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Strategies of Osteosynthesis: Problems and Perspectives

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Background. Urgent osteosynthesis requires number of organizational, material, technical and staff resources.
Aim of the study — to determine advantages and disadvantages of existing strategies for osteosynthesis basing on literature data and comparative analysis of organization of osteosynthesis on the first day after injury and at a later time.
Methods. Data were collected through review of medical records from first half of 2021 calendar year and consist of the patients have been treated by different types of osteosynthesis on the first day after admission to the hospital and later. Average length of hospital stay (LOS) for surgical procedures and duration of the operative time were compared.
Results. In total 266 osteosynthesis of the extremities immediately after admission to the hospital were performed in the first half of 2021 in 260 patients. The most frequently performed ankle fractures fixation (20.7%) and clavicle fractures surgical repairment (13.9%). Cases of early infections complications and no revision surgeries required due to unstable fixation after urgent osteosynthesis were excluded. In the same period 659 delayed osteosynthesis were performed. Mean value of inpatient day in patients, who underwent urgent surgery, was 8.40±16.67 days, while patients, who underwent delayed surgery, spent significantly greater ($p<0.05$) amount of time in the hospital — 12.98±6.28 days in average.
Discussion. Three strategies of osteosynthesis exist: urgent surgeries, delayed surgeries in daytime in operating rooms for planned surgeries and combination of these approaches. Urgent osteosynthesis surgeries do not lead to infectious complications or unstable fixation, what makes them viable option while choosing treatment tactics in case of some injuries. Precise determination of patient groups according to fracture pattern and its localization, that can be operated on in urgent manner, is necessary. Moreover, introduction of urgent osteosynthesis requires serious organizational measures. It is also necessary to perform economical assessment of described approach. Only after solving these questions, it will be possible to make final conclusions about optimal strategy for performing osteosynthesis.

Keywords: osteosynthesis, urgent osteosynthesis, urgent surgeries, planned surgeries, delayed surgeries.

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Стратегия выполнения остеосинтеза: проблемы и перспективы

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Актуальность. Для выполнения операций остеосинтеза переломов в неотложном порядке необходимо выполнение ряда организационных, материально-технических и кадровых требований.
Цель исследования — на основании сравнительного анализа структуры операций остеосинтеза, произведенных в первые сутки после травмы и в более позднее время, а также изучения данных литературы определить преимущества и недостатки существующих стратегий выполнения операций остеосинтеза.
Материал и методы. По материалам первичной медицинской документации, операционным журналам и базе рентгенологических исследований определены пациенты, которым в первом полугодии 2021 г. были выполнены операции остеосинтеза в течение первых 24 ч. после поступления в стационар, и пациенты с аналогичной патологией, остеосинтез которым выполнен в отсроченном порядке с определением среднего времени нахождения пациента в стационаре с момента поступления до и после операции, а также средней длительности хирургического вмешательства.
Результаты. Всего за первое полугодие 2021 г. было выполнено 266 операций остеосинтеза костей конечностей непосредственно при поступлении в стационар у 260 пациентов. Наиболее часто выполнялся остеосинтез переломов лодыжек (20,7%) и ключицы (13,9%). После выполнения операций остеосинтеза в неотложном порядке случаев ранней инфекции и/или ревизионных операций по причине некачественного выполнения первичного остеосинтеза в период госпитализации не было. За тот же период было выполнено 659 отсроченных операций остеосинтеза. Средний койко-день у пациентов, прооперированных в неотложном порядке, составил 8,40±16,67 дней, в то время как пациенты, перенесшие отсроченное хирургическое вмешательство, находились в стационаре в среднем 12,98±6,28 дней (p<0,05).
Обсуждение. Существует три стратегии выполнения операций остеосинтеза: неотложные операции, отсроченные операции в дневное время в плановых операционных и комбинация этих подходов. Операции остеосинтеза в неотложном порядке при определенных повреждениях безопасны в плане качества их выполнения и инфекционных осложнений и имеют право на жизнь. Необходимо четкое определение групп больных в зависимости от характера и локализации перелома, которым целесообразно выполнение подобных операций. Кроме того, внедрение практики выполнения остеосинтеза в неотложном порядке требует проведения серьезных организационных мероприятий. Крайне важно также провести экономическое обоснование целесообразности изложенного подхода. Только после решения всех этих вопросов можно будет сделать окончательные выводы о предпочтительной стратегии выполнения операций остеосинтеза.

