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## ORGANIZATION OF SORTING AND SURGERY OF WOUNDS WITH SOFT TISSUE DEFECTS DURING THE JOINT FORCE SURGERY

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#### **Personal contribution of the authors**

Khomenko IP - Research concept;

Lurin IA - Research design;

Korol SO - Collection of material;

Shapovalov VYu - Writing the text;

Hrebennikov KO - Formulation of conclusions;

Halushka AM - Statistical data processing;

Matviichuk BV - Introduction of the methodology at the second level of medical care;

Tertyshnyi SV - Implementation of the methodology at the third and fourth levels.

#### **Abstract**

**Introduction.** The experience of providing medical care during the Anti-terrorist operation in eastern Ukraine showed that in the structure of modern combat surgical trauma gunshot wounds with soft tissue defects are between 64.9-68.2%, of which 36.4-37.5% are small and medium, 28.5-30.7% are large and very large defects.

**Aim:** To improve the results of providing surgical care to the wounded with soft tissue defects by introducing a variety of surgical tactics of wound closure to the medical care levels.

**Material and Methods.** The total array of the study was 2537 wounded with shrapnel, bullet and mine injuries from April 2014 to September 2018. The determination of surgical tactics for closing soft tissue defects was performed at the basis of metric classification taking into account the area, volume and anatomical areas of the lesion.

**Results.** The combination of metric characteristics of wound defects by area, volume with localization of wounds in a single classification allowed the offer of a comprehensive approach to sorting the wounded at the level of medical care and to determine further surgical tactics to close soft tissue defects. In accordance with the sorting and evacuation purposes, the wounded with gunshot wounds to the foot and hand (third zone of injury) were treated in specialised centres to the fourth level of medical care. In the case of medium and large wounds of the thigh, leg, shoulder and forearm, medical care was provided at the second and

third levels. And in the case of large and very large wounds of the specified localisation was provided in specialised clinics of the fourth level.

**Conclusions.** The introduction of differentiated surgical tactics in the wounded with soft tissue defects at the levels of medical care has improved functional results: increase the proportion of good from 46.9% to 53.7%, reduce the relative number of unsatisfactory from 18.8% to 11, 6%.

**Key words: differentiated surgical tactics; gunshot wounds; Mine injuries; Soft tissue defects; Surgical care.**

### **Introduction**

The experience of the Anti-Terrorist Operation in eastern Ukraine showed that in the structure of modern combat surgical trauma gunshot wounds with soft tissue defects are observed in 64.9-68.2%, of which 36.4-37.5% are accompanied by small and medium, and 28.5-30.7% are large and very large defects [1, 2, 3].

To date, no sorting and evacuation principles and basic provisions for differentiated surgical tactics have been developed for the treatment of wounded with soft tissue defects. The choice of method for closing the defects in the wounded with combat surgical trauma is decided in accordance with the experience of the surgeon and the capability levels of medical support [4, 5, 6].

**Aim:** To improve the results of providing surgical care to the wounded with soft tissue defects by introducing differentiated surgical tactics for closing wounds at the level of medical care.

### **Material and Methods**

The total sanitary losses of the surgical profile for the period from 2014 to 2018 of the Anti-Terrorist Operation / Joint Forces Operation in the Armed Forces of Ukraine amounted to 3776 (100%) wounded. Of these, injuries of the extremities were observed in 2051 (54.3%), head and spine were 1041 (27.5%), 379 (10.1%) chest, 192 (5.1%) abdomen and 113 (3.0%) pelvis.

Those selected for the study were exactly 2735 (72.4%) wounded with injuries to the chest, abdomen, pelvis and limbs with combat surgical trauma. These men had an average age of  $33.7 \pm 4.1$  years were the total array of the study. The vast majority of the wounded received shrapnel damage were 2293 (83.8%), bullet damage were 375 (13.7%) and Mine explosion 67 (2.5%). Isolated combat surgical trauma was observed in 1517 (55.5%), multiple in 635 (23.2%) and combined in 583 (21.3%). Dominant injuries of the torso were observed

in 684 (25.0%), thighs in 613 (22.4%), legs in 489 (17.9%), shoulders in 355 (13.0%), forearms in 233 (8.5%), hands in 182 (6.7%) and feet in 179 (6.5%).

