

Research Article

<https://doi.org/10.23934/2223-9022-2022-11-1-199-209>

Emergency Traumatology at the N.V. Sklifosovsky Research Institute for Emergency Medicine: History and Modernity

A.M. Fain, V.B. Bondarev ✉, **A.Yu. Vaza, M.A. Malygina, I.Yu. Miguleva, K.V. Svetlov**

Department of Emergency Traumatology of the Musculoskeletal System
N.V. Sklifosovsky Research Institute for Emergency Medicine
3 Bolshaya Sukharevskaya Square, Moscow 129090, Russian Federation

✉ **Contacts:** Vasily B. Bondarev, Researcher of the Department of Emergency Traumatology of the Musculoskeletal System N.V. Sklifosovsky Research Institute for Emergency Medicine. Email: bondarev.niisp@gmail.com

SUMMARY The purpose of this work was to study the history of the development of traumatology-orthopedics at the N.V. Sklifosovsky Research Institute for Emergency Medicine.

Traumatology as an independent discipline began to form at the N.V. Sklifosovsky Research Institute for Emergency Medicine during the reign of Professor S.S. Yudin (chief surgeon since 1928), who invited the famous Argentinean traumatologist-orthopedist Professor Lelio Zeno to work at the institute.

In 1932, the trauma department of the N.V. Sklifosovsky Research Institute for Emergency Medicine was headed by Professor V.V. Gorinevskaya. She organized a 100-bed trauma clinic for the treatment of injuries to the head, spine, limbs, chest and abdominal cavity. She is rightfully considered one of the founders of trauma science in the USSR.

With the development of traumatology and orthopedics as an independent specialty in 1961, two clinics were formed at the institute. The first trauma clinic was run by Dr. med. sciences professor I.I. Sokolov. The second clinic was headed by Dr. med. Sci. P.N. Petrov.

In 1971, Dr. med. Professor, Honored Scientist of the Russian Federation, Academician of the Russian Academy of Medical and Technical Sciences of the Russian Federation V.P. Okhotsky was appointed the head of the traumatological service of the institute and the chief traumatologist of Moscow (from 1971 to 2001). With his active participation in Moscow, the reorganization of outpatient care was completed, work was widely launched on the medical aspects of the prevention of road traffic injuries and the introduction into practice of the most rational methods of diagnosis and treatment of patients with injuries of the musculoskeletal system. In the N.V. Sklifosovsky Research Institute for Emergency Medicine A.G. Suvalyan introduced the method of intramedullary osteosynthesis of long tubular bones (humerus, femur and tibia). Under the guidance of prof. V.P. Okhotsky the dissertation researches of A.G. Suvalyan, M.A. Suvalyan and S.S. Myakota were carried out. The expediency of early surgical intervention on the extremities in case of combined traumatic brain injury and multiple trauma of the extremities has also been proven, new functional methods of treatment of diaphyseal fractures of the shoulder, lower leg, spine and intra-articular injuries have been developed.

In close scientific cooperation with scientists from other clinics of the institute, a comprehensive method of treating open injuries of the limbs has been developed (dissertation researches of I.F. Byalik, I.Yu. Klyukvin, O.P. Filippov, M.V. Zvezdina, R.S. Titov). Much scientific work has been carried out to improve the diagnosis and treatment of intra-articular injuries of the knee joint (dissertation researches by M.A. Malygina, O.P. Filippov, A.Yu. Vaza).

From 2001 to 2016 the head of the department of emergency traumatology of the musculoskeletal system was a student of prof. V.P. Okhotsky – Dr. med. sciences, Professor, Academician of the Academy of Medical and Technical Sciences of the Russian Federation I.Yu. Klyukvin. Since 2016 the department is headed by Dr. med. sciences Alexey M. Fine.

The scientific developments of the employees of the Department of Emergency Traumatology have a practical orientation. Every year, the department's employees successfully perform more than 2500 surgical interventions using advanced low-traumatic techniques, making extensive use of the achievements of biotechnology.

Keywords: history of traumatology, emergency traumatology, N.V. Sklifosovsky Research Institute for Emergency Medicine

For citation Fain AM, Bondarev VB, Vaza AY, Malygina MA, Miguleva IYu, Svetlov KV. Emergency Traumatology at the N.V. Sklifosovsky Research Institute for Emergency Medicine: History and Modernity. *Russian Sklifosovsky Journal of Emergency Medical Care*. 2022;11(1):199–209. <https://doi.org/10.23934/2223-9022-2022-11-1-199-209> (in Russ.)

Conflict of interest Authors declare lack of the conflicts of interests

Acknowledgments, sponsorship The study has no sponsorship

Affiliations

Aleksey M. Fain	Doctor of Medical Sciences, Head of the Scientific Department of Emergency Traumatology of the Musculoskeletal System, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0001-8616-920X , finn.loko@mail.ru ; 50%, preparation of the article plan, writing part of the text, checking, making corrections
Vasily B. Bondarev	Researcher of the Department of Emergency Traumatology of the Musculoskeletal System, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0002-1183-3644 , bondarev.niisp@gmail.com ; 10%, writing part of the text of the article, checking, making edits
Alexander Yu. Vaza	Candidate of Medical Sciences, Leading Researcher of the Department of Emergency Traumatology of the Musculoskeletal System, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0003-4581-449X , vazal@inbox.ru ; 10%, checking, making edits

Marina A. Malygina	Doctor of Medical Sciences, Senior Lecturer of the Training Center, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0002-2748-6931 , lapundra@bk.ru ; 10%, writing part of the text of the article, checking, making edits
Irina Yu. Miguleva	Doctor of Medical Sciences, Senior Researcher of the Department of Emergency Traumatology of the Musculoskeletal System, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0002-6894-1427 , imiguleva@mail.ru ; 10%, writing part of the text of the article, checking, making edits
Kirill V. Svetlov	Candidate of Medical Sciences, Senior Researcher of the Department of Emergency Traumatology of the Musculoskeletal System, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0002-1538-0515 , Svetloffkirill@yandex.ru ; 10%, writing part of the text of the article, checking, making edits

A lot of significant events in the history of the development of our institute are associated with the name of Sergei Sergeevich Yudin (Fig. 1). The history of the development of the institute's trauma service is closely related to this name. Professor Yudin not only dealt with the problem of trauma of the musculoskeletal system himself, but also understood the need to separate traumatology into a independent specialty. Back in 1925 S.S. Yudin reported at the congress of Russian surgeons on the surgical treatment of forearm fractures using metal plates in 26 patients.

