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Application of Biological Glue in Orthopedics and Traumatology

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The purpose of the study was to investigate the method of osteosynthesis using glues.

Materials and methods. The simplest and most effective method in the treatment of traumatological patients is a plaster fixing bandage of different variations. This is a conservative type of treatment. Also, a very common method in the treatment of orthopedic and traumatological patients is the surgical method. Modern high-tech methods of osteosynthesis require a thorough preoperative examination of the patient, conducting a 3D tomographic examination for intra-articular fractures, clear planning of the course of surgical intervention, electro optical probing techniques during the operation, the availability of tool kits for installing retainers, the ability to choose a retainer intraoperative in the size range. An orthopedic-traumatologist and the entire operating team need appropriate training. All operational fixation methods must provide adequate stability to maintain axis length and rotation.

Results and discussion. In the world practice, biological glues are used in such areas as abdominal surgery, neuro- and cardiac surgery, plastic and pediatric surgery, orthopedics and traumatology.

Cyanocrylate glues have undergone extensive experimental clinical testing. Positive characteristics of cyanoacrylate glues are the ability to glue living tissues in a humid environment, polymerization rate, autosterility, bactericidal, absence of histotoxicity, hemostatic effect. Another glue in the review is sulfacrylate. It can be used in patients of any age, starting from newborns, regardless of the pathogenesis of the disease. Venaseal glue, used by many authors to treat fistulas of the gastrointestinal tract. Widely used fibrin glues, such as Evicel, are used to achieve hemostasis and sealing in surgery, for example, in vascular operations, kidney resection and neurosurgical interventions, in the surgical treatment of distal hypospadias in children. BioGlue glue is designed to seal surgical sutures, thereby preventing fluids (exudate, lymph, urine, gastric juice) and / or air from leaking through them. It is also used in liver surgery.

At the moment, the use of bone cement is the most common auxiliary method for surgical interventions. But its side effects are very clear. Bone cement can cause the patient to die on the operating table or, in the postoperative period, in intensive care. This is due to an immediate or rapid allergic reaction. This situation is dangerous for humans. Biological glues are not so toxic and do not cause such allergic reactions

Conclusion. The search for new materials and techniques for consolidating bone fragments is one of the most important problems of modern medical science, namely orthopedics and traumatology.

Substances that are included in the biological glue must be bioinert, contain elements of strength (for holding fragments), looseness of the structure (for germination of capillaries between fragments), natural antibiotic (for antibiotic prevention), activators of hematopoiesis processes (for the fastest callus), organic and inorganic substances (for the building material of bone tissue).

Therefore, the desire to improve treatment and improve its results, in particular in orthopedics and traumatology, is the key to the development of modern medicine.

Keywords: biological glue, bone tissue, consolidation, orthopedics and traumatology.

Introduction. Modern orthopedics and traumatology have made a significant step in the approach to the treatment of bone fractures. But period of consolidation of bone fragments is quite long. Recovery can take up to six months or more. The longer period of immobilization is, the longer and more difficult recovery period is. Joints lose their mobility, muscles decrease their activity. Hypotension, as well as atony of muscle tissue, rigidity or contractures of joints are, unfortunately, undesirable effects in the absence of activity of the human body. Irreversible degenerative-dystrophic processes in the tissues of the musculoskeletal system can appear in 1.5 months. Such processes as osteoarthritis, joint contractures, osteoporosis and others disrupt the rhythm of normal human life. This, in the vast majority of percentages, leads to disability [1]. The most common phenomenon in traumatological patients is disability. Disability due to injuries of the musculoskeletal system in the last two decades has firmly held on to the third place after cardiovascular and oncological diseases.

The purpose of the work is to study the method of osteosynthesis using glue (biological glue).

Materials and methods. Immobilization, starting from an external plaster cast, ending with osteosynthesis, is a necessary method in the consolidation of a fracture, namely bone tissue. Mobility between bone fragments is a disorder of growth.

The simplest and most effective method in the treatment of traumatological patients is a plaster fixing bandage of different variations. The rate of bone fusion can last from 21 days to 2 months. The time period of consolidation varies due to various factors, such as: the peculiarity of the fracture and its complexity, the age of the patient and his concomitant diseases, the correctness of medical care and individual characteristics of the person. It is necessary to remember about the functional exchange of phosphates and calcium, vitamin D, parathyroid hormone and calcitonin. For example, the interstitial calcium content directly depends on the reabsorption of calcium from the intestine, its absorption with vitamin D, and renal excretion with parathyroid hormone. Parathyroid hormone also controls the level of plasma phosphates along with controlling the concentration of calcium.

