

Features of the use of osteosynthesis in the treatment of flammable fractures of long bones

Abstract

Treatment of gunshot fractures of long bones is a complex and multi-stage process. The patient has to go through the path from primary fixation by extrafocal osteosynthesis to the moment of full fusion and restoration of function of the damaged limb. At the same time, determining the need for osteosynthesis in order to treat the patient is of great importance. The purpose of the work: to conduct an analysis of the effectiveness of using osteosynthesis in the treatment of victims with gunshot wounds of the limbs. An analysis of the treatment of ATO/JFO for the period 2014-2021 was carried out. the number of patients with gunshot fractures of long bones was 470. Conclusions: the analysis of the effectiveness of the replacement of the fixation method determined a significant ($p > 0.05$) reduction in the risk of the development of gunshot osteomyelitis, delayed consolidation with the possible subsequent development of false joints, and contributed to the timely union of fractures and the reduction of the development of persistent contractures by 26.5% ($p < 0.01$).

Keywords: gunshot wound, limbs, impact factor, osteosynthesis, regeneration of bone tissue

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Abbreviations: ATO, anti-terrorist operation; JFO, joint forces operation; NMMH «MMCH», national medical military hospital “main military clinical hospital”

Introduction

Treatment of gunshot wounds of long bones is a complex, multi-stage process. It requires primary fixation by extrafocal osteosynthesis followed by complete immobilization and restoration of function of the injured limb.¹ At the same time, it is very important to determine the need for osteosynthesis for treatment.

Taking into account the data of NMMH « MMCC » for the period 2014-2021. -65.7% were patients with gunshot wounds to the limbs, out of the total number of wounded. The specific gravity of patients with gunshot fractures was 25%, injuries of soft tissues of the limbs - 75%. At the same time, multiple fractures accounted for 13%. Bone defects in gunshot fractures of the limbs were found in 62%, of them - more than 6 cm - in 12%. At the same time, polystructural lesions accounted for 76%.

Treatment of gunshot fractures of long bones using modern surgical techniques significantly reduces the risk of joint contractures, wound suppuration and further development of gunshot osteomyelitis or delayed consolidation and possible further development of such complications as pseudarthrosis.² At the same time, conversion (instead of immobilization method) is controversial because early conversion increases the risk of surgical wound infection and further development of gunshot osteomyelitis.^{3,4} However, a number of authors express the opinion that the reasoned replacement of the method of fixation is a certain key to the successful restorative treatment of patients with gunshot fractures of long bones, because it creates optimal conditions for correcting the position of bone fragments, their stable fixation, and allows the process of medical rehabilitation to begin as soon as possible after the injury.

Nicholas B., Pape H. and most other authors emphasized in their publications that primary fixation cannot be performed in patients hospitalized with gunshot fractures of the long bones of the extremities.³ Pape H, Paderni, Nicholas B submerged osteosynthesis

can be performed 1.5 to 2 months after application of external fixation devices and significantly reduces the risk of infectious complications.²

Unfortunately, even today, the treatment of patients with gunshot fractures of long tubular bones is often accompanied by complications: osteomyelitis (16-18%), with significant (22%) and moderate dysfunction (15%) of persistent contracture, incorrect joints (11%), post-traumatic absolute limb shortening (10%) and neuropathy (13%). At the same time, in this category of victims, the frequency of unsatisfactory functional results is also quite significant (38%). Therefore, the issue of using effective osteosynthesis is currently relevant and needs to be resolved.⁵⁻⁹

The purpose of the work

To analyze the effectiveness of the use of osteosynthesis in the treatment of victims with gunshot wounds of the limbs, to generalize the experience and improve the effectiveness of the use of bone osteosynthesis as a method of treatment of gunshot injuries of the long bones of the limbs in the conditions of modern warfare.

Materials and methods

ATO/JFO treatment for the period 2014-2021 was analyzed. The number of patients with gunshot fractures of long tubular bones was 470. The average age of the wounded was 35.3 ± 2.32 years. Patients were divided into 2 control groups. The first group - 370 people - consisted of wounded who underwent osteosynthesis. The second group consisted of 100 patients in which extrafocal transosseous osteosynthesis (according to Illizarov using a stable external rod system and compression traction device) was the last treatment.

Fracture types classified according to R.B. were also considered. Gustillo, J.T. Anderson (1984): 52 (10.7%) Type I patients, 71 (14.6%) Type II patients, 347 (74.6%) Type III patients: III A - 218 (62.09%), III B - 116 (33.3%), III C - 18 (4.61%). To determine fracture complexity, the AO classification was used: Type A simple fracture was identified in 85 patients (18.06%), Type B fragmented fracture - 155 (32.9%), Type C multifragmented and segmental fracture - observed 230 (48.9%).