The year of birth of traumatology as an independent specialty at the Sklifosovsky Institute can be considered 1931. It was then that S.S. Yudin, having enlisted the support of the future People's Commissar of Health T.N. Kaminsky, invited the famous Argentine professor Lelio Zeno to work at our institute (Fig. 2), who for many years operated in leading clinics in Europe and America and was a first-class orthopedic traumatologist [1].



Fig. 1. Sergei Sergeevich Yudin (1891–1954)



Fig. 2. Lelio Zeno (1890–1968)

Professor Zeno introduced into practice advanced conservative and surgical methods based on the fracture treatment system proposed by Lorenz Beler. Professor Zeno was not only an excellent surgeon, but also a talented teacher. In those years at the N.V. Sklifosovsky Institute, one of the future founders of the Russian school of traumatology and orthopedics, Arkady Vladimirovich Kaplan, completed his residency. His first mentor in surgery was an outstanding (according to A.V. Kaplan - a genius) surgeon Sergei Sergeevich Yudin. Prof. Zeno immediately singled out A.V. Kaplan among young doctors and residents as the most gifted man and enjoyed working with him, thus becoming the first mentor of Arkady Vladimirovich in traumatology [2].

Working at the institute, L. Zeno for the first time in our country (with the participation of B.A. Petrov and A.V. Kaplan) performed an open osteosynthesis of the femoral neck with a three-blade Smith-Peterson nail - a landmark operation for all traumatologists

In 1932 Professor L. Zeno returned to Argentina. His impressions of the organization of medical care in the Soviet country are described in his book "Medicine in Russia". There is one more interesting fact of his biography. In the fall of 1935, he went to the Soviet Union for the second time and even joined the Union of Health Workers of the RSFSR. This time his stay in Russia was 1.5 years. He created and

developed the second after the Sklifosovsky Institute the Traumatology Center in Moscow on the basis of the Basmanny Hospital. Below is the original text of the employment contract concluded by the administration of the Basmanny Hospital with Prof. L. Zeno [3].

Contract

This agreement is concluded between Professor L. Zeno and the Basmannaya Hospital in the person of its director, Comrade Kechker, on the other hand, consisting of the following:

1. Prof. Zeno since 2 / VI 1935, has been in charge of the trauma department of the Basmanny Hospital and is fully responsible for the quality of work, in accordance with the existing statutes and instructions of the People's Commissariat for Health; in his work is directly subordinate to the director of the hospital, following all his instructions on the production work of the department.

2. Conducts research work according to the plan approved in advance by the director of the hospital, providing the latter with literary works designed for publication on time

3. Conducts training and improvement of medical and secondary personnel.

4. Supervises the work of the district trauma center in the V single Dispensary.

For the conducted by prof. Zeno work Basmanny hospital for its part:

1. Pays to prof. Zeno 1000 (one thousand rubles) per month.

2. Provides him with an apartment.

3. Contains a translator at the expense of the hospital.

4. Provides prof. Zeno is entitled to travel abroad at his expense without pay once a year, excluding travel to international conventions.

This agreement is concluded for 1 (one) year from the date of its signing.

3.07.1935 г.

Hospital director (L. Kechker).

Prof. Zeno (Zeno)

For many decades, before the start of the "optimization of health care", the center he founded (the future department of hand surgery) successfully functioned in the city clinical hospital No. 6 on Novaya Basmannaya street and was the clinical base of the scientific department of emergency traumatology of the N.V. Sklifosovsky Institute. The Argentine surgeon intended to unite the existing orthopedic centers in Kharkov, Moscow, Leningrad, Yekaterinburg and proposed a plan to improve trauma care in the context of intensive industrialization, promote new techniques, and train professional young orthopedists. Now, unfortunately, it is no longer possible to find out why these plans were not destined to come true. But we can say with confidence that 90 years ago, only the recently implemented idea of creating trauma centers of various levels was born in Russia.

The basis for the transformations of the Institute's traumatology, carried out with the support of S.S. Yudin, the principles of treating the victims and the original equipment of Lorenz Beler, supplied to the Institute for Emergency Medicine at L. Zeno's own funds.

In 1932 L. Zeno wrote an article, and S.S. Yudin, having translated it into Russian, on behalf of the author read a report at a meeting of the Surgical Society of Moscow and the Moscow Region on the "impending military epidemic", on promising methods of treating wounds and open fractures. Below is a direct quote from this report published in the journal New Surgical Archives [4].

THE PROBLEM OF TRAUMATOLOGY

Prof. Lelio O. Zeno (Rosario, Argentina)

"Bone fractures are accidents that require particularly urgent treatment. Most of the poor results in the treatment of fractures are the result of either incorrect, temporary measures, or palliative measures, or delayed reduction of a broken limb. Loss of tissue elasticity, muscle retraction, pain, and worsening spasms will continue until the broken bones are put into place. At the same time, the fracture reposition itself is much easier if it is done in the first hours after the fracture. Each fracture is a sophisticated traumatic complex, which includes not only bone damage, but also a number of adjacent tissues and entire organs: muscles, nerves, blood vessels, skin. The psyche of the victims also suffers a lot. Early reduction of bone fragments best prevents persistent and difficult to correct muscle retraction, degeneration of tissues, ligaments and joint stiffness. This shortens the term of disability, restoration of working capacity comes faster and more completely.