Ключевые слова: остеосинтез, остеосинтез в неотложном порядке, неотложные операции, плановые операции, отсроченные операции.

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BACKGROUND

The relevance of the problem of providing specialized inpatient care to patients with trauma is beyond doubt. Thus, in each first-level trauma center in St. Petersburg, more than 800 surgeries are performed per year for limb fractures. Moreover, over time, in the absence of significant changes in the number of patients in need of hospital care, the share of those with multisystem and concomitant injuries increases, as well as the severity of polytrauma and both the total proportion of open fractures of the long bones and degree of damage to the soft tissues of the extremities [1]. These changes also affect the structure of surgical interventions. Specifically, analysis of the structure of surgeries shows a significant increase in the proportion of surgeries for near- and intra-articular fractures in 2010 compared with the beginning of the first decade of the XXI century. Moreover, the share of minimally invasive osteosynthesis surgeries increased, which was accompanied by a decrease in the number of preoperative bed-days and, consequently, the total hospital stay after such surgeries [2].

Theoretically, to improve the work of a trauma hospital, all patients with trauma requiring surgical treatment, should undergo definitive osteosynthesis surgeries immediately upon admission to the hospital, except for patients with severe polytrauma, open fractures, high-energy peri- and intra-articular fractures, and other fractures accompanied by significant closed soft tissue injuries. In such cases, primary extrafocal osteosynthesis with external fixation devices should be performed [3]. However, to organize work in accordance with these principles, several requirements must be observed. First, a team of traumatologists should be on duty around the clock, which can physically form a surgical team without disrupting the reception of patients entering the admission and diagnostic department. Second, this team should have a high-level traumatologist on a 24-h basis, who cannot only perform complex surgeries but can also make decisions about treatment approach and the choice of the osteosynthesis technique. In addition, a 24-h trauma operating room equipped with a basic set of instruments for performing trauma surgeries, necessary supply of sterile consumables for osteosynthesis, and an X-ray electron-optical image intensifier (EOII) should be available. Finally, an on-duty team is required, consisting of an anesthesiologist, a nurse anesthesiologist, a surgical nurse, and an aide, who will ensure the work of the trauma team. Therefore, ensuring adequate work of the inpatient trauma service in accordance with modern standards for the provision of specialized trauma care requires significant additional costs for the hospital to increase the staff schedule, equip additional operating rooms, and purchase additional consumables for osteosynthesis. This is a complex problem and cannot be fully resolved in a single hospital without revising the standards for staffing and financing trauma care in the system of compulsory medical insurance. Nevertheless, this problem can be solved to a large extent even under these conditions.

The experience of international hospitals demonstrates the possibilities and prospects of emergency surgery with the competent organization of the process of providing emergency medical care and clear patient routing [4, 5, 6, 7, 8]. However, most first-level Russian trauma centers do not have algorithms for providing emergency trauma care, particularly for performing emergency osteosynthesis surgeries. On the contrary, the delayed performance of osteosynthesis surgeries in elective operating rooms during daytime and a combination of emergency and delayed options for surgical treatment of fractures are possible.

This study aimed to determine the advantages and disadvantages of existing strategies for performing osteosynthesis surgeries based on a comparative analysis of the structure of osteosynthesis surgeries performed on day 1 after injury and at a later time. Literature data were also analyzed.

