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## NON-OPERATIVE TREATMENT OF GUNSHOT WOUNDS OF SOFT TISSUES

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The purpose of the study was to analyze own experience of soft tissues gunshot wounds non-operative treatment. Clinical observations were performed on 829 wounded which were admitted to the Military Medical Clinical Centre of the Northern Region of the Command of the Medical Forces of the Armed Forces of Ukraine. All of the wounded were men. The wounded were randomized on 3 groups according to the needs for primary surgical treatment of the wound. All wounded received the same treatment. Foreign bodies (metal fragments) were partially removed with the help of a modern surgical magnetic tool. A third of all soft tissue gunshot wounds were proved do not require primary surgical treatment. The criteria for primary surgical treatment not performing are soft tissues gunshot wounds of small sizes, of different localization and number without signs of inflammation. Non-operative treatment of soft tissues gunshot wounds includes antibiotic prophylaxis, anti-tetanus toxoid administration, anesthesia, treatment of wounds with antiseptic solutions, aseptic wound dressings. Non-operative treatment of wounded with soft tissue gunshot wounds using the magnetic detection turned out to be highly effective in modern conditions for a significant number of people due to the acceleration of diagnostic process, treatment and recovery and due to entirely medical accompanying advantages.

**Key words:** gunshot wounds, soft tissue, non-operative treatment, magnetic detection

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## НЕОПЕРАТИВНЕ ЛІКУВАННЯ ВОГНЕПАЛЬНИХ ПОРАНЕНЬ М'ЯКИХ ТКАНИН

Метою дослідження був аналіз власного досвіду неоперативного лікування вогнепальних поранень м'яких тканин. Всі 829 поранені були чоловічої статі проходили обстеження та лікування в умовах Військово-медичного клінічного центру Північного регіону за визначений період часу. Поранені були поділені на 3 групи відповідно потреб у первинній хірургічній обробці рани. Всі поранені отримали однакове лікування обробку ран розчинами антисептиків, асептичні пов'язки на рани. Сторонні тіла (металеві осколки) видаляли частково під час маніпуляцій за допомогою сучасного хірургічного магнітного інструменту. Доведено, що третина від всіх вогнепальних ран м'яких тканин не потребує первинної хірургічної обробки. Критеріями не проведення первинної хірургічної обробки є вогнепальні рани м'яких тканин малих розмірів, різної локалізації та чисельності без ознак запалення. Неоперативне лікування вогнепальних поранень м'яких тканин включає в себе антибіотикопрофілактику, введення протиправцевого анатоксину, знеболювання, обробку ран розчинами антисептиків, асептичні пов'язки на рани. Неоперативне лікування поранених з вогнепальними ураженнями м'яких тканин із застосуванням магнітодетекції виявилось високоефективним за сучасних умов на значному контингенті осіб через прискорення процесу діагностики, лікування та відновлення та супровідними перевагами суто медичного характеру.

**Ключові слова:** вогнепальні поранення, м'які тканини, неоперативне лікування, магнітодетекція

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Modern firearms are extremely destructive, and gunshot injuries in a war zone are becoming widespread. It's well-known that 30-35 % of the sanitary losses belong to limbs soft tissues wounds. 68 % of the lightly wounded cases within the sanitary losses structure are due to shrapnel wounds and 32 % are bullet wounds. Isolated injuries were registered in 2/3 of all cases, multiple – in 1/3 cases. Injuries of the extremities prevailed among the wounded – 63 %, including both lower – 38 % and upper – 25 % [1, 4].

The soft tissues gunshot injuries within the structure of modern combat surgical trauma are observed in 64.9–68.2 % [3]. These soft tissues gunshot injuries by location are distributed in the following sequence: limbs injuries – 48.9 %, head injuries – 26.3 %, chest – 9.3 %, abdomen – 4.9 %, burns – 2.7 %, pelvis – 1.5 %, neck – 0.9 % and combined injuries – 22.7 %. Soft tissue wounds according to the type of wound canal are the following: penetrating – 39.6 %, blind – 44.8 % and tangential – 15.6 % [4, 6, 7, 9].