Just as military surgery provides for an appropriate medical and surgical organization within the army itself, so traumatology finds its obligatory place in industry. A striking example of the same can be the Sklifosovsky Institute, organized for emergency surgery in the capital of the USSR. This Institute, thanks to the good organization of communication, transport and hospitalization, makes it possible to provide extremely

clearly and quickly the necessary surgical care in the most critical cases of injuries and dangerous diseases. Heart wounds are delivered to the operating table as soon as possible after the accident. The tremendous successes of this institution in the treatment of acute appendicitis, perforated ulcers and internal bleeding (ectopic pregnancies), etc., are due precisely to the correctly understood goal of the central Institute of Emergency Surgery.

No one doubts the importance of such institutions for vital diseases. A different matter in relation to traumatics. Not all doctors understand enough to themselves that most traumatics require not only the most thoughtful attitude to themselves, but the main thing is absolutely urgent surgical care”.

After this report Prof. V.V. Gorinevskaya and Prof. N.N. Burdenko criticized L. Zeno for his ideological incontinence, and S.S. Yudin was branded as a right-wing opportunist and alarmist. Nevertheless, L. Zeno, with the support of S.S. Yudin, managed to insist on publishing in 1932, albeit in an abbreviated form, the work of L. Beler "Methods for the treatment of bone fractures" ("Die Technik der Knochenbruchbehandlung". - 1929) in Russian and introduce methods of treatment of fractures into the practice of the Institute, promoted by L. Beler [6].

In 1932, the Trauma Department of the N.V. Sklifosovsky Institute was headed by Valentina Valentinovna Gorinevskaya (Fig. 3). At the same time, a traumatology clinic with 100 beds was opened.

B V.V. Gorinevskaya is one of the founders of trauma science in the USSR, an active promoter of physical education and physiotherapy in the treatment of injuries and wounds. Her guide "Fundamentals of Traumatology" (1936) went through three editions and for many years was the reference book of traumatologists and surgeons. In 1941 she published the book "Modern methods of treating wounds", and in 1942 she published her book "First surgical aid for injuries in war and peacetime".

In October 1941, the Institute's trauma clinic ceased to exist, and the treatment of trauma patients passed to general surgeons. On the basis of the N.V. Sklifosovsky Research Institute for Emergency Medicine, an evacuation hospital for the wounded was organized at that time. The leading surgeons of the institute (D.A.Arapov, A.A.Bocharov, B.A.Petrov, V.V.Gorinevskaya, I.I.Sokolov and others) went to the front. V.V. Gorinevskaya headed the work of hospitals for the treatment of lightly wounded. At that time, the institute organized a surgical hospital for the wounded, headed by S.S. Yudin [5].

Later, with the development of traumatology and orthopedics as an independent discipline, two traumatology clinics were organized at the institute (1961).

For many years, the first trauma clinic was headed by the chief traumatologist of Moscow, Doctor of Medical Sciences, Professor I.I. Sokolov. He developed issues of urgent surgical treatment for injured limbs. In 1950, for the work "Intraosseous fixation with a metal rod in fractures of the hip, lower leg, shoulder and forearm" he was awarded the Prize. S.I. Spasokukotsky. The second clinic was headed by P.N. Petrov, who was engaged in the surgical treatment of fractures using homografts [19].

In February 1971, Professor V.P. Okhotskiy was appointed the head of the department of emergency traumatology of the musculoskeletal system and the chief traumatologist of Moscow (Fig. 4).



Fig. 3. Valentina Valentinovna Gorinevskaya (1891–1954)



Fig. 4. Vladimir Pavlovich Okhotskiy (1924–2016)

Vladimir Pavlovich Okhotskiy went through the Great Patriotic War at the very front line. From September 1943 in the rank of junior lieutenant, he fought as a paramedic, commander of a medical platoon on the First Baltic Front in the Lithuanian rifle division.

Like most front-line soldiers, Vladimir Pavlovich talked very little about the war, and even more so about his awards. From the archives of the Ministry of Defense, we learned that the junior lieutenant of Okhotskiy V.P. was the best commander of the regiment's sanitary platoon.

From the presentation to the awards: "in 1943, in a battle under enemy fire, being wounded himself, he personally carried a wounded tanker from a burning tank, a wounded commander from the battlefield. 1944 in a battle near Klaipeda, he personally carried out 12 seriously wounded in full gear, he was able to organize medical assistance for them". For military exploits V.P. Okhotskiy was awarded two Orders of the Red Star, Orders of the Patriotic War, 2nd and 1st degree, the medal "For Victory over Germany" and the medal "For Victory over Japan".

With the name of V.P. Okhotskiy is associated with many achievements both in traumatology and orthopedics itself, and in the organization of public health services in Moscow. Created by V.P. Okhotskiy as the chief traumatologist of Moscow, a well-organized system of outpatient trauma care, which, despite all attempts to "reorganize", "improve" and "optimize" it, still works to this day.

By the 70s, surgical treatment of fractures was widely used both throughout the country and at the N.V. Sklifosovsky Institute. We used all types of osteosynthesis: extramedullary, intramedullary and extrafocal osteosynthesis with Ilizarov devices. With the arrival of Professor V.P. Okhotskiy, the institute began to introduce intramedullary osteosynthesis with massive pins with reaming of the bone marrow canal. The fundamental difference from the generally accepted methods of immersion osteosynthesis at that time was that in the postoperative period, due to the strong fixation of the fragments with massive pins, in most cases additional external immobilization was not required. This made the patient more mobile, made it possible to carry out early development of movements in the joints, to exercise the load on the injured limb with an incompletely healed fracture, which ultimately led to a reduction in the time of restorative treatment. The method of closed intramedullary osteosynthesis with massive pins, developed by the staff of the N.V. Sklifosovsky Institute was introduced into clinical practice throughout the country. An invaluable contribution to the development and implementation of this method of osteosynthesis was made by Prof. Avetis Grigorievich Suvalyan (1934 -2006) (Fig. 5).



