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

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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 ± 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:

\[ S = \frac{1 \times h}{2}, \]

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:

\[ V = \frac{1 \times h}{2} \times \frac{d}{4}, \]

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).

| Zones of damage (localization) | Metric parameters | The size of the wound defect |
|-------------------------------|------------------|-----------------------------|
|                               | length, cm       | < 2 | 2-10 | 11-20 | > 20 |
|                               | area, cm²        | < 2 | 2-50 | 51-200 | > 200 |
|                               | volume, cm³      | < 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 | Total |
|-----------------------------------------------|-------------------------|-------|
|                                              | shrapnel                | mines | bullets |           |       |
|                                              | 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                      | -    | -                 | -    | -        | -     | -                | -    | -                |

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 flapsas 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 unsatisfaction 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<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 (≤ 50 cm²).

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.

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