Gunshot wounds, for which primary surgical treatment is not indicated, make up totally till 30 % of all gunshot wounds, but they become later a source of various complications. Therefore, one of important radical aim of the gunshot wound primary surgical treatment is removal of both foreign bodies and free bone fragments which can provoke an additional tissue injury throughout the postponed period [4, 5]. Small superficial (single or multiple) wounds usually do not require surgical intervention at all [3].

Only 14.5 % of active surgeons reported they have an institutional policy for bullet removal according to the 2022 survey. Many clinicians believe that bullet removal and thorough debridement are indicated in all cases. Their scientific opponents believe that that balloon removal and debridement are unnecessary but in these cases one could expect an additional tissue damage or complications such as infection, iatrogenic neurovascular injury, deep vein thrombosis and bleeding [11]. However, specific tissue damage and form of the wound significantly vary and determine the method and degree of intervention.

**The purpose** of the study was to analyze own experience of soft tissues gunshot wounds non-operative treatment.

**Materials and methods.** Clinical observations were performed on 829 wounded which were admitted to the Military Medical Clinical Centre of the Northern Region of the Command of the Medical Forces of the Armed Forces of Ukraine from the beginning of the full-scale invasion of the territory of our country. All of the wounded were men, their average age was  $38.2 \pm 2.4$  years.

All wounded were randomized on three groups as follows. Group I consisted out of 327 persons (39.4 %) who received soft tissue injuries and did not require primary surgical treatment of the wound. Group II consisted out of 254 persons (30.6 %) who had soft tissues combined and/or multiple injuries, some of which required only primary surgical treatment. And group III consisted out of 248 persons (30.0 %) who had soft tissues combined and/or multiple injuries, some of which required primary surgical treatment and other surgical interventions aimed to soft tissue defect closing.

There were the following criteria for inclusion into the study: soft tissue wounds of small sizes, of different localization and number, without signs of inflammation, which did not require primary surgical treatment.

Criteria we used for exclusion out of the study were the following: the medium, severe and extremely severe condition of the wounded, the penetrating wounds into the wound cavity, the presence of vascular and neural structures, joints and bones damage.

All the injured were subjected to general clinical and biochemical blood and urine analysis, blood coagulogram using “Respons 920” (Germany), “Lab Analyt” (China), “HumaClot Duo Plus” (Germany), “Labline 40” and “Sunrise” (Austria) devices with additional BIORAD equipment and BIOSAN.

“Logiq P8P910” (USA) ultrasound device, with a linear L3-12 p sensor with a frequency of 3-12 MHz used for soft tissues ultrasound examination.

Multispiral computed tomography of the head, neck, thoracic and abdominal organs, and pelvis was performed using “Toshiba Activion 16” (Japan) device with a tomograph step of 0.5 mm.

X-rays of the limbs were performed using the complex X-ray diagnostic KRD-50 “INDIASCOP-01” (Ukraine).

All wounded received the same treatment which includes antibiotic prophylaxis, tetanus toxoid, pain relief, wounds treatment with antiseptic solutions, aseptic wound dressings.

Foreign bodies (metal fragments) were partially removed with the help of a modern surgical magnetic tool – with this aim we used a magnetic search tool and a magnetic universal tool for ferromagnetic foreign bodies finding and removing from large wounds [2].

Statistical analysis of the data obtained was performed with the help of “Statistica 10” software (StatSoft, Inc., USA) using modern nonparametric and parametric criteria.

**Results of the study and their discussion.** Based on our distribution of the wounded by clinical groups, group I included the wounded with soft tissues gunshot injuries that did not require operative treatment. Thus, we took multiple wounds of the frontal and lateral surface of the abdomen that do not require primary surgical treatment in the wounded B. (fig. 1 A) and gunshot fragment wounds of the soft tissues of the right lower limb in the wounded G. (fig. 1 B) as examples for the results of treatment describing.