METHODS

According to the primary medical documentation, dictated procedure reports, and X-ray database of the I.I. Dzhanelidze Research Institute of Emergency Medicine, patients who underwent osteosynthesis surgeries within the first 24 h after admission to the hospital in the first half of 2021 were identified. Surgical interventions were performed in an antishock operating room equipped with an orthopedic table and an X-ray EOII and in an emergency operating room of the operating unit

equipped with a surgical table without an X-ray EOII. Accordingly, surgeries that required an orthopedic table and/or direct intraoperative radiological control could only be performed in an antishock operating room. Surgeries were grouped according to the localization of injuries and type of osteosynthesis. Surgeries in patients with multiple and concomitant traumas were singled out separately. Using the same method, patients with a similar pathology, whose osteosynthesis was performed on a delayed basis for the same period, were identified.

We determined the average hospital stay from the time of admission and after the surgery and the average duration of the surgical intervention, presence or absence of revision surgeries, and early infectious complications of osteosynthesis.

Statistical analysis

Statistical processing of quantitative data was performed using Excel and basic statistics/tables modules of the Statistica for Windows software package. The nature of the distribution of the studied data was determined using the Shapiro-Wilk test. In the statistical analysis of changes in the studied parameters, the nonparametric Mann-Whitney test was used. Differences in indicators were considered significant at $p<0.05$. The frequency of the studied phenomena was analyzed by calculating the relative values expressed as a percentage. Moreover, using the above programs, the average indices were calculated, including their standard deviation, median, quartiles, and maximum and minimum values.

RESULTS

In total, for the first half of 2021, at the I.I. Dzhanelidze Research Institute of Emergency Medicine, 266 osteosynthesis surgeries of the limbs immediately were performed on 260 patients upon admission to the hospital. During 236 surgical interventions (88.7%), internal osteosynthesis was performed, whereas in the remaining 32 (11.3%) cases, an external fixation apparatus was applied. Surgical stabilization of the fracture was performed in 114 and 152 cases in the antishock operating room and emergency operating room, respectively. Data for individual locations and segments are presented in Table 1.

For patients who underwent osteosynthesis surgeries in the antishock operating room of the trauma center, the osteosynthesis surgery was performed after an average of 6 h 56 min±3 h 52 min from the time of hospital admission. The average duration of surgical intervention was 1 h 28 min ± 47 min. Moreover, patients with multisystem and concomitant injuries underwent surgery in the same operating room after an average of 3 h 20 min±1 h 43 min, and their average duration was 1 h 24 min±51 min.

Patients who underwent osteosynthesis surgeries in the emergency operating room of the surgery unit stayed in the hospital for an average of 6 h 27 min±3 h 01 min from the time of admission to the start of the surgery. The duration of surgery in this group was 2 h 11 min±41 min.

During the study period, osteosynthesis surgery was performed on 18 patients with multisystem and concomitant injuries upon admission to the hospital, including those with fractures of the bones of the extremities. Moreover, in 14 (77.8%) patients with an injury severity of <25 points on the ISS scale, primary internal osteosynthesis was performed in accordance with the protocol of early total care. In 4 (22.2%) patients with more severe injuries, the fractures were immobilized with external fixation apparatus in accordance with the damage control protocol and Yu.N. Tsibin – A.N. Keyer medical approach-tactical prediction method [9].

An analysis of the surgeries performed revealed that osteosynthesis of fractures of the ankles (20.7%) and collarbone (13.9%) was most often performed. After emergency osteosynthesis surgeries, there were no cases of early infection and/or revision surgeries because of poor quality of primary osteosynthesis during hospitalization.

In the first half of 2021, 659 elective osteosynthesis surgeries were performed, along with 266 emergency ones, on patients who were not operated on urgently (925 surgeries in total). Moreover, the average number of bed-days in patients who underwent emergency surgery was 8.40±16.67 days, whereas patients who underwent delayed surgery had a longer hospital stay ($p=0.025$) for an average of 12.98±6.28 days. The distribution of two independent data samples does not correspond to the normal one; therefore, the nonparametric Mann-Whitney test was used to assess the significance of differences. For individual localizations, the sample sizes of bed-day values (with non-normal distribution) enabled statistical analysis using the nonparametric Mann-Whitney test.

