



TACTICS OF TREATMENT OF GUNSHOT WOUNDS OF THE LIMB IN CONDITIONS OF MILITARY CITY SURGERY

Professor E.S. Djumabaev, Mirzaev K.K., Djumabaeva S.E., Saidkhodjaeva D.G., Pakirdinov A.S.
Andijan State Medical Institute Republic of Uzbekistan

Article history:	Abstract:
<p>Received: August 8th 2022 Accepted: September 8th 2022 Published: October 14th 2022</p>	<p>Purpose. Optimization of tactics for the treatment of gunshot bullet wounds of the extremities in the conditions of military-urban surgery. Methods. The experience of treating 169 wounded with gunshot bullet injuries of the limbs as a result of terrorist attacks and counter-terrorist operations in the Andijan region (Uzbekistan) is presented. The studies were carried out at the Department of Hospital and Faculty of Surgery of the Andijan State Medical Institute. All the wounded were divided into 4 groups, depending on the type of wounds and the nature of complications. Each of the groups included the main subgroup, in which the methods of regional lymphatic therapy were used, and the control group, in which therapeutic measures were carried out without the use of methods of lymphatic therapy. Characteristics of the groups: I - isolated wounds of the soft tissues of the extremities (59 wounded): main - 40, control - 19. II - gunshot bone fractures, without extensive soft tissue defect (31 wounded): main - 16, control - fifteen. III-gunshot bone fractures with extensive soft tissue injuries (42 wounded): the main one - 26, the control one - 16. IV - infectious complications of gunshot wounds to the extremity (37 wounded): main - 25, control - 12. Experimental studies on animals are presented, with a model of a gunshot wound of a limb, a study of the pharmacokinetics of antibiotics, as well as light and electron microscopy. Results. An important role of the lymphatic system during the wound process was revealed. Regional lymphatic therapy provides high concentrations of antibiotics in the pathological focus and in the lymphatic channel, limits the area of necrosis, prevents the development of purulent-septic complications, and creates conditions for more physiological tissue remodeling. Early "saving" primary surgical treatment of wounds and gunshot fractures, using reconstructive, restorative, microsurgical approaches, "orthopedic damage control" tactics, contributed to a decrease in the observed groups of suppuration of the n/o wound to 5-20%, osteomyelitis to 6.2-13.3%, systemic inflammatory response syndrome - 2.5-6.6%, limb amputations to 3%. Conclusion. Features of military-urban surgical tactics, with the possibility of early delivery of the wounded to the stage of specialized medical care, make it possible to optimize the treatment of gunshot wounds of the extremities, reduce the frequency of purulent-septic complications and amputations of the extremities.</p>

Keywords: Military-urban surgery, gunshot wounds of extremities, regional lymphatic therapy.

INTRODUCTION. The processes of urbanization and globalization, as well as turbulent socio-demographic and political events in the modern world, cause armed conflicts to increasingly arise in cities and towns. At the same time, not infrequently, injuries among the civilian population are massive [5,6,7,15,16]. For all the seemingly inviolability of the military field doctrine, which has proven its worth over the centuries of medical support in military conflicts, it becomes obvious that it needs to be improved in the modern

conditions of urbanized armed clashes. Suggested by B.V. Petrovsky and other authors [10, 15], "military-urban", "military-extreme" or "military-civilian" surgical tactics, due to the possibility of early provision of specialized, high-tech medical care and improvement of therapeutic approaches in hospitals of the city and settlements, certainly deserves attention. In addition, recurring terrorist attacks and counter-terrorist armed operations, as well as larger-scale armed conflicts in cities and villages, show that "civilian" surgeons lack



experience in treating combat injuries, especially in the mass flow of victims [7,10,15].

In modern armed conflicts, gunshot wounds often dominate in the structure of mortality. Gunshot injuries during terrorist attacks and local wars cause death: in the focus of hostilities in 30-60% of cases, on medical evacuation routes - in 40-60%, at the stages of providing specialized medical care - in 8-15% of cases [2,3,11,12,14]. Noteworthy is the high proportion of gunshot bullet injuries of the extremities observed in 46-80% of cases, accompanied by injury to bones - in 20-45%, joints - 10-22%, blood vessels and peripheral nerves - 7-18% of the case [2,3, 10,14]. Early and late complications observed with these injuries in the form of limb amputations in 14-40% of cases, purulent-septic processes (wound infection: 15-35%, osteomyelitis: 25-30%, sepsis: 1.6-7%), contractures , ankylosis, paralysis, etc., in 15-60% of cases, determine the relevance of the problem under consideration [2,3,10,11,13,14].