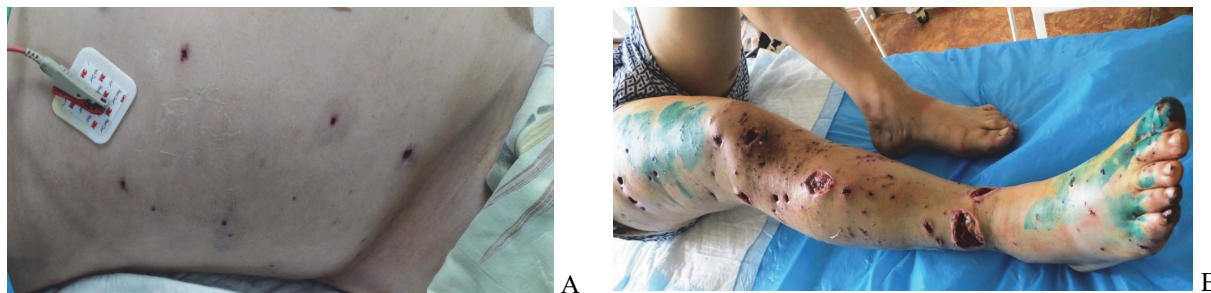


Fig.1. The appearance of soft tissue gunshot lesions in the wounded persons which did not require primary surgical treatment.

A – Wounded B., 38 years. Multiple wounds on the frontal and lateral of the abdomen. The 1st day after the injury. B – Wounded G., 28 years. Multiple gunshot shrapnel wounds of the right lower limb. Wounds without primary surgical treatment and after primary surgical treatment. The 4<sup>th</sup> day after the injury.

The data of the X-ray examination are shown on fig. 2.

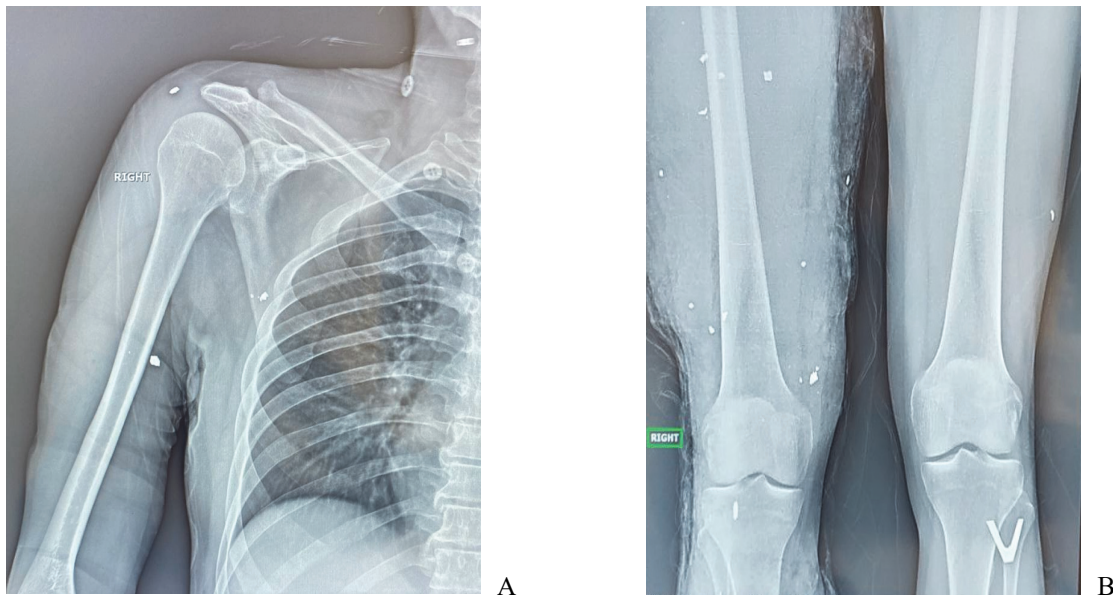


Fig. 2. X-ray examination data of the wounded K., 46 years: A – X-ray of the right half of the chest, shoulder and neck on the right, direct projection. Numerous foreign bodies in the soft tissues are identified; B – X-ray of the hips, direct projection. Numerous foreign bodies in the soft tissues are identified.

One could see the prevalence of combined soft tissues gunshot wounds (468 cases, 56.4 %), multiple (289 cases, 34.9 %) and isolated soft tissues gunshot injuries (72 cases, 8.7 %) among all injuries according to our distribution of soft tissues gunshot wounds depending on the formed clinical groups of the wounded (Table 1).