Table 1

Number, type, and location of emergency surgical interventions depending on the fracture location

Segment	Osteosynthesis	Antishock operating room	Emergency operating room	Total	
		n	n	n	%
Collarbone	Internal	1	36	37	13.9
Humerus	Internal	6	5	11	4.1
Bones of the forearm, including the distal metaepiphysis of the radial bone	Internal	6	20	26	9.8
Proximal femur	Internal	16	0	16	6.0
Diaphysis and distal segment of the femoral bone	Internal	11	2	13	4.9
	External fixation	4	5	9	3.4
Patella	Internal	0	2	2	0.8
Lower leg bones	Internal	24	3	27	10.2
	External fixation	5	8	13	4.9
Ankle	Internal	5	50	55	20.7
Foot bones	Internal	1	2	3	1.1
Hand bones	Internal	6	19	25	9.4
Polytrauma	Combined	18	0	18	6.8
Pelvis	Internal	8	0	8	3.0
	External fixation	3	0	3	1.1
Total		114	152	266	100.0

The calculated *p* values in all cases were less than the accepted significance level of 0.05.

The shortest hospital stay was registered for patients who underwent osteosynthesis of the foot bones, and it averaged 2.66±2.52 days. The highest indicator of the average number of bed-days was expectedly noted in patients with pelvic fractures and polytrauma (30.07±39.92 days). The maximum number of bed-days among patients in this group was 136 days, which was explained by the development of postoperative infectious complications in a patient with polytrauma, which required multiple repeated surgical interventions. If we consider the average hospital stay in all patients who underwent osteosynthesis, then this value was 11.80±10.70 bed-days (Table 2). Thus, we can state a significant decrease in the hospital stay of patients with the injuries under study in the case of emergency osteosynthesis surgeries upon admission.

DISCUSSION

The problem of organizing surgeries for osteosynthesis of bone fractures in an emergency hospital is long overdue. Unfortunately, the transition to modern standards of specialized trauma care is hindered by several factors. First, most hospitals were designed and built more than 20-30 years ago and are oriented toward the extensive model of care that was implemented at that time; these hospitals do not have the number of operating rooms necessary to work in the new conditions. Second, the current procedures for providing specialized trauma care to patients with both isolated and multisystem and concomitant injuries do not provide a suffi-

Table 2

Number of surgical interventions and average number of bed-days depending on the fracture location

Fracture location	Emergency surgery		Elective surgery		*p*	Total	
	Number	Bed-days	Number	Bed-days		Number	Bed-days
Collarbone	21	2.40±1.14	50	10.88±7.33	2.4×10-10	71	8.46±7.31
Collarbone—dislocation	16	3.81±2.59	0	0	–	16	3.81±2.59
Proximal humerus	5	2.40±1.34	67	10.95±4.47	–	72	10.30±4.83
Humeral diaphysis	6	8.67±10.52	39	13.10±5.34	–	45	12.50±6.29
Olecranon	16	4.81±6.10	37	10.59±5.93	0.00054	53	8.85±6.56
Bones of the forearm, including the distal metaepiphysis of the radial bone	10	4.70±5.60	53	10.57±6.51	–	63	9.63±6.69
Femoral neck	0	0	130	15.11±6.57	–	130	15.11±6.57
Pertrochanteric fracture of the femoral bone	16	10.63±4.44	149	14.67±5.98	0.000798	165	14.30±5.96
Subtrochanteric fracture of the femoral bone	0	0	20	14.85±5.67	–	20	14.85±5.67
Femoral shaft	4	11.50±8.39	8	9.50±2.62	–	12	10.20±4.95
Distal femur	18	6.78±6.84	15	13.47±7.09	0.00179	33	9.82±7.64
Patella	2	1.00±1.41	14	11.36±3.71	–	16	10.10±4.96
Proximal tibia	0	0	21	15.14±6.19	–	21	15.14±6.19
Diaphysis and lower third of the tibia	40	7.95±9.28	6	16.50±12.86	–	46	9.09±10.10
Ankles	55	5.16±9.11	50	10.16±3.59	4.9×10-15	105	7.52±7.43
Foot	3	2.66±2.52	0	0	–	3	2.66±2.52
Hand	25	5.48±11.50	0	0	–	25	5.48±11.50
Pelvis and polytrauma	29	30.07±39.92	0	0	–	29	30.07±39.92
Total	266	8.40±16.67	659	12.98±6.28	1×10-17	925	11.80±10.70
min/max	–	0/136	–	3/46	–	–	0/136
Q1/Me/Q3	–	2/3/8.75	–	9/12/15	–	–	6/10/15