 Purpose of the study. Optimization of tactics for the treatment of gunshot bullet injuries of the extremities in the conditions of military-urban surgery.

Material and research methods. We present the experience of treating 169 wounded with gunshot bullet injuries to the limbs as a result of terrorist attacks and counter-terrorist operations in the Andijan region [1]. The studies were carried out at the Department of Hospital and Faculty Surgery of the

Andijan State Medical Institute, located in the Andijan branch of the Republican Scientific Center for Emergency Medical Care (Uzbekistan).

All the wounded were divided into 4 groups, depending on the type of wounds and the nature of complications. Each of the groups included the main subgroup, in which the methods of regional lymphatic therapy were used according to the protocols approved by the AFRSCEMC, and the control subgroup, in which therapeutic measures were carried out without the use of methods of lymphatic therapy. The distribution of the wounded by subgroups depended on the emerging medical and tactical situation (transfer of the wounded from other medical institutions, the intensity of admission, etc.) and was random.

Tables 1,2,3,4,5,8 show the distribution of the wounded by groups, gender, age, terms of medical care, localization, nature of injuries, type of surgical interventions and complications. Distribution of the wounded by groups: I - isolated wounds of the soft tissues of the extremities (59 wounded): main - 40, control - 19. II - gunshot bone fractures, without extensive soft tissue defect (31 wounded): main - 16, control - 15. III - gunshot bone fractures with extensive soft tissue injuries (42 wounded): main - 26, control - 16. IV - infectious complications of gunshot wounds of the extremities (37 wounded): main - 25, control - 12

Table 1 Distribution by sex and age (n=169)

Groups of the wounded	Sex				Age											
	Husband		wives		Up to 20 years		21 - 30		31 - 40		41 - 50		51 - 60			
	o	k	o	k	o	k	o	k	o	k	o	k	o	k		
I (n=59)	39	18	1	1	4	3	18	8	5	-	10	7	2	2		
II (n=31)	16	15	-	-	4	3	6	5	5	5	1	2	-	-		
III (n=42)	26	16	-	-	5	3	10	6	8	5	3	2	-	-		
IV (n=37)	25	12	-	-	4	2	8	3	8	4	4	2	1	1		
All	106	61	1	1	17	11	42	22	26	14	18	13	3	3		

Note: o-main subgroup; k-cotrol subgroup

Table 2
 Terms of first qualified and specialized medical care

Timing income	First medical care (n=169)		Qualified second aid (sub-branches and other health facilities) (n=37)		Specialized assistance-AF RRC MP (n=169)	
	Abs.	%	Abs.	%	Abs.	%
Up to 1 hour	124	73,4	24	64,8	100	59,2
Up to 2 hour	24	14,2	8	21,6	19	11,2
Up to 3 hour	21	12,4	5	13,6	13	7,8
*from 3 hours to 2	-	-	-	-	37	21,8



sytok						
Total:	169	100	37*	100	169	100

The wounded brought from sub-branches-regional divisions of the EMP and other hospitals

Table 3
 Localization and nature of gunshot wounds

Nature of injury	Upper limb (n=78)				Lower limb (n=91)				All	
	Shoulder		Forearm		Hip		Shin			
	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Soft wounds fabrics isolated-	17	10	11	6,5	22	13	15	8,9	65	38,4
Injuries from bone injury-										
Isolated-	10	5,9	9	5,3	18	10,6	36	21,4	73	43,2
-multiple	3	1,8	4	2,4	3	1,8	5	2,9	15	8,9
-combined	5	2,9	4	2,4	2	1,1	5	3,0	16	9,5
Total:	35	20,7	28	16,6	45	26,6	61	36,1	169	100

The technique of regional lymphatic therapy consisted in stimulation of lymphatic drainage from the affected limb (decongestant therapy) and lymphotropic antibiotic therapy. Technique: subcutaneously, 16-32 units of lidase diluted in 0.5%-20.0 novocaine solution are injected along the back surface of the foot or hand, without removing the needle, a heparin solution (70 units / kg) is injected after 5 minutes, then, after tightening the needle by 0.5 cm, an antibiotic is injected in a single therapeutic dose. Antibiotics were

administered once a day, as a rule, aminoglycoside and cephalosporin preparations were used, with a course of 5-8 days. The clinical application of the method is justified by experimental studies on animals, with a model of a gunshot wound of a limb, the study of data on the pharmacokinetics of antibiotics, as well as light and electron microscopy [10,11]. The maintenance and use of laboratory animals corresponded to the rules adopted by the Andijan State Medical Institute and the Nazi