Fig. 5. On the left — prof. V.P. Okhotskiy, on the right _ prof. A.G. Suvalyan

V.P. Okhotskiy was also one of the pioneers in the study of the problems of treating patients with concomitant trauma in our country. Prof. V.P. Okhotskiy together with Prof. V.V. Lebedev, for the first time in the country, developed the tactics of early osteosynthesis on the limbs with combined traumatic brain injury and made a keynote speech at the III All-Union Congress of Traumatologists and Orthopedists in 1975, and a monograph on this topic was published in 1980.

In the 1980s, closed intramedullary osteosynthesis with blocked pins was developed in foreign countries. This expanded the possibilities of closed osteosynthesis, especially in the treatment of

unstable, complex, comminuted fractures. This method was introduced into practice for the first time in Russia at the N.V. Sklifosovsky Research Institute for Emergency Medicine. The credit for this also belongs to Prof. A.G. Suvalyan. This method meets the following requirements: minimal trauma to functionally important structures in the fracture zone, minimal blood loss, strong fixation of bone fragments, which makes it possible to exclude external immobilization and, as a result, significantly reduce the risk of postoperative purulent complications, which was proved by the scientific research of S.S. Myakota and M.A. Suvalyan. In 1995, the first operation on closed osteosynthesis of the tibia with a lockable pin was performed. The operation was performed by Prof. A.G. Suvalyan, assisted by S.S. Myakota. The low trauma of the method of closed osteosynthesis with lockable pins predetermined the possibility of its implementation in patients with multiple and concomitant trauma even at the resuscitation stage in the presence of anemia and hypoproteinemia. Today, closed osteosynthesis with locking pins is the main one in the treatment of diaphyseal fractures all over the world.

Sklifosovsky Research Institute became one of the first clinics in Moscow, where the beginning of the formation of hand surgery as an independent branch of traumatology and orthopedics with the provision of specialized assistance to the population and the training of qualified medical personnel was laid.

Back in 1948, a monograph by the first head of the Institute's trauma clinic, Prof. V.V. Gorinevskaya, "Injuries to the hand and their treatment" was published [7]. It was one of the first domestic special guidelines for hand surgery, which touched on a wide range of problems in the treatment of industrial and household damages.

The first scientific research on hand surgery at the Institute of Emergency Medicine began in the second half of the 1950s, and was devoted to the treatment and rehabilitation of patients with flexor tendon injuries, the in-depth development of functional treatment methods for such injuries, and a number of others [8, 9].

In 1971, on the basis of the department of emergency traumatology of the musculoskeletal system, created by combining two trauma clinics, a group of doctors (V.P. Vershinin, T.N. Yashina, V.V. Chukin and I.M. Prokhorov) was entrusted with the development of the most relevant topics in practical terms: osteosynthesis of the bones of the hand, restoration of the damaged skin of the hand, treatment of injuries of the flexor tendons of the fingers.

Traumatologists of the N.V. Sklifosovsky Institute were among the first domestic specialists who began to successfully apply bone osteosynthesis with needles and develop its advanced technologies. Osteosynthesis with wires has become the basis of all restorative operations for open fractures of the phalanges of the fingers and metacarpal bones; for the first time it was recommended to perform it simultaneously with skin grafting. In subsequent years, the methods of osteosynthesis of the bones of the hand in the department of emergency traumatology of the musculoskeletal system of the Research Institute of the EM were further developed. A technique was developed for osteosynthesis of distal phalanges with thin wires (L.L. Pavlyuchenko, 1979), and the possibilities of using osteosynthesis with thin wires with restoration of congruence of articular surfaces simultaneously with endoprosthesis of flexor tendons or restoration of extensor tendons with open intra-articular injuries of the fingers of various degrees of severity (V.P. Okhotskiy, I.Yu. Miguleva, T.N. Yashina, 1998) [10, 11].

A system of complex treatment of traumatic wounds of the upper extremity was developed with the aim of sanitizing and preparing them for skin-plastic operations using low-frequency ultrasound, the effectiveness of which was confirmed in the treatment of more than 500 patients (E. Ya. Dubrov, T.N. Yashina, A. A. Orlova, O. P. Filippov, 1977).

Employees of the N.V. Sklifosovsky Research Institute for Emergency Medicine, became pioneers in the use of domestic optical quantum generators for laser therapy for open injuries of the hand (A.P. Kuzmichev, V.P. Okhotskiy, A.K. Polonskiy, L.L. Pavlyuk-Pavlyuchenko, I.Z. Nemtsev, 1979) [12].

Together with the Department of Angiography and Endovascular Surgery (headed by Prof. L.S. Zingerman), the state of blood circulation in the hand and forearm was studied using the angiographic method (T.N. Yashina, T.I. Kiseleva, 1986). Together with the Moscow City Medical and Physical Training Dispensary, a study of the anatomical and clinical features of the structure and injuries of the metacarpal bones was carried out.

Organization by Prof. V.P. Okhotskiy in February 1978, the clinical base at the City Clinical Hospital No. 6 in the opened specialized department of hand injury for 60 beds, became a qualitatively new stage in the development of hand surgery at the N.V. Sklifosovsky Institute. For permanent work in this department immediately after its opening, Prof. V.P. Okhotskiy sent researchers from the N.V. Sklifosovsky Institute – T.N. Yashina and L.L. Pavlyuk-Pavlyuchenko, and in 1985 – I.Yu. Miguleva.

On the basis of the specialized department of hand trauma, scientific work was launched to create new effective methods of primary plastic surgery for fresh injuries of the flexor tendons in the area of the fibro-synovial canals of the fingers, programs of postoperative rehabilitation of patients, which was entrusted to the junior researcher L.L. Pavlyuk-Pavlyuchenko. In 1979-80 when studying the indications for deep flexor tendon reinsertion surgery and developing two of its variants L.L. Pavlyuk-Pavlyuchenko was one of the first to use ultrasonic echolocation to determine the position of the ends of the transected tendon. In 1983 in the clinical practise also were used silicone flexor tendon endoprotheses for the first time.