According to the characteristics of injuries, in 1824 (66.7%) cases, blind injuries were observed in 692 (25.3%) through, 189 (6.9%) tangential and 30 (1.1%) limb tears.

To determine the main metric characteristics of the wounds, the length (the largest distance between the edges of the wound), width (the largest perpendicular to l segment h) and depth (the largest perpendicular from the plane to the bottom of the wound d) were measured. The area of the wound (S) in square centimeters was determined by the formula:

$$S = l \times h / 2,$$

where l is the length of the wound, h is the width of the wound.

When conducting planimetric studies of the wound defect, in addition to the total area of the wound, determined the volume of the wound defect in cubic centimeters by the formula:

$$V = l \times h / 2 \times d / 4,$$

where h is the width of the wound, d is the depth of the wound.

Determination of differentiated surgical tactics for closing soft tissue defects was carried out on the basis of the metric classification of gunshot wounds developed by the staff at the Ukrainian Military Medical Academy [5].

The metric classification was created by analyzing the clinical-anatomical and clinical-epidemiological characteristics of combat surgical trauma, area and extent of damage, taking into account the anatomical areas (Table 1).

Table 1. Classification of wound defects by area, volume and location

Zones of damage (localization)	Metric parameters	The size of the wound defect			
		< 2	2-10	11-20	> 20
	length, cm	< 2	2-10	11-20	> 20
	area, cm <sup>2</sup>	< 2	2-50	51-200	> 200
	volume, cm <sup>3</sup>	< 2	2-125	126-1000	> 1000
first (torso, thigh)		small	medium	large	extra large
second (shin, shoulder, forearm)		medium	large	extra large	-
third (brush, foot)		large	extra large	-	-

## Statistical analysis

The values are expressed as median [interquartile range — IQR] if it is not stated otherwise. The non-parametric Mann-Whitney U test was used to test for a group differences in continuous variables. Two-tailed Fisher's exact test was applied to test for a group differences in categorical variables. Data were analysed using STATISTICA 8.1 (StatSoft). All statistical significance levels were set at  $p \leq 0.05$ .

## Results

We conducted a comparative analysis of the metric characteristics of gunshot wounds. In accordance with the developed classification of soft tissue defects, small gunshot wounds were observed in 485 (17.7%), medium in 1481 (54.2%), large in 654 (23.9%) and ultra-large in 115 (4.2%) cases (Table 2).

Table 2. Characteristics of gunshot wounds according to the developed classification of wound defects

Wound defects according to the classification	The structure of wounds							
	shrapnel		mines		bullets		total	
	Abs.	Specific weight,%	Abs.	Specific weight,%	Abs.	Specific weight,%	Abs.	Specific weight,%
Small	443	19,3	0	0	42	11,1	485	17,7
Medium	1279	55,8	2	3,0	200	53,5	1481	54,2
Large	514	22,4	24	35,8	116	31,0	654	23,9
Extra large	57	2,5	41	61,2	17	4,4	115	4,2
Total	2293	100	67	100	375	100	2735	100
Statistical reliability	$\chi^2 = 122.63; p < 0.001$				-	-	-	-
	-	-	$\chi^2 = 104.51; p < 0.001$				-	-

As shown in table. 2, the structure of Mine injuries differed significantly from shrapnel to bullet wounds due to the increase in the area and volume of damage to the extremities, the predominance of large and very large soft tissue defects ( $\chi^2 = 122.63; p < 0.001$  and  $\chi^2 = 149.01; p < 0.001$ , respectively).