Table 4
 Characteristics of combined gunshot wounds

Combined injuries	Abs.	%
Limb + Head	3	1,8
Limb + chest	6	3,5
Limb + Abdomen	3	1,8
Limb + pelvis	2	1,2
Limb+ Spine	2	1,2
Total:	16	



Table 5
Characteristics of surgical interventions

Type of operations	I gr. (n=59)		II gr. (n=31)		III gr. (n=42)		IV gr. (n=37)		total n=169
	o n=40	k n=19	o n=16	k n=15	o n=26	k n=16	o n=25	k n=12	
PHO, primary Seam	33	15	-	-	-	-	-	-	48
Primary-delayed suture	4	2	-	-	8	3	19	7	43
Plastic with local fabrics	-	-	-	-	8	5	-	-	13
Autodermoplasty with a free split flap	3	2	-	-	10	8	6	5	34
Primary Extracellular osteosynthesis (PEMO):									
- without bone autoplasty	-	-	10	10	-	-	-	-	20
- with bone autoplasty	-	-	6	5	-	-	-	-	11
Extra-focal osteosynthesis (VO)									
without bone autoplasty	-	-	-	-	22	13	-	-	35
with bone autoplasty	-	-	-	-	4	3	-	-	7
Total operations:									211

Note: o is the main subgroup; k is the control subgroup.

The results of the study. Our studies [8] revealed the important role of the lymphatic system and its drainage function in the course and outcome of the wound process. A gunshot injury, already in the early stages after injury, is characterized by swelling of the intercellular space, with the spread of microbes and necrobiosis products in the interstitial, lymphatic

vessels and lymph nodes. The increasing volume of edematous fluid leads to a violation of microcirculation with the development of lymphatic drainage insufficiency, the accumulation of microbes and dysmetabolism products in the zone of molecular concussion. (Fig.1,2,3,4).

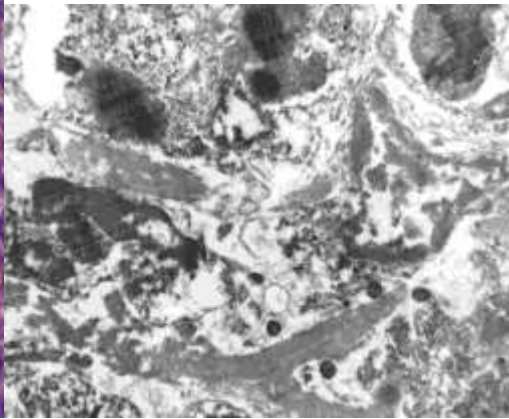
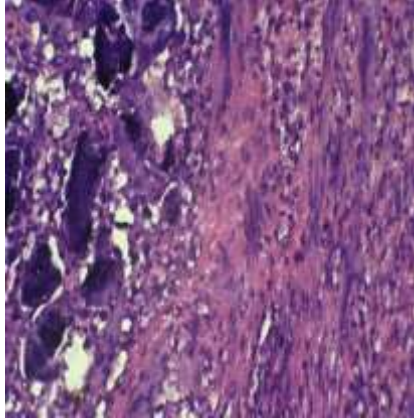


Fig. 1. Edema, infiltration stagnant microvessels at the border of the primary and secondary necrosis zone. 3 days after the injury. Control. Hematoxylin-eosin (G-E) 10x16
 Fig. 2 Fibrin, cellular detritus in the necrosis zone and the commotion of the wound. 3 days after the injury. Control. Transmission electron microscopy (TEM)x7500.