Also, of note, 39.3% of upper extremity injuries were localized: 30 (15.9%) forearm gunshot fractures and 42 (23.3%) humeral gunshot fractures. Lower extremity injuries - 60.7%: lower leg - 92 cases (32.06%), femur - 84 cases (28.64%). Age, sex, clinical and disease classification structure, origin of injury, type and severity of gunshot wounds did not differ between controls ($p>0.05$), while the study sample was representative.

Research methods: comparative analysis, descriptive, statistical methods, systematic methods. Statistical analysis of information obtained during the study was performed using the IBM SPSS Statistics Base v.22 suite of applications.

Results and discussion

In the general distribution, the first group consisted of patients who underwent osteosynthesis - 370 people. During the procedure, two different methods of fixation were employed: osseous submerged metal osteosynthesis (OSMS) was used in 138 cases (37%), while blocked intramedullary osteosynthesis (BIOS) was implemented in 232 cases (63%).

The experimental group 1 implemented the use of screw-secured plates as the preferred method of fixation for 138 patients, replacing previous methods. These plates were utilized in the treatment of bone fractures, specifically 36 (26.7%) cases of forearm fractures, 44 (31.1%) cases of humerus fractures, 19 (13.9%) cases of tibia fractures, and 39 (27.9%) cases of femur fractures. The decision to perform osseous osteosynthesis was based on several indications: insufficient alignment of anatomical fragments, angular displacement of major fragments, fractures located behind the articular surface, intra-articular fractures, the presence of a primary defect in the bone tissue, delayed consolidation, and the formation of a false joint.

Advanced regenerative technologies such as PRF, PRP, and bone autospontaneous technologies were employed when dealing with bone tissue defects. The analysis of clinical data and materials revealed that out of the individuals who suffered from gunshot fractures in their long bones, 39 (28.2%) had bone tissue defects.

The autologous preparation Vivostat® PRF (Denmark) was used as a means for combined autoplasty. The Vivostat® PRF system consists of applicator and processor modules, as well as a set of disposable PRF consumables. The processor module is located outside the operating unit, in which the preparation was directly prepared. The applicator module was located in the operating room and was used to administer and dose Vivostat® PRF during surgery. The first step in the preparation of Vivostat® PRF is to feed the citrate and ampoule into the blood collection container. The patient's venous blood (120 ml) was taken into a container through a previously installed catheter. A container with blood and a syringe were placed in the processor module and the drug preparation program was started. The duration of the procedure was 23 minutes, 5 - 6 ml of the finished drug was received (its amount depended on the level of fibrinogen in the patient's blood plasma). The drug can be stored at a temperature of 18-22°C for up to 12 hours.

The next step was to insert the syringe into the applicator module. During the surgical intervention at the stage of replacement of the fixation method, the victims were repositioned, and a bone-cancellous autograft was taken (from the wing of the ilium or the proximal metaepiphysis of the tibia). After preparing the operating field for bone-cancellous-fibrin autograft implantation, the tube of the spray pen was connected to the applicator module and started, after which, in order to release pH4 and completely fill the spray system, the

drug was applied to the litmus paper. The biological preparation was administered by pressing the pedal. With the help of the applicator module, the biological preparation was dosed during the entire period of surgical intervention. The advent of free bone autospontaneous plastic has facilitated the replacement of bone defects and enhanced osteoregeneration processes, thereby reducing the chances of slow consolidation and false joint development.

A total of 232 patients underwent blocked intramedullary osteosynthesis. For forearm fractures, BIOS was utilized in 38 cases, while for humerus, tibia, and femur fractures, it was used in 40, 42, and 112 cases respectively, accounting for 16.4%, 17.1%, 17.8%, and 48.7% of all cases respectively. During surgery, the closed repositioning of fragments was quality controlled with the aid of an electronic optical transducer (EOP). Prompt final fixation of the fracture played a critical role in the complete restoration of limb function.

In exploration group 2, the use of stable external rod systems was carried out in 100 cases. For forearm fractures in 20(20) cases, humerus fractures in 28 (28%), tibia fractures in 16 (16 %) and femur fractures in 36(36 %) cases.

The use of stable rod systems, which is achieved due to the use of obsessionmulti-plane rod variations, contributes to the minimization of essence structures in apkins, the possibility of optimal displacing in a projectile crack and effective primary stabilization of bone fractions. Complications after osteosynthesis were studied in 342 (72.7% of the total study sample) injured 1-3 years after the injury (Table 1).