Under the guidance of Prof. V.P. Okhotskiy, a huge contribution to solving problems of hand surgery was made by I. Yu. Miguleva, who for many years has been successfully engaged in the clinical application of plastic surgery on the flexor tendons of the fingers of the hand at various times after injury [13].

On the basis of the Department of Hand Surgery, a method of conservative treatment of closed fractures of the metacarpal bones was developed and introduced into practice (Miguleva I.Yu., Semiletov G.A., Mirzoyan A.S., 2002), based on the principles of early functional treatment. Interestingly, this previously developed method of conservative treatment of closed metacarpal fractures proved to be in demand and proved to be effective when admitting patients with fractures of both cervical and diaphyseal localization, during the period of work in an epidemic regime according to Covid-19.

By 2008, the Department developed a two-stage technique for endoprosthetics of finger joints with preliminary distraction in the apparatus at the first stage (Ph.D. A.V. Afanasyev).

On various problems of treating hand injuries by traumatologists of the N.V. Sklifosovsky Institute and GKB No. 6, a total of about 90 scientific articles were published in domestic medical journals and more than 250 reports were made at various conferences and congresses.

An important milestone in the development of emergency traumatology at the N.V. Sklifosovsky Research Institute became 2018, when a group of reconstructive surgeons was included in the trauma department. The Department of Emergency Reconstructive and Plastic Surgery was organized at the Institute in 2000. On the initiative of the director of N.V. Sklifosovsky Institute, Prof. A.S. Ermolov, with the active patronage of Prof. V.L. Lemenev, a group of microsurgeons came to the institute (A.V. Sachkov, K.V. Svetlov, A.V. Chemodurov), the head of the group was Ph.D. E.Yu. Shibaev. The traditional sphere of "interests" of microsurgeons was traumatology - severe trauma of the extremities with damage to blood vessels, nerves, tendons, open fractures with impaired circulation of the extremities, complete traumatic amputations, crush injuries of the extremities.

Replantology, and this is the name of the branch of surgery designed to return - replant segments of the hand, limbs, separated as a result of trauma. It was replantology that became the "calling card" of emergency microsurgery.

In the early 2000s, the first replantations of fingers, segments of the hand and limb at different levels were performed in the institute. Gradually operations on replantation of severed fingers, etc. became routine at the institute, that operations were performed by all employees of the department.

The loss of a limb or its segments is a serious injury, and in the absence of the possibility of providing specialized care, it leads to profound disability.

However, even if replantation is performed, there is always a risk of complications, primarily vascular, which result in necrosis of the replant. But damage is not uncommon when replantation is impracticable due to the destruction of the detached fragment itself.

In both situations, the result is a fangless brush that loses its unique functions. The only solution to the problem of a fingerless hand was autotransplantation of a toe into the position of a lost finger. The transplantation of a toe to a hand is based on the replantation technology, when sequentially osteosynthesis is performed, the suture of the flexor and extensor tendons, and, in fact, the micro-stage. This stage is the quintessence of microsurgery, when veins, arteries and nerves of an autograft are restored under optical (up to 20 times) magnification. It is the defining moment of the operation. The difference between autotransplantation and replantation is the stage of graft collection on the foot, with the isolation of blood vessels, nerves, tendons. Autotransplantation of toes on the hand is currently the only way to rehabilitate a fingerless hand. Available as single or multiple, it results in a hand capable of performing basic functional grips. Toe autotransplantation is also successfully applied in the case of congenital absence of fingers in children. The result of the operation is a hand with sensitive fingers that perform basic grips, allowing for successful functional rehabilitation of the hand [14].

Perhaps one of the most important stages in the treatment of severe open injuries of the limbs is the restoration of full-fledged skin. This can be achieved by traditional methods, for example, autodermoplasty (ADP), local plastic surgery. But the implementation of ADP is not always possible due to the depth of the wound, the complexity of the relief, the presence, nature and significance of the underlying structures, and local plastic surgery is not feasible due to the lack of resources of the surrounding tissues.

Indications for the use of free autologous transplantation are extensive defects of the skin, accompanied by exposure of significant structures (vessels, nerves, tendons, bones) of the limb, if it is impossible to perform traditional interventions.

The situation worsens significantly if the defect of the integumentary tissues coincides with the area of the fracture. As you know, for the successful consolidation of a fracture, an adequately blood-supplied soft tissue bed is necessary, and the fracture itself must be isolated from the external environment, which guarantees it from infection. A vascularized musculocutaneous graft not only restores reliable skin, but also, due to the muscle portion of the graft, provides conditions for fracture consolidation. In addition, the graft muscle successfully resists infection [15].

Localization of soft tissue defects is diverse and can be found in any anatomical region. Unfortunately, such situations arise not only in the practice of a traumatologist, but also in the practice of a neurosurgeon. Inconsistency of skin sutures in the area of surgical approaches in the convexital section of the skull after trepanation, osteoplastic operations is not rare condition. Taking into account the localization and relative deficiency of the soft tissue resource, such a complication can lead to the formation of an extensive defect in the integument, necrosis of the underlying bone, and other negative consequences.

We have experience in the successful closure of a defect in the fronto-parietal region with a free vascularized graft, namely, a radial-fascial skin flap. The blood circulation in the graft is restored by anastomosing the graft artery and the temporal artery. As a result, it is possible to achieve replacement of the defect of problem localization with a good cosmetic and functional result [16].

Treatment of osteomyelitis of any localization, which has a chronic wave-like course, gives a lot of concern to the patient and currently remains a difficult surgical task. Osteomyelitis in a broad sense is not only inflammatory changes in the bone itself, but also in the bone marrow, surrounding and integumentary tissues. In the course of surgical treatment, it is necessary to perform not only osteonelectomy, removal of sequestration, but also often - altered skin around the fistulas, scars. Often, patients undergo several local plastic surgeries, sometimes until the supply of soft tissues in the affected area is depleted. And again, the task of closing a skin defect becomes urgent. Professor A.N. Pogodina and E.Yu. Shibaev jointly developed a technique for the surgical treatment of patients with chronic osteomyelitis of the ribs. After osteonelectomy of the affected rib, plastic surgery of the resulting defect was performed with a muscle graft from the pectoralis major muscle on the feeding pedicle [27].