There was no significant difference between the structure of shrapnel and bullet wounds ( $\chi^2 = 4.13; p = 0.248$ ). The above results allowed to differentiate between surgical, sorting and evacuation tactics at the levels of medical care depending on the location of the injury, taking into account the metric characteristics.

The combination of metric characteristics of wound defects by area, volume with the localization of the wounds in a single classification allowed to offer a comprehensive approach

to sorting the wounded at the level of medical care and to determine further surgical tactics to close soft tissue defects.

In accordance with the sorting and evacuation purposes, the wounded with gunshot wounds to the foot and hand (third zone of injury) were treated in specialized centres of the Role 3 and Role 4. The casualties with the medium and large wounds of the torso, thighs, legs, shoulders and forearms medical care were provided at the Role 2 and Role 3, the large and very large wounds of the specified localization in specialized clinics of the Role 4 (Table 3).

Table 3. Clinical and organizational approach to providing surgical care to the wounded with soft tissue defects

Injury areas (wound localization)	Level of medical care		
	Role 2 (MMH, CDH)	Role 3 (MH, MMCC, clinical hospitals)	Role 4 (MMCC, NAMS Research Institute, specialized centers)
First (torso, femur)	small + medium	small + medium + large	large + extra large
second (shin, shoulder, forearm)	medium	medium + large	large + extra large
Third (brush, foot)	-	Large	large + extra large

**Notes:** MMH - Military Mobile Hospital, CDH - Central District Hospital, MH - Military Hospital, MMCC - Military Medical Clinical Center, NAMS Research Institute - Research Institutes of the National Academy of Medical Sciences.

The developed and scientifically substantiated characteristics of gunshot wounds of extremities depending on clinical and organizational purposes allowed to create the concept of "reconstructive ladder" at levels of medical support (tab. 4).

For small wounds without damage to the deep structures, primary surgical treatment with extensive wound dissection, excision of necrotic tissue, revision of damaged anatomical structures, fasciotomy and drainage, as well as repeated surgical treatments were mandatory. The wounded, who were referred to the first two steps, were given primary and primary-delayed sutures, mainly on the Role 2 and Role 3, in the absence of inflammation signs.

In the wounded of the third step after the initial surgical treatment, the primary sutures were not applied and the skin plastic surgery was not performed. Wound defects healed on their own by secondary tension under the bandage and secondary sutures at the Role 4 were used if closure was required.

The optimal method of closing superficial wound defects of medium size with a shortage of donor resources was autodermoplasty with a split flap. The advantage of the method was one-time closure, low trauma, technical simplicity.

Table 4. The concept of "reconstructive ladder" at the levels of medical care in the wounded with soft tissue defects

Conditional steps	Method of plastic closing	Level of medical care		
		Role 2 (MMH, CDH)	Role 3 (MH, MMCC, clinical hospitals)	Role 4 (MMCC, NAMS Research Institute, specialized centers)
First	Primary sutures	+	+	-
Second	Primary-delayed seams	+	+	-
Third	Secondary sutures (late, early)	-	+	+
Fourth	Allo- and xenodermoplasty	+	-	-
Fifth	Autodermoplasty	-	+	+
Sixth	Local rags with accidental blood supply	-	+	+
Seventh	Distant whistle flaps	-	+	+
Eight	Distant flaps on the leg with axial blood supply	-	-	+
Ninth	Microsurgical tissue autotransplantation	-	-	+

**Notes:** MMH - Military Mobile Hospital, CDH - Central District Hospital, MH - Military Hospital, MMCC - Military Medical Clinical Center, NAMS Research Institute - Research Institutes of the National Academy of Medical Sciences.

Plastics with local tissues were used in the wounded with deep defects of small areas, provided sufficient mobility of the edges by extensive mobilization and use of plastic subcutaneous fat and muscle. The duration of treatment was significantly reduced by the case of vacuum therapy and ultrasonic cavitation.

