphostasis (chronic lymphovenous insufficiency grade II).

## Discussion

Polytrauma with skeletal damage is one of the most common and difficult to treat, as well as life-threatening, so the study of clinical and organizational problems of treating victims with such trauma is relevant and necessary. Despite the achievements of modern medicine, mortality and disability in conditions of polytrauma with skeletal damage remain quite high, which is associated not only with the severity of lesions, but also with various kinds of complications of a general and local nature that occur both in the early and in the remote period after injury.

It is known that in victims with polytrauma and skeletal damage, traumatic disease follows a more severe variant and is characterized by signs of multiple organ failure, which is the predominant cause of death. The main target organs of traumatic disease in the period of unstable adaptation are the lungs, brain, liver and kidneys, morphological and clinical signs of insufficiency were detected in 67.8; 44.5; 40.1% and 38.2% of cases [21].

In the first place among patients with skeletal polytrauma [20], fractures of the bones of the lower leg were found, which is comparable to the data obtained in this study (77; 70%).

The main task of prehospital care is the speedy restoration of vital functions and the fastest delivery of victims to the trauma

center [22-24]. Analysis of the experience of providing medical care to victims under the American EMSS system made it possible to formulate the idea of the «golden hour of shock» of emergency care, since it is in the first 60 minutes after the injury, in fact, that the fate of the victim is decided. Subsequently, the concept of Platinum Ten Minutes appeared - the time when prehospital care measures should be started. Numerous studies confirm a decrease in mortality due to polytrauma, if the delivery of the victim to a specialized hospital does not exceed one hour [25]. The best way to achieve this goal is to transport the victims by specialized helicopters with the implementation of intensive care and resuscitation measures during the evacuation process.

The development and solution of issues of safe transport of victims with polytrauma and skeletal damage will increase the effectiveness of intensive care during transportation and reduce the mortality of patients in this category [15]. Immediate assistance at the scene of the case should be carried out within the first («golden») hour from the moment of injury [15,27,28]. In such a situation, the role of emergency medical care at the prehospital stage is crucial. Therefore, determining the adequacy of providing medical care to victims, especially with multiple and combined trauma, at the prehospital stage and developing optimal approaches to it is an important medical and social problem, the solution of which should be considered at the state level.

It is proved that the risk of death in polytrauma is much lower in the case of assistance in the trauma center than in a non-specialized hospital. Based on this, the American system of prehospital care and trauma centers has received deserved recognition in most European countries [29,30]. Advanced Trauma Life Support (ATLS) is a protocol of the American College of Surgeons for the treatment of victims with severe injuries, approved as the «gold standard» in most European countries since 1990 [31,32].

According to the results of the study, a positive result of treatment was noted in 73 (79%) cases in patients with earlier delivery to a specialized hospital in Donetsk region (2-5 hours from the beginning of the injury). Patients of this group were in a state of combined shock II degree (moderate), had acute ischemia of the lower limb IIa - IIb degree, which is considered reversible according to the Savelyev-Rutherford classification, subject to urgent (immediate) revascularization.

## Conclusions

The structure of combined bone and vascular occupational injuries of the extremities is dominated by mine injuries - 102 (82.9%) cases with damage to the femur, tibia and damage in the basin of the popliteal artery - 116 (78.9%) cases.

The most favorable outcome of two-stage reconstructive surgical treatment of industrial combined bone-vascular injuries of the lower extremities is indicated in the early delivery of the injured to specialized hospitals (up to 2 hours) with anti-shock therapy in the early stages of care.

In 73 (79%) cases, a positive result of treatment was achieved: preservation of the supporting function of the limb, improvement of the quality of life of the injured.

The unfavorable outcome was due to the severity of shock, massive blood loss, long preoperative and surgical periods, the severity of reconstruction of ischemia, the young age of the patient, the absence of compensatory mechanisms for acute limb ischemia.

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