Another example of the versatility of the microsurgical method, free transplantation of tissue complexes - joint work with combustiologists. Thermal injury is a severe lesion, differs in the prevalence and depth of the lesion. Deep burns lead to the death of the skin, and after performing necrectomy - to the exposure of the underlying formations. Burns located in functionally significant areas, such as joints, projections of great vessels, require restoration of the lost integument with tissues that are not subject to retraction, rough scarring. That is, autodermoplasty, traditionally and successfully used in the burn department, is not always feasible due to the anatomical features of the affected area. In these cases, in the early stages of a deep burn, necrectomy, osteonelectomy is performed, and the resulting defect is covered with a free vascularized graft. Plastic surgery preserves the joint and function of the limb.

An extremely difficult group of patients - with extended tracheal defects arising from various reasons, but with a single result - the formation of a combined skin defect of the anterior neck surface and the underlying trachea. Such a complication dooms the patient to a tangible decrease in the quality of life, social and labor maladjustment for a long time or for life. Another example of the productive cooperation of Prof. A.N. Pogodina and E.Yu. Shibaev - development of a technique for closing tracheal fenestrated defects with the reconstruction of its cartilaginous frame, when the possibilities of modern microsurgery, tissue autotransplantation and prefabricated tissue complexes radically expand the possibilities of reconstructive surgery. The first stage was prefabrication - implantation of rib cartilage strips into the thickness of the pectoralis major muscle. At the second stage, the tracheal defect was replaced with a prefabricated musculocartilaginous flap of the pectoralis major muscle on the vascular pedicle. In addition to closing the tracheal defect itself, a well-perfused graft successfully fights chronic infection in the area of operation [17].

Injuries to the anterior part of the neck, oncological diseases, complications of purulent-inflammatory diseases often lead to the formation of defects in the esophagus. Such complications are difficult for patients to tolerate, cause a lot of difficulties in everyday life, and disable the patient. One of the options for microsurgical restoration of the anatomical integrity of the esophagus is its reconstruction with a portion of the jejunum. An important condition for performing such an operation is the condition of the tissues, great vessels, in the area of often transferred radiation therapy [18].

The past spring and summer have become a real test for the entire health care system in Moscow. The re-profiling of many Moscow hospitals for infectious diseases hospitals could not but affect the

microsurgical service of the Institute. At the moment when all hospitals specializing in treating hand trauma were redesigned, the Institute took over significantly, several times, an increased flow of victims with injuries of the hand and upper limb. The microsurgical service of the Institute, in close cooperation with traumatologists, surgeons, managed to cope with the flow of patients, provided and continues to provide highly qualified surgical care throughout the quarantine period.

Currently, the Department of Emergency Traumatology not only successfully applies advanced minimally invasive osteosynthesis technologies using modern lockable pins and plates, but also develops and implements its own original techniques.

The traditional cooperation of the Department of Emergency Traumatology with the Department of Cell and Tissue Technologies is currently undergoing a new development. High-tech techniques for replacing bone defects (bone alloplasty) and stimulating osteogenesis are being developed jointly. The developed implant from non-demineralized cancellous bone has long-lasting mechanical strength, which, in combination with bone osteosynthesis, provides stable fixation and the possibility of early loading on the limb [20, 21, 22].

A sponge made of allogeneic collagen type 1 with bone chips has a more pronounced osteoconductive effect than non-demineralized cancellous bone, which leads to a more complete restoration of the structure of the bone in the defect zone. The developed combined perforated implant from non-demineralized cancellous bone and collagen sponge combines the mechanical strength of an implant from non-demineralized bone and the pronounced osteoconductive effect of a sponge made from allogeneic collagen type 1. The results of the use of this implant indicate the prospects of its use [23].

In our country, the life expectancy of the population is increasing, which, of course, is a positive trend. But at the same time, the number of patients with severe osteoporosis is growing. The problem of treating fractures against the background of a deficiency of bone mass is an urgent and complex problem of our time. The appearance of plates with locking screws in the practice of traumatologists only partially helps to solve this problem, and the result of traditional osteosynthesis in conditions of a deficit of bone mass often remains unsatisfactory [24]. An example of this is fractures of the proximal humerus, when osteosynthesis in conditions of pronounced bone mass deficit often ends with a collapse of the humerus head, eruption of screws, a sharp limitation of the function of the shoulder joint, and constant pain syndrome.

Together with the staff of the Department of Cellular and Tissue Technologies, a transplant was developed, patented and introduced into clinical practice. This is a transplant from the head of the fibula, which has osteoconductive properties and which can be given osteoinductive properties by impregnating with biologically active substances. The developed method includes the technique of reduction and augmentation of the proximal humerus with a perforated allograft from the fibular head impregnated with type 1 collagen [23, 25].

The use of the method allows avoiding shoulder arthroplasty, achieving good functional results and dramatically improving the patient's quality of life.

A promising direction in the development of traumatology at the N.V. Sklifosovsky Research Institute - the use of new implants. Metal fixators traditionally used in the osteosynthesis of intra-articular fractures, have a number of disadvantages: the need to remove them in some situations, rather frequent migrations of the wires, significant interference with computed and magnetic resonance imaging, which significantly complicates the interpretation of the results of these studies.

Bioresorbable PLGA (glycated lactic acid) implants can serve as an alternative to traditional fixators in certain cases. These fixators have the following useful properties - they are completely bioresorbable within 2 years, after insertion into the bone, within 24 hours they are shortened by 2% and increase in volume by 2% (self-compression effect), the pins have ribs that prevent migration.