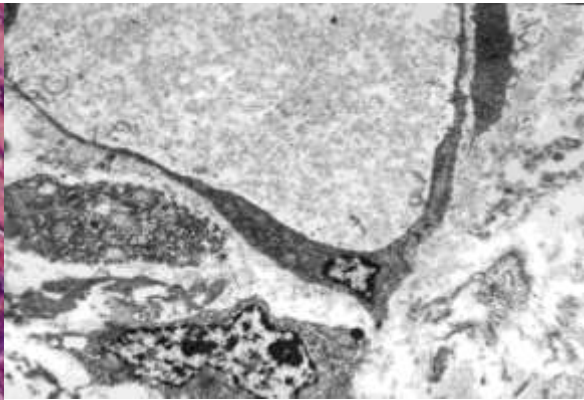
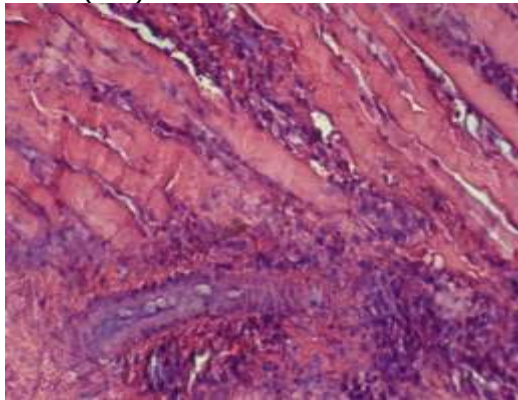


Fig. 3. Dilated lymphatic capillaries and interstitial edema at the border of the zone of commotion and lumen. 5 days after the injury. Control. G-E 10x16.
 Fig. 4 Lymphatic capillary with dilated undamaged tissue. 7 days of injury. Control of TEM X 7500.

With untimely surgical care, antibacterial and decongestant therapy, new areas of the molecular concussion zone are involved in the pathological process, with an increase in the area of necrosis and the development of infectious complications (Fig.5).

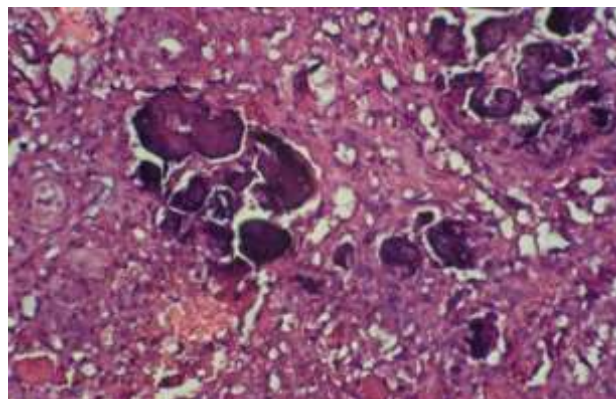


Fig. 5 Necrotized myocytes, giant cells foreign bodies of the commotion zone. 5 batches after being wounded.

Control. G-E 10x16.

Regional lymphotropic administration of antibiotics and stimulation of lymphatic drainage of the pathological process zone reanimate tissues in a state of parabiosis, contribute to the restriction of the necrosis zone, prevent the development of purulent-septic process, create conditions for more physiological remodeling of affected tissues. (Fig.6,7,8).

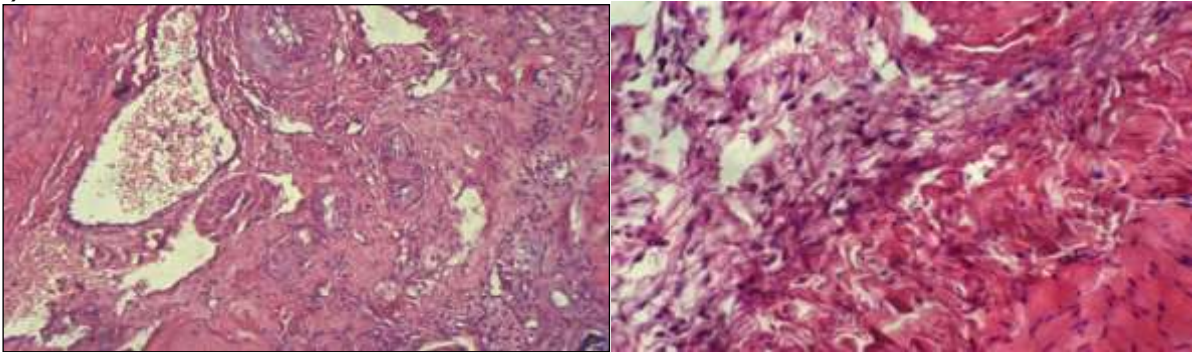


Fig. 6 Reduction of edema, infiltration and diameter Fig.7 The beginning of wound remodeling, abundant proliferation of microvessels of the molecular concussion zone. 5 days of weakly vascularized granulation tissue. after being wounded. Lymphotherapy. G-E 10x16. 7 days after the injury. Control. G-E 10 X 16.