min — minimum value, max – maximum value, Q1 – first quartile, Me – median, Q3 – third quartile.

cient number of personnel to perform surgeries at night. To ensure such work, the heads of hospitals are forced to search out reserves and increase the staff schedule with the introduction of additional doctors and operating nurses*. This is a global problem and has not yet been resolved even in developed countries.

Van der Wee et al. reviewed the provision of emergency surgical care in different countries and indicated great heterogeneity in the struc-

* The procedure for providing medical care to the population in the field of Traumatology and Orthopedics (approved by order of the Ministry of Health of the Russian Federation of November 12, 2012, No. 901n) and the procedure for providing medical care to patients with concomitant, multiple, and isolated injuries accompanied by shock (approved by order Ministry of Health of the Russian Federation dated November 15, 2012, No. 927n).

ture and components of the acute care surgery system worldwide [8]. Indeed, undoubtedly, high-quality osteosynthesis, upon admission of a patient to a hospital, reduces significantly the duration of hospital stay and thereby helps reduce the number of beds without reducing surgical activity. On the contrary, this practice requires the availability of round-the-clock specialized operating rooms with qualified personnel and therefore a significant increase in funding, which is not offset by a decrease in the bedspace capacity of the trauma service.

Thus, various trauma pathologies and the unpredictability of the number of patients with fractures of varying severity who will be admitted to the clinic should be considered. All these patients are traditionally hospitalized to await surgery. This means that during periods of significant workload, the expectation of surgery lasts for several days, the duration of the patient's hospital stay increases, the excessive burden falls on the operating room staff, and the satisfaction of patients with the availability (efficiency) and quality of medical care decreases. The problem is solved by introducing additional surgical teams and even working at night. Moreover, in recent years, surgeries performed at night have increased the risk of complications, treatment costs, and risks of loss of health by hospital staff [10].

Furthermore, the vast majority of traumatological surgeries can be performed on a delayed basis without compromising their quality. For example, in Finland, performing surgeries has four categories of urgency, namely, extremely urgent surgeries must be performed immediately, category 1 surgeries must be performed within 3 h, category 2 must be performed within 8 h, and category 3 must be performed within 24 h. In addition, in the range of osteosynthesis surgeries, only fixation of femoral fractures is included in category 3; therefore, other osteosynthesis surgeries are not performed on an emergency basis. According to Oulu Level 1 Trauma Center, extremely urgent surgeries (4.5% of all surgeries) were started in an average of 26 min after admission, and category 1 surgeries (9.7%) were started after 59 min. Moreover, the target indicator was achieved in 93% of cases. Category 2 surgeries (23.3%) were started after an average of 337 min with the achievement of the target value in 86% of cases, and category 3 surgeries (62.5%) were started in an average of 830 min after admission to the hospital with the achievement of the target value in 62.5% of cases. As the urgency of surgeries decreases, the proportion of interventions performed in compliance with the target indicators decreases. Furthermore, as the urgency decreases, surgeons choose the most suitable patients for themselves, and haste often has a negative effect. This leads to the postponement of surgeries at the lowest category of urgency, which include most osteosynthesis surgeries. These patients often expect surgery at home [4, 6].