Table 1 Characteristics of complications after conversion in comparison groups

Characteristics of complications	Specific weight. %		Certainty. P_{α}
	Group 1 (n=205)	Group 2 (n=137)	
Contractures	7.5	32.0	< 0.01
Osteomyelitis	4.9	6.4	> 0.05
Slow consolidation and false joint	4.6	8.1	< 0.05

Analysis of the effectiveness of the use of osteosynthesis determined a significant reduction in the terms of technical trauma treatment by 15.3 ($p<0.05$), contributed to the timely union of fractures and a reduction in the development of contractures by 26.5 ($p<0.01$). The reason for the development of common contractures in 4(3.7) of the wounded was late conversion of osteosynthesis-1.6 \pm 0.9 months from the moment of injury. At the same time, the functional results of the treatment of the wounded using the relief of the obsession system were examined in 342 wounded according to the Matic- Lyuboshits-Schwartzberg system in Shevtsov's revision and the SF 36 scale.

In group 1(205 cases), good functional results were observed in 135(66.1) of the wounded, satisfactory - in 49(24.2), wrong - in 21(8.3). In group 2 (137 cases), good functional results were determined in 38(27.7) wounded, satisfactory- in 74(54.2), wrong- in 25(18.1). therefore, it was established that osteosynthesis conversion in injured with projectile fractures of the branches leads to an increase in good functional results from 27.7 to 66.1 and decreases the relative number of wrong cases- from 18.3 to 8.3 ($p<0, 05$).

The SF- 36 questionnaire was used to assess cases' quality of life. The questionnaire reflects general well- being and the degree of satisfaction with those aspects of a person's life, which are affected

by the state of health. The SF-36 consists of 36 questions grouped into eight scales: physical functioning, part functioning, fleshly pain, vitality, general health, emotional state, social functioning and internal health. The pointers of each scale are collected in such a way

that the advanced the value of the index (from 0 to 100), the better the score on the named scale. They form two parameters: psychological and physical components of health. Evaluation of long-term results of treatment results was carried out in terms of 1.2-1.5 years (Table 2).

Table 2 Subjective assessment of treatment results and assessment of the quality of life of victims of the main and first comparison groups according to the SF-36 scale in the long term (1.2-1.5 years)

Groups	n	The result of treatment according to the score				
		5 (80-100)	4 (60-79)	3 (40-59)	2 (20-39)	1 (0-19)
1 group	n=205	44 (53,6%)	23 (27,6%)	10 (11,7%)	4 (5,6 %)	2 (1,5%)
2 group	n=137	20 (34,5%)	19 (32,1%)	12 (21,1%)	5 (7,7%)	3 (4,6%)

Analysis of the integrated subjective assessment of the quality of life in the long term (shows that the developed treatment algorithm improves the subjective assessment of one's own quality of life by an average of 17.2%.

Conclusion

- Based on a retrospective analysis of the treatment outcomes of patients with long tubular bone fractures, 370 were found to have been treated with internal fixation using the following fixation methods: Bone-embedded metal osteosynthesis (BMOS) in 37% of cases and obstructed intramedullary Bone fixation (BIOS) – 63%. At the same time, an analysis of the effectiveness of the replacement fixation method showed a significant reduction in the risk of gunshot osteomyelitis ($p>0.05$), delayed consolidation and possible subsequent formation of pseudarthrosis, and facilitated timely fracture healing and persistent The occurrence of contractures was reduced by 26.5% ($p<0.01$).
- The results of long-term (1.2-1.5 years) restorative treatment in the injured control group were analyzed according to the Mathis-Lyuboshits-Schwarzberg scale, in Shevtsov's modification good functional results were observed in 66.1% of the wounded in group 1, Satisfactory - 24.2 %, dissatisfied - 8.3%. In Group 2, 27.7% of the casualties had good functional outcomes, 54.2% were satisfied, and 18.1% were not. Namely, the change in osteosynthesis for gunshot extremity fractures resulted in an increase in functionally favorable outcomes from 27.7% to 66.1%, and a decrease in the relative number of unsatisfactory cases from 18.3% to 8.3% ($p<0.05$).
- According to the quality of life assessment scale (SF 36) in group 1: a total of 53.6% of patients received a score of 5, a score of 4 – 27.6%, a score of 3 – 11.7%, a score of 2 – 5.6%, and a score of 1 – 1.5% of patients. In group 2: 34.5% of patients received grade 5, grade 4 – 32.1%, grade 3 – 21.1%, grade 2 – 7.7%, and grade 1 – 4.6% of patients. That is, the developed treatment algorithm improves the subjective assessment of one's own quality of life by an average of 17.2%.

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Conflicts of interest

The authors declare no conflicts of interest

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