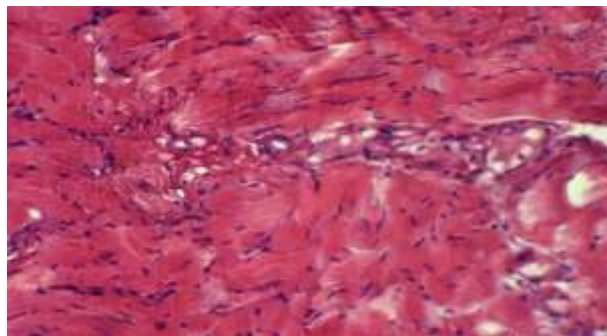


Fig. 8 Thin layers of connective tissue, accelerated

The determination of the content of antibiotics showed that generally accepted methods of administration do not create prolonged therapeutic concentrations of antibiotics both in the tissues of the area of the gunshot wound and in regional lymph nodes, which contributes to the progression of the infectious-septic

process. Lymphotropic administration of antibiotics provides a longer accumulation of inhibitory concentrations of drugs in the pathological focus and in the lymphatic bed- on the path of infection, which is an important measure for the prevention of purulent-septic process (Tables 6,7,8)

Table 6

The content of gentamicin (mcg / g) after a single intramuscular injection, at a dose of 1 mg / kg, in the lymph nodes and soft tissues of the limb

Biological substrate	Time after administration(h)	
	6	24
Inguinal lymph nodes	Footprints	No
Muscles	Footprints	No
Subcutaneous tissue	Footprints	No



Table7

The content of gentamicin (mcg / g) after a single lymphotropic injection, at a dose of 1 mg / kg, in the lymph nodes and soft tissues of the limb

Biological substrate	Time after administration(h)	
	6	24
Inguinal lymph nodes	2,25 ± 0,26*	1,02 ± 0,22*
Muscles	1,55 ± 0,13*	0,2 ± 0,06*
Subcutaneous tissue	1,13 ± 0,4	0,1 ± 0,03*

* P<0.005 when compared with intramuscular administration.

Our research and literature data [5,6,8,9] indicate the need to highlight the important components of the modern treatment of gunshot wounds. The first is early delivery to the stage of specialized surgical care. The second is early primary surgical treatment of wounds, using a reconstructive and restorative approach in the treatment of damaged structures. The third is rational antibacterial and decongestant therapy.

The described medico-tactical approach, as our experience has shown, can be implemented in many respects in the conditions of military-urban medical care. The modernized system of emergency medical care in Uzbekistan ensures the provision of qualified and specialized emergency medical care during the "golden hour" in almost any region of the republic. The work of the system is coordinated by the Republican Scientific Center for Emergency Medical Care (RSC EMC) in Tashkent. Its structure includes 14 regional branches and 174 sub-branches (district branches of EMP). The system includes ambulances "103", air ambulances and rapid response teams with emergency depots. As our experience has shown, the described EMF structure provides the maximum conditions for timely response to emergencies of various origins [8].

The first and qualified medical aid was rendered within the first 3 hours after the gunshot wound to the overwhelming number of victims. More than 78% of the wounded received specialized assistance during this period (Table 2). Ambulances delivered 23% of the victims. First aid consisted of anesthesia, temporary stop of bleeding, application of an aseptic dressing and immobilization. For the wounded who were admitted to the hospital by gravity, first aid was provided at the level of the admissions department. It included the elimination of defects in the provision of medical care of the previous stage, in the form of additional immobilization, conduction novocaine

blockade, the introduction of tetanus toxoid, etc. surgical departments.

The low intensity of the arrival of victims in the emergency department (up to 10 wounded per hour) allows, along with sorting, to provide first aid. In case of mass admission of the wounded (more than 10 victims per hour), reorganization of the admission department is required, according to pre-approved protocols. The admission department under these conditions only sorts the flow of the wounded into operating rooms, dressing rooms, plastering, or surgical wards and resuscitation departments.