The wounded with large soft tissue defects were evacuated to Role 3 and Role 4. To close the wounds, the plastic with full-layer local flaps was used, which provided better functional results, but the risk of complications in particular from the donor wound was high. Excessive soft tissue defects required highly specialized treatment in the R 4. Techniques of free plasticity of tissue complexes were the top of the reconstructive ladder in terms of complexity. This required the necessary knowledge and skills of the operational team and appropriate logistics.

We investigated the functional results of treatment according to the method of Matisa - Luboszyca - Schwarzberg (1980-1985) in the modification of Shevtsov (1995) 1-2 years after injury. It is established that the introduction of differentiated surgical tactics in the wounded with soft tissue defects at the levels of medical care improved functional results, increased the proportion of good from 46.9% to 53.7%, reduced the relative number of dissatisfaction from

18.8% up to 11.6%. The share of wounded who were discharged from the Armed Forces of Ukraine was also reduced from 28.1% to 21.7% ( $p < 0.05$ ).

### **Discussion**

Our Research confirmed the results of scientists [7, 8, 9], who believed that in the case of puncture shrapnel wounds in the absence of damage to the vascular nervous bundle, it is possible to conduct conservative treatment in parallel with comprehensive dynamic monitoring of the wounded with combat surgical trauma.

In contrast to previous Research results [10, 11, 12, 13, 14, 15], showed the lack of conventional Surgical tactics for low-energy gunshot wounds, as well as the following authors [16, 17, 18, 19, 20], are supporters of strict adherence to the medical-diagnostic algorithm for providing medical care to the wounded with combat surgical trauma with soft tissue defects.

We confirmed the scientific hypothesis of some scientists [21, 22, 23] about the possibility of closing gunshot wounds by applying primary-delayed sutures for 5-7 days in the absence of infection signs at the Role 2 and Role 3. At the same time, the results of the study do not correspond to the data of Researchers [24, 25], according to whom it is possible to leave bullets and fragments in the absence of plumbing and damage to vascular-nerve bundles. Foreign bodies must be removed if the medical and tactical circumstances allow and there is expertise in performing such operations with neodymium magnets.

The studies have confirmed the need [26, 27, 28, 29, 30, 31] to perform complex reconstructive and restorative interventions to repair large and very large soft tissue defects at the Role 4.

The studies became the basis for improving the organization of surgical care for the wounded to the level of medical care, which reduced the level of complications from 65.3% to 37.9% ( $p_{\alpha} < 0.05$ ).

### **Conclusion**

1. The proposed and implemented differentiated tactics of treatment of wound defects at the levels of medical care allowed to determine the medical and evacuation purpose of the wounded with combat surgical trauma.

2. Clinical and organizational features of surgical care at the Role 3 are the final treatment of small (17.7%) and medium wounds (54.2%) of soft tissues ( $\leq 50 \text{ cm}^2$ ).

3. The main task of surgical care at the Role 4 is the reconstructive and restorative treatment of combat surgical trauma and the final closure of large and very large soft tissue defects (28.1%).



Conflict of interest. The authors declare no conflict of interest.