Table 1

**Soft tissues gunshot wounds distribution by clinical groups (raw and relative data)**

N	Soft tissues gunshot wounds	Group I	Group II	Group III	Totally
1	Isolated	72 (8.6±0.2 %)	0	0	72 (8.7±0.2 %)
2	Multiple	102 (12.4±0.3 %)	98 (11.8±0.3 %)	89 (10.7±0.3 %)	289 (34.9±0.6 %)
3	Combined	153 (18.4±0.5 %)	156 (18.8±0.5 %)	159 (19.2±0.5 %)	468 (56.4±0.8 %)
Totally		327 (39.4±0.4 %)	254 (30.6±0.3 %)	248 (29.9±0.3 %)	829 (100 %)

96 (11.6 %) foreign bodies were partially removed during magnetic detection. Ferromagnetic foreign bodies were removed using a magnetic search tool (in 73 cases, 8.8 %) and a magnetic universal tool for ferromagnetic foreign bodies finding and removing from large wounds which was used for magnetic detection (in 23 cases, 2.8 %; fig. 3).

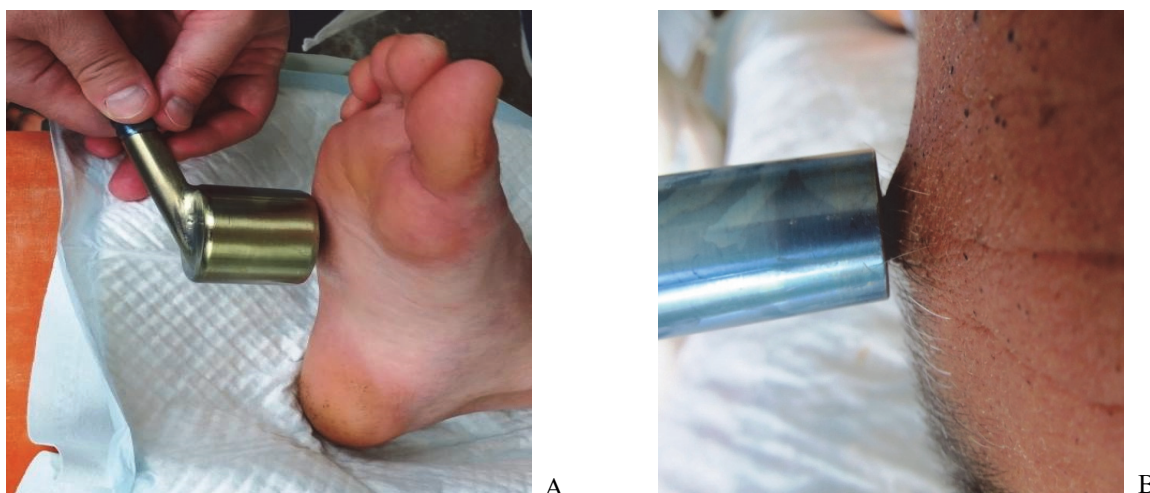


Fig. 3. The magnetic search tool application for ferromagnetic foreign bodies of small sizes finding and removing inside soft tissues: A – Magnetic search tool; B – moment of detection of a foreign ferromagnetic body.



There were no operative interventions in the group I in 327 cases (39.4 %), in the group II – in 212 (25.6 %) and in the group III – in 176 (21.2 %) cases.

The primary surgical treatment of wounds in the group II was performed in 42 cases (5.0 %). Primary surgical treatment of wounds with the primary and delayed sutures application followed by repeated treatment with the soft tissue defect closure by parts of wounds various types plastics in the group III was performed in 72 (8.7 %) cases. On average, 28.7 % of wounds did not require surgical treatment.

The total bed day in the group I ranged from 0 to 3 days, on average it was equal to  $1.8 \pm 0.2$  days; in the group II this average index was equal to  $7.3 \pm 1.3$  days, and in the group III, it ranged from 18 to 36 days, on average –  $24.3 \pm 3.6$  days.

Thus, the data obtained of significant number of wounded with soft tissues gunshot injuries treatment confirm the applied non-operative treatment method high efficiency. The non-operative treatment method has expressed advantages in terms of the speed of execution, safety and efficiency of the treatment, the complete absence of complications in the postponed period and the load” reduction for the subsequent stages of wounded militaries evacuation. It is clear that in this case, with the application of metal and ferromagnetic foreign bodies magnetic extraction, the process of wounded persons rehabilitation will also be faster, better and more efficient.