Diagnostic measures in the conditions of military-urban surgery can be carried out quite early and include ultrasound dopplerography, computed tomography, if necessary, endovisual diagnostic methods, etc. to carry out the whole complex of necessary instrumental and laboratory diagnostics. The accelerated implementation of the required volume of specialized medical and diagnostic care for victims with gunshot wounds was facilitated by the presence in the regular structure of EMT units of such specialists as microsurgery, ENT, maxillofacial surgeons, specialists in purulent-septic surgery, etc. For the timely implementation of early specialized medical care, the possibility of re-profiling a number of EMP units is of great importance.

With a large flow of wounded, in a short time, the dressing rooms were equipped with small operating rooms and plastering rooms. The necessary stock of beds is replenished by converting therapeutic beds into surgical beds.

The rapid delivery of victims to the stages, qualified and specialized medical care, in the conditions of military-urban surgery, allows us to improve the approaches to treatment tactics, while it is necessary to remember about the timely provision of security for medical institutions. Within a few hours after the start of the terrorist attacks, the perimeter of



the Andijan branch of the RSCEMC was provided with paramilitary guards [8].

The vast majority of victims with soft tissue injuries underwent early primary surgical treatment of wounds (PSW), including dissection, excision of non-viable tissues and restoration of damaged structures (Table 5). Primary surgical treatment was not carried out with shallow and tangential wounds, as well as in the wounded in an agonal state. The use of early active surgical tactics and regional lymphatic therapy in the main subgroup provided a more favorable course of the wound process.

In case of injuries of peripheral nerves, tendons and main vessels, an important feature of military-urban surgical tactics is the possibility of early use of reconstructive-restorative and microsurgical approaches. In the wounded with bone injuries, the conditions of military-urban surgery made it possible in 82% of cases to apply the tactics of "saving" primary surgical treatment of gunshot fractures [2,3]. It consisted of the following:

- only small free-lying bone fragments are removed, with maximum preservation of bone tissue.
- with gunshot fractures, without significant displacement of fragments, with a small inlet and outlet of the wound channel, without bleeding and intense hematomas, primary surgical treatment is not indicated. In these wounded, the fracture was immobilized with the Ilizarov apparatus with adequate drainage and regional lymphatic therapy.
- for comminuted fractures with significant damage to soft tissues, transosseous stable extrafocal osteosynthesis by the Ilizarov method was used.
- after performing the primary surgical treatment, in most cases (66%), the wounds were sutured with a primary suture, or were performed using a semi-closed method (34%). We used regional lymphotropic antibiotic therapy with regional stimulation of lymph flow, as well as flowing drainage of the wound.
- fasciotomy was an important element of PHO.

Victims with wounds of large joints (5 cases) in the conditions of military-urban medical care used an early specialized tactic:

- in the wounded, without damage to the bone, according to indications, only a puncture of the joint was performed with immobilization with a plaster splint.

- in case of significant damage to the bone tissue, arthrotomy was performed, surgical treatment of the wound with the establishment of inflow-outflow drainage in the joint cavity.

- in the wounded with significant bone damage, arthrotomy, joint resection and external hardware immobilization were performed. In case of injuries of the main vessels, the capabilities of a military-city surgeon allow the use of Doppler ultrasound, contrast angiography, as well as a microsurgical and reconstructive-restorative approach. All 12 (7.1%) wounded with damage to the main vessels underwent surgical intervention with the participation of a vascular surgeon. The final hemostasis was carried out by: using a lateral suture in 2 wounded, a circular suture in 7, plasty with an autovein in 3. Due to irreversible ischemia and gangrene, limb amputation was performed in 5 cases (3%).

With damage to the peripheral nerves, under our supervision were 6 (3.5%) wounded: median - in 1 case, femoral - 2, tibial - 1, radial - 2. The possibilities of military-urban surgery made it possible in all cases to perform early reconstructive and restorative interventions by a microsurgeon using magnifying optics.

In the wounded with multiple and concomitant trauma (Table 4), the tactics of "orthopedic damage control" (software surgical treatment technology) were used. This tactic was successfully used by us in 11 wounded with severe concomitant trauma. A feature of this tactic was the division of fracture treatment into several periods [13,14]. At the first stage, emergency operations were performed on the organs of the abdominal and thoracic cavities, head and main vessels. After stabilization of the condition to the level of severity, according to the APPACHE scale 25-30 points, SBP - not less than 90 mm Hg, minimally invasive osteosynthesis with the Ilizarov apparatus was performed.

In order to reduce the time and reduce the severity of the surgical injury, the task of precise reposition was not set. At the second stage, in the intensive care unit, complex intensive therapy was carried out. After stabilization of the condition (APPACHE index less than 15 points), they proceeded to the third stage (days 6-11).