## References

1. Franke A, Bieler D, Wilms A, Hentsch S, Johann M, Kollig E. Treatment of gunshot fractures of the lower extremity: Part 1: Incidence, importance, case numbers, pathophysiology, contamination, principles of emergency and first responder treatment. *Unfallchirurg*. 2014;117(11):975-84. doi:10.1007/s00113-014-2635-y. [In German].
2. Khomenko IP, Korol SO, Matviichuk BV. Klinichno-organizaciyni osoblivosti nadania travmatologichnoi dopomogi poranenim z defectami myakih tkanin pri vognepalnih ta minno-vibuhovih ushkodzhinah kincivok. *Trauma*. 2018;5:129-133. doi:1022141/1608-1706.5.19.2018.146655. [In Ukrainian].
3. Zarutskiy YaL, Biliy VYa, editors. Voenno-polova hirurgiya. Kyiv: Fenix; 2018. 552 p. [In Ukrainian].
4. Franke A, Bieler D, Wilms A, Hentsch S, Johann M, Kollig E. Treatment of gunshot fractures of the lower extremity: Part 2: Procedures for secondary reconstruction and treatment results. *Unfallchirurg*. 2014;117(11):985-94. doi: 10.1007/s00113-014-2636-x. [In German].
5. Zarutskiy YaL, Plis I.B., Korol S.O., Kompaniec A.O. Optimizatia etapnogo likuvania poranenih na osnovi metrichnoi klasifikacii defectiv myakih tkanin. *Klin hir*. 2018;2(85):77-80. doi:10.26779/2522-1396.2018.02.77. [In Ukrainian].
6. Zarutskiy YaL, Zaporozhan VM, editors. Voenno-polova hirurgiya. Odesa: Odesky meduniversitet. 2016. 416 p. [In Ukrainian].
7. Al Rawahi AN, Al Hinai FA, Boyd JM, Doig CJ, Ball CG, Velmahos GC, Kirkpatrick AW, Navsaria PH, Roberts DJ. Outcomes of selective nonoperative management of civilian abdominal gunshot wounds: a systematic review and meta-analysis. *World J Emerg Surg*. 2018;13:55. doi: 10.1186/s13017-018-0215-0
8. Dougherty PJ, Najibi S, Silverton C, Vaidya R. Gunshot wounds: epidemiology, wound ballistics, and soft-tissue treatment. *Instr Course Lect*. 2009;58:131-9. PMID: 19385526
9. Singh N, Hardcastle TC. Selective non operative management of gunshot wounds to the abdomen: a collective review. *Int Emerg Nurs*. 2015;23(1):22-31. doi: 10.1016/j.ienj.2014.06.005

10. Abghari M, Monroy A, Schubl S, Davidovitch R, Egol K. Outcomes Following Low-Energy Civilian Gunshot Wound Trauma to the Lower Extremities: Results of a Standard Protocol at an Urban Trauma Center. *Iowa Orthop J.* 2015;35:65-9
11. Engelmann EWM, Roche S, Maqungo S, Naude D, Held M. Treating fractures in upper limb gunshot injuries: The Cape Town experience. *Orthop Traumatol Surg Res.* 2019;105(3):517-522. doi: 10.1016/j.otsr.2018.11.002
12. Franke A, Hentsch S, Bieler D, Schilling T, Weber W, Johann M, Kollig E. Management of Soft-Tissue and Bone Defects in a Local Population: Plastic and Reconstructive Surgery in a Deployed Military Setting. *Mil Med.* 2017;182(11):2010-20. doi: 10.7205/MILMED-D-16-00372
13. Nguyen MP, Como JJ, Golob JF Jr, Reich MS, Vallier HA. Variation in treatment of low energy gunshot injuries - A survey of OTA members. *Injury.* 2018;49(3):570-574. doi: 10.1016/j.injury.2018.01.027.
14. Stefanopoulos PK, Mikros G, Pinalidis DE, Oikonomakis IN, Tsiatis NE, Janzon B. Wound ballistics of military rifle bullets: An update on controversial issues and associated misconceptions. *J Trauma Acute Care Surg.* 2019;87(3):690-698. doi: 10.1097/TA.0000000000002290.
15. Stefanopoulos PK, Pinalidis DE, Hadjigeorgiou GF, Filippakis KN. Wound ballistics 101: the mechanisms of soft tissue wounding by bullets. *Eur J Trauma Emerg Surg.* 2017;43(5):579-586. doi: 10.1007/s00068-015-0581-1
16. Kozusko SD, Liu X, Riccio CA, Chang J, Boyd LC, Kokkalis Z, Konofaos P. Selecting a free flap for soft tissue coverage in lower extremity reconstruction. *Injury.* 2019;50(5):32-39. doi: 10.1016/j.injury.2019.10.045
17. Saldanha V, Tiedeken N, Godfrey B, Ingalls N. Wartime Soft Tissue Coverage Techniques for the Deployed Surgeon. *Mil Med.* 2018;183(9-10):247-254. doi: 10.1093/milmed/usy022
18. Voskresenskiy OV, Abakumov MM, Tarabrin EA. [Thoracic and abdominal injuries caused by air weapons]. *Khirurgiia (Mosk).* 2019;(8):63-68. doi: 10.17116/hirurgia201908163. [In Russian].
19. Weinstein J, Putney E, Egol K. Low velocity gunshot wounds result in significant contamination regardless of ballistic characteristics. *Am J Orthop (Belle Mead NJ).* 2014;43(1):14-18.
20. Tosti R, Rehman S. Surgical management principles of gunshot-related fractures. *Orthop Clin North Am.* 2013;44(4):529-40. doi: 10.1016/j.ocl.2013.06.006