FitzPatrick et al. also reported the need for gradation of surgeries depending on the urgency of performing them. They provide data on the introduction in 2003 of the concept of "emergency surgical patient" at the level 1 trauma center of the University of Pennsylvania. This patient needs surgery within 24 h. Moreover, courses in traumatology for general surgeons were organized; subsequently, the Trauma Case Management Team was created. When comparing 1999 and 2003, the number of patients remained approximately the same, but the proportion of older patients increased. The severity of injuries on the ISS scale slightly increased, amounting to more than 13 points. The duration of hospital stay varied from 5.5 to 6.9 days. The rate of refusal to pay for treatment decreased from 4.6% in 1998 to 2.8% in 1999 after the Trauma Case Management Team was established. This figure continued to decrease and reached 0.5% in 2004. In 2004, the rehospitalization rate was 1.8% compared with 4.0% in 1998 [5].

Among the systems that take into account the priority categories of patients expecting surgeries, the so-called traffic-light coding system is noteworthy [6]. According to this system, emergency surgeries are coded red and must be performed within the first 8 h. Surgeries coded orange are performed within 8–24 h, and those in the yellow code must be performed within 24–48 h. Other interventions, which include most osteosynthesis surgeries for isolated fractures, are coded green and can be delayed for a longer time. These patients, after first aid and examination, are discharged home to wait for the surgery that is scheduled for a certain time. Given the limited resources of operating rooms, the wait-

ing time is often longer than previously planned because of injuries that need to be treated first, such as femoral fractures. This causes dissatisfaction among the patients and staff, overloads the wards, and forces surgeries to be performed at night. The results of surgeries for proximal femur fractures are significantly worse when they are performed later than 48 h after the injury; however, there are no reliable data on the deterioration of the treatment results of patients with other traumatological pathologies requiring surgical treatment, when the surgery is performed later than 48 h. This is true for fractures of the upper limbs. Outcomes of surgeries performed beyond the working hours, including at night, are the subject of long-lasting discussions. However, night-time surgeons make more mistakes than daytime surgeons. The risks of complications after surgeries performed on weekends are higher than on weekdays [11]. The quality and safety of surgical treatment performed by on-duty personnel are lower than those of interventions performed during the daytime by surgeons who were not on duty the previous night [12, 13]. In this regard, the traffic-light coding system enables distinguishing priority surgeries (proximal femur) and less urgent surgeries that are included in the operating plan and performed during the daytime in specialized operating rooms by experienced surgeons [10].

In this aspect, the experience of Sweden is interesting, where the model of emergency assistance ensures its high level for all citizens. However, even there, the greatest organizational difficulties are caused by emergency surgeries that cannot be planned. Consequently, emergency surgeries may be performed in an elective operating room and conflict with elective surgeries when the operating room capabilities are limited. This is true for very urgent surgeries. In some cases, the postponement of the surgery leads to additional patient suffering, a longer rehabilitation period, and a deterioration in the final functional result. Moreover, studies on the cancellation or postponement of surgeries reveal suboptimal use of hospital resources and a decrease in its income [7].

When analyzing the experience of Sweden, Bhattacharyya et al. stated that despite the improvement of the material base and resources of clinics and the introduction of new technologies, delays in surgeries in trauma departments occur every day. They are usually explained by a large flow of patients with a wide range of injuries in need of emergency care [14]. However, the real emergency conditions in traumatology requiring immediate intervention are acute compartment syndrome, such as fractures, dislocations, and other injuries accompanied by vascular damage. Most other surgeries can be postponed without harm; however, they should be performed as quickly, as the patient's condition is stabilized and the hospital resources enable them to do it [15]. Thus, emergency osteosynthesis surgeries should be performed depending on the severity of injuries, general status of the patient, and availability of the operating room. Moreover, in some cases, elective orthopedic surgeries can be postponed to perform emergency ones.

All reasons for delaying surgeries can be divided into patient-related and organizational ones. A study of one of the centers in Sweden, which included 9,500 traumatological and orthopedic surgeries (46% elective and 54% emergency), revealed that the priority in surgical treatment was distributed as follows: fractures of the femur (osteosynthesis in the first 24 h), emergency patients admitted to the hospital and awaiting surgery, and patients who received primary care and awaited a call for surgery (home pathway surgery). The system of registration for the operating room and calling patients from home was organized well; however, a large number of delays in performing osteosynthesis surgeries were identified, which can be divided into organizational and medical ones.