It consisted in the final fixation, due to the remounting of the devices under the control of digital fluoroscopy.

Treatment of 37 victims with purulent-septic complications of wounds of the extremities in the conditions of an urban multidisciplinary medical institution made it possible to ensure the isolation of these wounded in the department of purulent-septic surgery. They were provided with specialized medical care in the form of dynamic software control over the course of the wound process, including bacteriological and cytological studies, the use of ultrasound and X-



ray diagnostics, as well as minimally invasive technology for semi-closed management of purulent wounds. The use of lymphotropic antibiotic therapy

contributed to a more favorable course of local and generalized surgical infection (Table 8).

Table 8
 Infectious complications of gunshot wounds of extremities depending on the type of surgical interventions

Type of operation	Total wounded		Complications											
			suppuration of the wound				Osteomyelitis				systemic inflammatory reaction syndrome			
	o	k	o		k		o		K		o		k	
			abs	%	abs	%	abs	%	abs	%	abs	%	abs	%
PHO soft tissue wounds with Suturing	40	19	2	5	2	10,5	-	-	-	-	1	2,5	1	5,2
Primary extracellular osteosynthesis	16	15	2	12,5	3	20	1	6,2	2	13,3			1	6,6
Out-of-hours osteo-synthesis	26	16	2	7,7	3	18,5	2	7,6	2	12,5	1	3,8	1	6,2

* P<0.005 when compared with intramuscular administration.

Our research and literature data [5,6,8,9] indicate the need to highlight the important components of the modern treatment of gunshot wounds. The first is early delivery to the stage of specialized surgical care. The second is early primary surgical treatment of wounds, using a reconstructive and restorative approach in the treatment of damaged structures. The third is rational antibacterial and decongestant therapy.

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of military-urban surgery made it possible in all cases to perform early reconstructive and restorative interventions by a microsurgeon using magnifying optics.

In the wounded with multiple and concomitant trauma (Table 4), the tactics of "ortopedic damage control" (software surgical treatment technology) were used. This tactic was successfully used by us in 11 wounded with severe concomitant trauma. A feature of this tactic was the division of fracture treatment into several periods [13,14]. At the first stage, emergency operations were performed on the organs of the abdominal and thoracic cavities, head and main vessels. After stabilization of the condition to the level of severity, according to the APPACHE scale 25-30 points, SBP - not less than 90 mm Hg, minimally invasive osteosynthesis with the Ilizarov apparatus was performed.

In order to reduce the time and reduce the severity of the surgical injury, the task of precise reposition was not set. At the second stage, in the intensive care unit, complex intensive therapy was carried out. After stabilization of the condition (APPACHE index less than 15 points), they proceeded to the third stage (days 6-11).

It consisted in the final fixation, due to the remounting of the devices under the control of digital fluoroscopy.

Treatment of 37 victims with purulent-septic complications of wounds of the extremities in the conditions of an urban multidisciplinary medical institution made it possible to ensure the isolation of these wounded in the department of purulent-septic surgery. They were provided with specialized medical care in the form of dynamic software control over the course of the wound process, including bacteriological and cytological studies, the use of ultrasound and X-ray diagnostics, as well as minimally invasive technology for semi-closed management of purulent wounds. The use of lymphotropic antibiotic therapy contributed to a more favorable course of local and generalized surgical infection (Table 8).

CONCLUSIONS.

1. Features of military-urban surgical tactics, with the possibility of early delivery of the wounded directly to the stage of specialized medical care, make it possible to optimize the treatment of gunshot wounds of the extremities, reduce the number of purulent-septic complications and reduce the frequency of limb amputations to 3%.

2. Regional lymphotropic antibiotic therapy with stimulation of lymphatic drainage provides a

prolonged and higher content of antibiotics both in the tissues of the gunshot wound and in the regional lymph nodes. This contributes to a more favorable course of the wound process.

3. The conditions of military-urban medicine make it possible to ensure a quick transition to a more intensive level of service, due to the reprofiling of EMP units, the accelerated mobilization of qualified medical personnel, including allied and "narrow" specialists.

4. The advance development of standards and protocols for military-city medical care, as well as the preparation of the medical administration and civilian doctors to work in conditions of terrorist attacks and local armed conflicts is one of the important tasks of modern healthcare.

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