Currently, more than 100 operations have been performed for intra-articular injuries of all localizations, work continues on the scientific substantiation and features of the use of bioresorbable implants in modern traumatology. An example is the developed technique of osteosynthesis of fractures of the tibial condyles. In 41B2 fractures (according to the AO-OTA classification), when compression of the condyle was not accompanied by a split, the settled area of the articular surface was lifted through the burr hole, two bioresorbable pins were inserted subchondrally in the sagittal plane, and then two bioresorbable screws were inserted in the frontal plane in such a way that the elevated and the repositioned bone-cartilaginous area relied on them. For fractures 41B3, 41C3, bioresorbable pins were used to fix the fragmented articular bone and cartilage plate. The fragments were fastened by stringing on pins that were passed through the subchondral bone. After that, the articular site was repositioned, the bone defect was filled with osteoplastic material, the fracture was fixed with a metal plate [26].

The Department of Emergency Traumatology today (Fig. 6) has more than 3 thousand patients and 2700 operations per year. Of these, about 450 surgeries are performed by microsurgeons, more than 500 patients with fractures of the proximal femur (the average age of patients with this pathology is 83.5 years).). Treatment of patients of older age groups with fractures of the proximal femur is a separate and complex medical and social task, which the staff of the department has been dealing with for many decades. According to WHO, mortality among elderly patients and centenarians with a fracture of the proximal femur reaches 12-15%. More than 92% of patients with fractures of this localization suffer from severe chronic comorbidities. As a result of the work carried out in the Department of Emergency Traumatology, the preoperative bed-day was reduced by 2 times, which now amounts to 1.2 bed-days for these patients. The number of non-operated patients decreased by more than 2 times. The mortality has decreased from 3.3% to 1.3%. The operation time was reduced by 1.5 times for hip arthroplasty and by 1.4 times for osteosynthesis of the proximal femur. The average blood loss during hip arthroplasty has decreased by 2.3 times. The number of complications has decreased too. For example, thrombosis of the veins of the lower extremities decreased by 1.7 times.



Fig. 6. Employees of the Emergency department of traumatology of musculoskeletal system (2020)

Currently, the Department employs 4 doctors of medical sciences, 7 candidates of medical sciences. Thirty clinical residents are being trained, and cadets under additional professional training programs. Researchers of the Department carry out research on two promising research topics. In the near future - approbation of one and planning of three PhD theses. In the last year alone, the staff of the Department received 4 patents of the Russian Federation for inventions, published 2 textbooks, 9 articles in various peer-reviewed journals.

Promising areas for the department are the development and implementation of new, high-tech methods for treating injuries of the musculoskeletal system, the further development of minimally invasive technologies, the development and implementation in clinical practice of innovative methods for replacing bone defects and stimulating reparative processes using cellular technologies, introduction of microsurgical technologies for the treatment of complex limb injuries and optimization of surgical approaches in osteosynthesis of bones into the practice of traumatologists, the development of arthroscopic methods for the treatment of intra-articular injuries, including arthroscopy of small wrist joints.

CONCLUSION

The tasks of the Department of Emergency Traumatology include qualified treatment of patients with bone fractures, soft tissue injuries of the extremities, the consequences of injuries - delayed consolidation

and nonunion of fractures, arthrosis of the joints. Every year, the staff of the Department successfully performs more than 2,700 surgical interventions in the pathology of the musculoskeletal system.

Scientific developments of the employees of the Department of Emergency Traumatology have a practical focus. The doctors of the department perform surgeries at the highest level using modern techniques. Cellular and biotechnologies are widely used. The key to success is the coordinated work of researchers and doctors, who have at hand all the interdisciplinary power of the N.V. Sklifosovsky Research Institute for Emergency Medicine.