The organizational causes of the delays are as follows:

– Admission of patients with severe trauma, who have priority in surgical treatment.

– An increase in the time of the previous surgery relative to that planned previously.

– Change or cancellation of indications for surgery.

– A decrease in the number of available intensive care beds or departments.

– Lack of staff in the operating room and intensive care unit, surgeons, or anesthesiologists.

In addition, organizational problems include refusal of treatment in the clinic and transfer of the patient to another hospital. Medical causes of delays in surgical treatment are the aggravation

of the patient's condition, development of infectious complications, and desire of the patient to undergo the surgery later or refuse it.

Consequently, surgery was postponed once in 18% of patients, twice in 4%, three times in 1%, and four times in less than 1%. In addition, the proportion of surgeries postponed and performed on time did not change for 7 years; 21% of all postponed surgeries were performed within 24 h after cancellation, 41% of patients waited up to 3 days, 17% waited from 3 days to a week or longer, and 6% of patients refused surgery in this clinic. Specifically, 80% of causes of cancellations and delays of surgeries were organizational, whereas only 20% were due to medical reasons [7].

Another problem is that trauma clinics traditionally face a shortage of operating rooms for osteosynthesis of fractures. Thus, such surgeries are often postponed and performed at night. Moreover, the proportion of complications in patients operated on during non-working hours is significantly higher than that in patients whose surgery was performed in daytime, and the duration of the same surgeries performed at night is significantly longer than that performed during the day. The solution can be the organization of the work of one operating room reserved for performing trauma surgeries. This was implemented in 1999 at Massachusetts Hospital where this operating room is open from Monday to Saturday from 7:45 to 17:00 and is under the supervision of traumatologists who determine the sequence of surgeries depending on their urgency. Other types of surgical and orthopedic surgeries are not performed there. The priority indications for the use of this operating room are fractures of the ankles, lower leg, femur, and hip joint, as well as open fractures. As a result, the proportion of night surgeries decreased from 28% to 9%. Moreover, the waiting list for representatives of other subspecialties has significantly decreased [14]. The desire to postpone the majority of surgeries for fractures to working hours is understandable; however, another important aspect of this problem should be considered. The inability to perform surgeries reduces the job satisfaction of a surgeon who deals with non-surgical treatment of closed blunt injuries. To increase job satisfaction, a rational combination of surgical and non-surgical treatment of fractures is required, but this requires extensive skills in the personnel [16].

The international community has also not resolved the issue of who should provide emergency trauma care to patients with fractures. In different countries of the European Union, to provide care to patients with skeletal trauma, different training is required and appropriate certificates obtained, namely, orthopedic surgery (Finland, France, Italy, Norway, Portugal, Romania, Spain, Turkey, Great Britain, Czech Republic, and Germany), trauma surgery (Croatia, Luxembourg, Netherlands, Czech Republic, and Germany), and general surgery (Croatia, Luxembourg, Netherlands, Greece, and Switzerland) [17]. The modern trend in surgery is an increase in the number of subspecialties and, accordingly, a decrease in the number of surgeries and manipulations performed by doctors providing emergency care. The more highly specialized the surgeon, the less competent he/she is in issues of emergency care, while emergency surgery and traumatology require constant training [18]. Moreover, there is a steady increase in the age of patients, financial problems of hospitals, decrease in the number of trained doctors, increase in specialization, and unavailability of consultants 24/7. Physicians do not have enough opportunities for training, which leads to a lack of specialists with a certificate in traumatology. Duty traumatologists usually have a large amount of night work while experiencing a shortage of elective surgery. Therefore, in recent years, the problem of centralization of trauma care and subspecialization of emergency trauma and surgical care has become relevant [17, 18].