21. van Waes OJ, Halm JA, Vermeulen J, Ashford BG. «The Practical Perforator Flap»: the sural artery flap for lower extremity soft tissue reconstruction in wounds of war. *Eur J Orthop Surg Traumatol.* 2013;23(2):285-9. doi: 10.1007/s00590-012-1133-6
22. von Lübken F, Achatz G, Friemert B, Mauser M, Franke A, Kollig E, Bieler D. Update on gunshot wounds to extremities. *Unfallchirurg.* 2018;121(1):59-72. doi:10.1007/s00113-017-0449-4. [In German].
23. Yıldırım AR, İğde M, Öztürk MO, Ergani HM, Ünlü RE. Delayed bipedicled flap: An alternative and new method for reconstruction of distal leg defect after gunshot trauma: A case report and review of the literature. *Ulus Travma Acil Cerrahi Derg.* 2017;23(6):515-520. doi: 10.5505/tjtes.2017.90016
24. Barner-Rasmussen I, Frisk O, Handolin L, Tukiainen E. Gunshot wounds in Finland. *Duodecim.* 2016;132(22):2080-6. PMID: 29190056
25. Omid R, Stone MA, Zalavras CG, Marecek GS. Gunshot Wounds to the Upper Extremity. *Am Acad Orthop Surg.* 2019;27(7):301-310. doi: 10.5435/JAAOS-D-17-00676
26. Chang EI, Liu J. Prospective Comparison of Donor-Site Morbidity following Radial Forearm and Ulnar Artery Perforator Flap Harvest. *Plast Reconstr Surg.* 2020;145(5):1267-1274. doi: 10.1097/PRS.00000000000006790
27. Ignatiadis IA, Mavrogenis AF, Igoumenou VG, Polyzois VD, Tsiampa VA, Arapoglou DK, Spyridonos S. Gunshot and blast injuries of the extremities: a review of 45 cases. *Eur J Orthop Surg Traumatol.* 2019;29(2):295-305. doi: 10.1007/s00590-018-2350-4
28. Georgescu AV, Matei IR. Propeller perforator flaps in forearm and hand reconstruction. *Eur J Orthop Surg Traumatol.* 2019;29(2):357-366. doi: 10.1007/s00590-018-2323-7
29. Khominets VV, Zhigalo AV, Mikhailov SV, Shakun DA, Shchuhkin AV, Foos IV, Pochtenko VV. [Plastic reconstruction of soft tissue defects of extremities resulted from gunshot with the help of triangular flap]. *Voен Med Zh.* 2015;336(8):17-22. PMID: 26829866. [In Russian].
30. Kokkalis ZT, Papanikos E, Mazis GA, Panagopoulos A, Konofaos P. Lateral arm flap: indications and techniques. *Eur J Orthop Surg Traumatol.* 2019;29(2):279-284. doi: 10.1007/s00590-019-02363-0
31. Korompilias A, Gkias I, Korompilia M, Kosmas D, Kostas-Agnantis I. Reverse sural artery flap: a reliable alternative for foot and ankle soft tissue reconstruction. *Eur J Orthop Surg Traumatol.* 2019;29(2):367-372. doi: 10.1007/s00590-018-2330-8