REFERENCES

1. Rusakov AB. K 100-letiyu so dnya rozhdeniya akademika AMN SSSR S.S. Yudina (stranitsy zhizni). *Grekov's Bulletin of Surgery*. 1993;150(3-4):137-139. (in Russ.)
2. Teryaev VG, Bognitskaya TN, Umanskaya VV, Belyaev AA. S.S. Yudin, ego nauchnaya i prakticheskaya deyatel'nost'. *Grekov's Bulletin of Surgery*. 1993;150(3-4):140-142. (in Russ.)
3. Kuz'min Igor' Viktorovich. Sovetskaya travmatologiya i Lelio Zeno. (in Russ.) Available at: http://ikzm.narod.ru/Zeno/Zeno_2.htm [Accessed Feb 5, 2021]
4. Zeno LO. Problema travmatologii. *Novyy khirurgicheskiy arkhiv*. 1932;26(4-5):104-112. (in Russ.)
5. Ermolov AS, Abakumov MM, Bognitskaya TN. *Uchastie instituta im. N.V. Sklifosovskogo v pomoshchi bol'nym i ranenym voynam v gody krupnykh voennykh srazheniy. Trudy instituta, Vol. 179*. Moscow: NII SP im. N.V. Sklifosovskogo Publ.; 2005. (in Russ.)
6. Böhler L. *Technik der Knochenbruch Behandlung*. Wien:W. Maudrich, 1933 [Russ. Ed.: Beler L. *Tekhnika lecheniya perelomov kostey*. Moscow; Leningrad Publ.; 1937.]
7. Gorinevskaya VV. *Povrezhdeniya kisti i ikh lechenie*. Moscow: tipografiya Izdatel'stva Glavsevmorputi Publ.; 1948. (in Russ.)
8. Takanova AD. *Povrezhdeniya sukhzhilyi kisti, pal'tsev i predplech'ya i ikh lechenie: cand. med. sci. diss. synopsis*. Moscow; 1966. (in Russ.) Available at: <https://search.rsl.ru/ru/record/01006161208> (Accessed at Feb 11, 2021)
9. Sagiroy EA. *Metodika funktsional'nogo lecheniya travm sukhzhilyi sgibateley pal'tsev kisti: Cand. ped. sci. diss. synopsis*. Moscow; 1968. (in Russ.) Available at: <https://search.rsl.ru/ru/record/01008382891> (Accessed at Feb 11, 2021)
10. Pavlyuchenko L.L. Lechenie otkrytykh perelomov distal'nykh falang pal'tsev kisti. *Sovetskaya meditsina*. 1979;(3):98-100. (in Russ.)
11. Okhotskiy VP, Miguleva IYu, Yashina TN. Pervichno-vosstanovitel'nye operatsii pri otkrytykh sochetannykh vnutrisustavnykh povrezhdeniyakh pal'tsev kisti. In: *Sovremennyye problemy lecheniya povrezhdeniy i zabolevaniy verkhney konechnosti*. Moscow, 1998: 35-37 (in Russ.)
12. Kuz'michev AP, Okhotskiy VP, Polonskiy AK, Pavlyuchenko LL. Lechenie otkrytykh perelomov pal'tsev kisti s ispol'zovaniem lazernogo izlucheniya. *Pirogov Russian Journal of Surgery*. 1979;(5):99-100. (in Russ.)
13. Miguleva IYu. *Metod tendoplastiki pri povrezhdeniyakh sukhzhilyi sgibateley pal'tsev kisti v oblasti fibrozno-sinovial'nykh kanalov: Dr. med. sci. diss. synopsis*. Moscow; 1997. (in Russ.)
14. Shibayev E.Yu., Ivanov P.A., Kisel D.A. Foot replantation by the autotransplantation type as an alternative to reamputation and prosthesis replacement. *The Russian Journal of Transplantation*. 2010;(1):58-60. (in Russ.) <https://doi.org/10.23873/2074-0506-2010-0-1-58-60>
15. Shibaev EY1, Ivanov PA, Kisel DA, Nevedrov AV. Closing of Soft Tissue Defects After Severe Open Tibia Fractures. *Polytrauma*. 2012;(1):21-31. (in Russ.)
16. Sachkov AM, Shibayev EY, Kisel DA. The Abruption of the Scalp: Modern Techniques of its Reconstruction (The Application to the Article by Smirnov S. V. "The Reconstruction of the Soft Tissues of the Head in a Patient with Extensive Skin Defect of the Scalp". *The Russian Journal of Neurosurgery*. 2008;(2):47-48. (in Russ.)
17. Pogodina AN, Shibaev EYu, Nikolaeva EB. Diagnostika i lechenie mekhanicheskikh povrezhdeniy trakhei. *Innovatsionnye tekhnologii v khirurgii*. 2018; 118-121. (in Russ.)
18. Pogodina AN, Shibayev EYu, Rabadanov KM, Kisel DA. Cervical esophageal and tracheal plasty with microsurgical tissue autotransplantation: a clinical observation. *The Russian Journal of Transplantation*. 2010;(2):35-37. (in Russ.) <https://doi.org/10.23873/2074-0506-2010-0-2-35-37>
19. Petrikov SS, Gol'dfarb YuS, Kabanova SA. *Nauchnye shkoly NII Skoroy pomoshchi im. N.V. Sklifosovskogo*. Moscow: NPO VNM NII SP im. N.V. Sklifosovskogo DZM Publ.; 2018. (in Russ.)
20. Vaza AYU, Istranov LP, Shekhter AB, Kanakov IV. Razrabotka metoda stimulyatsii zazhivleniya kostno-khryashchevykh defektov v eksperimente. *Zdravookhraneniye i meditsinskie tekhnologii*. 2008;(1):8. (in Russ.)
21. Khubutiya MSh, Klyukvin IYu, Istranov LP, Khvatov VB, Shekhter AB, Vaza Ayu, et al. Stimulyatsiya regeneratsii gialinovogo khryashcha pri kostno-khryashchevoy travme v eksperimente. *Byulleten' Eksperimental'noj Biologii i Mediciny*. 2008;(11):597-599. (in Russ.)
22. Khvatov VB, Vaza AYU, Zhirkova YA, Bocharova VS. Cell Replacement Therapy. *The Russian Journal of Transplantation*. 2009;(1):31-33. (in Russ.) <https://doi.org/10.23873/2074-0506-2009-0-1-31-33>
23. Fayn AM, Vaza AYU, Borovkova NV, Titov RS, Mironov AYU, Kaulen VD, et al. *Allogenny kombinirovanny kostnyy transplantat dlya lecheniya slozhnykh perelomov proksimal'nogo otdela plechevoy kosti, sposob ego polucheniya*. Patent RU 2721873. App. 07.31.2019. Publ. 05.25.2020. (51) MTK A61F 2/28 (2006.01), (52) CTK A61F 2002/2889 (2020.02). (in Russ.) Available at: <https://patent.ru/patent/RU2721873C1> (Accessed at Feb 11, 2021)
24. Titov RS, Klukvin IU, Filippov OP, Vaza AU, Slastinin VV. Use of Hydroxyapatite in Treatment Patients With Femoral Neck Fractures. *Russian Sklifosovsky Journal Emergency Medical Care*. 2012;(4):22-25. (in Russ.)
25. Vaza AYU, Makarov MS, Slastinin VV, Borovkova NV, Klyukvin IYu, Pokhitonov DYU, et al. Efficiency of allogenic platelet-rich plasma, combined with collagen, in rat's humerus injury healing. *The Russian Journal of Transplantation*. 2016;(2):36-44. (in Russ.)
26. Mamatov EA, Fayn AM, Vaza AYU, Sergeev AYU, Titov RS, Bogolyubskiy YuA, et al. Polimernye implanty iz polilaktid ko-glikolevoy kisloty (PLGA) v khirurgii vnutrisustavnykh perelomov verkhney konechnosti pechatnaya. In: *Neotlozhnaya meditsinskaya pomoshch' 2020: Materialy nauchno-prakticheskoy konferentsii (16-17 iyulya 2020g.)*. Trudy instituta, Vol. 244. Moscow: NPO VNM, NII SP im. N.V. Sklifosovskogo DZM Publ.; 2020. (in Russ.)
27. Tatarinova EV, Pogodina AN, Korovkina EN. Postoperative complications in patients with cervicothoracic injuries. *Pirogov Russian Journal of Surgery*. 2014;(10):10-14. (in Russ.)

Received on 10.03.2021

Review completed on 12.05.2021

Accepted on 27.12.2021