Thus, three strategies of osteosynthesis surgeries can be distinguished, namely, emergency surgeries upon hospital admission, delayed surgeries in elective operating rooms during daytime, and a combination of these two strategies.

Performing urgent surgeries of osteosynthesis of fractures has benefits and drawbacks. Analysis of the results of the I.I. Dzhanelidze Research Institute of Emergency Medicine showed that the practice of emergency osteosynthesis of isolated fractures leads to a significant decrease in hospital stay. Contrary to literature data, we have not registered an increase in the number of early osteosynthesis complications associated with emergency surgery. Nevertheless, it appears theoretically more adequate to perform surgeries

during working hours when all the most experienced surgeons are in the clinic, and in case of intraoperative complications or unforeseen situations, they can be fully involved, and all clinic resources are available. This is a global problem and consists in the lack of operating rooms. The desire of surgeons to operate should not be disregarded, as it can be fully actualized during duty hours. This is true for young surgeons.

Some fractures are quite difficult for osteosynthesis, which is impossible to perform or can be performed with inadequate quality by the team of on-duty traumatologists. To avoid such situations, we have defined a list of osteosynthesis surgeries that can be performed on an urgent basis. According to this list, internal osteosynthesis is indicated in isolated and combined cases with a favorable prognosis for the surgical treatment of fractures and dislocations of the clavicle according to Yu.N. Tsibin – A.N. Keyer, as well as two-part fractures of the surgical neck of the humerus, fractures of the olecranon, diaphyseal fractures of the forearm bones, extra-articular fractures of the distal radius, medial fractures of the femoral neck (in case of indications for osteosynthesis), transtrochanteric, subtrochanteric, and diaphyseal fractures of the femoral bone, low-energy fractures of the tibial shaft, fractures of the ankles (in the absence of pronounced soft tissue edema), fractures of the patella, bones of the hand and foot, fractures and dislocations of the talus bone. Primary immobilization of the fracture with an external fixation apparatus is indicated in all cases with unstable hemodynamics (systolic blood pressure <90 mm Hg), unfavorable prognosis of surgical treatment according to Yu.N. Tsibin – A.N. Keyer for fractures of the knee and ankle joints, diaphyseal part of the lower leg due to high-energy trauma, with open fractures G2–G3 (according to the Gustillo–Andersen classification), fractures of the long bones of the lower extremities with polytrauma (ISS > 17) when internal fixation is impossible, and unstable damage to the pelvic ring (if it is impossible to perform primary internal osteosynthesis of the pelvic bones and stabilize the fracture).

The material presented herein is only the beginning of a large work on the analysis of the results and duration of inpatient treatment of patients, depending on the timing of osteosynthesis surgeries. The data obtained indicate that emergency osteosynthesis surgeries with certain injuries are safe in terms of the quality of their performance and infectious complications and deserve to be used. On the contrary, the optimization of the hospital operation during daytime can decrease the need for emergency osteosynthesis surgeries and reduce the load on the bed capacity, making the problem of emergency osteosynthesis less urgent.

Regarding urgent osteosynthesis surgeries, it is necessary to define clearly the groups of patients depending on the nature and location of the fracture, that is, who should undergo such surgeries, with the creation of adequate algorithms for choosing a treatment method and strict adherence to them. In addition, the introduction of performing urgent osteosynthesis requires serious organizational measures. Not all trauma centers, even if they wish, can presently shift to such a practice of providing assistance due to the peculiarities of the staffing and organizational structure. Thus, conducting an economic justification for the expediency of the approach outlined is extremely important.

CONCLUSIONS

Nowadays, the trauma community lacks the unanimity of views on the optimal strategy for osteosynthesis surgeries. The lack of consensus is due to the multifactorial nature of the problem, which affects the organization of the provision of specialized trauma care, financing, staffing of the hospital, and professional training of the personnel.

The conclusions about which strategy of osteosynthesis surgery is optimal can be made after an extensive discussion of this problem and a deeper analysis of it.

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Author contribution

All authors made equal contributions to the study and the publication.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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