While discussing the results obtained, we note that our data do not have discrepancies with the existing data regarding the frequency of soft tissues gunshot wounds non-operative treatment [1, 3, 4]. An important aspect of the obtained results, unfortunately, is that we are practically the only medical specialists who massively treat the wounded with soft tissues gunshot injuries as the result of ongoing military aggression against our country [1, 3]. The rest of the scientific messages from a similar orientation have a peaceful, most often domestic or social character [11]. Nevertheless, mankind is constantly improving the means and methods of firearms and the delivery of wounding projectiles, which, in view of the ongoing military aggression, only increases the relevance of wounded both clinical examinations and treatment.

Hence, we see the military medics leading task the highest quality and fastest return to health of the wounded with the least involvement of the forces and capabilities of the relevant medical workers. The constant search for fundamentally new methods of wounded persons and servicemen treating continues for this purpose.

Such a new direction of soft tissues gunshot wounds non-operative treatment is the use of a modern magnetic tool for diagnosis and superficially located ferromagnetic foreign bodies removal [2, 3, 5]. The principles of selection and the list of measures in the soft tissues gunshot wounds non-operative treatment have not changed in recent years, which indicate their efficacy [8].

The advantages of the foreign body’s magnetic extraction method from soft tissues used by us are the following: lower risk of infectious complications development, lower risk of local bloodflow disruption and subsequent soft tissues damage, speed and efficacy.

From a fundamental point of view, our clinical observations, despite their superficial simplicity, are extremely risky and require highly specialized training of surgeons. The fact is that limbs firearms injuries most often affect the muscle-skeletal tissues and therefore can lead to more complex injuries due to the nearby attached neurovascular structures which often coexist in a limited space [13]. The cavity of a temporary wound from high-energy projectiles can rupture capillaries and other small blood vessels with a high risk of arterial bleeding, painful shock, a decrease in the volume of circulating blood, hypoxia and other pathophysiological phenomena that significantly reduce the body's general recourse for resistance [14]. The skeletal muscles as the result of gunshot wounds undergone to cytoplasmatic damage induced by high-energy influence and thermal effects, interstitial blood extravasation with severe edema development and muscle fibers damage [14]. The sooner doctors manage to remove a foreign metal body from superficially located soft tissues, the lower is the risk of local edematous reaction, compartment syndrome development and further damage to adjacent soft tissues [13]. The abovementioned list of mandatory and progressively developing pathophysiological processes in the body of the wounded outlined the fundamental importance of the results we obtained.

There are single scientific publications devoted to gunshot wounds non-operative treatment but most of them refer to low-energy gunshot injuries of soft tissues without complications, with little or no bullet fragments, without soft tissues destruction or bone comminution [10, 12, 15]. It is clear that priority of the Ukrainian surgical medical school is available and undoubtful in conditions of soft tissues high-energy injuries, with which we most often deal nowadays.

Resuming, we note that non-operative treatment of wounded with soft tissue gunshot wounds using the magnetic detection turned out to be highly effective in modern conditions for a significant number of people due to the acceleration of diagnostic process, treatment and recovery and due to entirely medical

accompanying advantages in the form of complications absence, including infectious ones, reducing the amount of pharmacological load on a specific patient, chronic pain preventing, etc.

### Conclusions

1. A third of all soft tissue gunshot wounds do not require primary surgical treatment.
2. The criteria for primary surgical treatment not performing are soft tissues gunshot wounds of small sizes, of different localization and number without signs of inflammation.
3. Non-operative treatment of soft tissues gunshot wounds includes antibiotic prophylaxis, anti-tetanus toxoid administration, anesthesia, treatment of wounds with antiseptic solutions, aseptic wound dressings.
4. The use of a modern magnetic tool in soft tissues gunshot wounds magnetic detection allows to remove ferromagnetic foreign bodies partially during the examination.
5. Non-operative treatment of wounded with soft tissue gunshot wounds using the magnetic detection turned out to be highly effective in modern conditions for a significant number of people due to the acceleration of diagnostic process, treatment and recovery and due to entirely medical accompanying advantages.

*Prospects for further researches include study of the promising possibility of soft tissue gunshot injuries non-operative treatment using the method of magnetic detection in conditions of bodies deep tissues damage. The use of modern magnetic tool in soft tissues gunshot wounds magnetic detection and foreign ferromagnetic bodies extraction should be maximally used while treating the patients with soft tissues gunshot wounds.*

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