Modern high-tech methods of osteosynthesis require a thorough preoperative examination of the patient, conducting a 3D tomographic examination for intra-articular fractures, clear planning of the course of surgical intervention, EOP techniques during the operation, the availability of tool kits for installing retainers, the ability to choose a retainer intraoperative in the size range. An orthopedic-traumatologist and the entire operating team need appropriate training.

All operational fixation methods must provide adequate stability to maintain axis length and rotation.

Results. At the end of 1958, the JSC (Association of orthopedists) formulated 4 treatment principles that were expected to improve the results of fracture treatment in general and the use of internal fixation in particular (Miller et al.1984). Now, it seems appropriate to test how well these four principles have stood the test of time. These principles are:

- anatomical reposition of bone fragments, especially in intra-articular fractures;
- stable internal fixation that meets local biomechanical requirements;
- preservation of blood supply to bone and soft tissue fragments using atraumatic surgical techniques;
- early active painless mobilization of muscles and joints adjacent to the fracture, preventing the development of fracture disease [3].

The main goal of osteosynthesis is to ensure strong fixation of the matched fragments until they are completely consolidated. Submerged osteosynthesis includes blocking and non-blocking rods, gamma rods, previously used DHS and DCS retainers, plates, screws, wire, and spokes. This method of fixing bone fragments is not always successful. A lot of false joints or signs of osteoreparation disorders are observed in almost all orthopedic clinics, as well as in fairly experienced orthopedic-traumatologists [4].

A wide variety of metal alloys used in plates, screws, rods and other structures, despite modern medicine, still periodically causes metal rejection, metallosis [5], allergic reactions and other ailments. The metal structure must be removed without fail after the fracture is consolidated. The minimum time is 6-8 months. And this is an additional operation and the subsequent recovery period of the patient. Of course, there are cases when metal structures remain for life. But these are special cases and causes of this choice.

Also, in some cases, during surgical interventions, bone cement is used, more often for joint replacement. This substance sometimes causes “bone cement implantation syndrome (BCIS)” after staging. BCIS is characterized by hypoxia and / or hypotension (with potential loss of consciousness), an immediate allergic reaction. It includes complications such as the cause of a pulmonary embolism. In 20% of cases of cement joint prosthetics, BCIS occurs, about 1% of which lead to cardiovascular collapse, which requires CPR. Therefore, BCIS is a potentially fatal complication of orthopedic surgery [6].

Each method has its own positive and negative feedback, its goal and method of helping with a particular pathology in the musculoskeletal system. Recently, as a simplification of the treatment of patients with injuries, additional methods of fixing skeletal bones has been proposed to introduce biological glue into the practice of orthopedics and traumatology.

Therefore, the current topic is the review of the use of biological glues in the medical field.

Cyanoacrylate glue created on the basis of a-cyanoacrylic acid esters: MK-2, Mk-6, MK-7, MK-7m, MK-8, MK-9, MK-14i. Undesirable properties are insufficient elasticity of the glue [7], which disrupts the functional activity of mobile organs, heat release during polymerization, which can sometimes lead to coagulation necrosis of tissue treated with cyanoacrylate. Cyanoacrylate is also used in abdominal surgery.

Sulfacrylate glue is a colorless transparent liquid consisting of ethyl-a-cyanoacrylate (binding component), butylacrylate (plasticizer) and sulfolanomethacrylate (anti-inflammatory, antimicrobial component). Sulfacrylate can be used in patients of any age, starting from newborns, regardless of the pathogenesis of the disease. There is adhesion to various tissues, almost everything except adipose tissue. Sulfacrylate is successfully used to fix bone grafts when closing defects in the bones of the skull. With the help of this glue composition, it is possible to ensure hemostasis of the spongy substance of bone tissue and reliable fixation of the bone fragment. Fixation occurs after 1 min, the graft is securely fixed to the bone tissue [8].

An important role was also played by the practical work of Professor V. T. Marchenko, who showed the wide possibilities of using glue in pediatric surgery

and neurosurgery, professor A. L. Krivoshapkin, who performed unique operations on brain vessels using Sulfacrylate [9, 10].

Venaseal (N-butyl-2-cyanoacrylate), USA, Indermil from Covidien and Histoacryl from TissueSeal. This glue is used by many authors to treat fistulas of the gastrointestinal tract. Cyanoacrylate glues are widely used in vascular surgery, and their effectiveness in this area has been confirmed by numerous experimental studies. Dr. Ulf Zirau and others have been using this glue for 7 years in practice on treated varicose veins [11].

Evicel fibrin glue, which contains thrombin and fibrinogen of human origin, is widely used to achieve hemostasis and sealing in surgery, such as vascular surgery, kidney resection, and neurosurgical interventions. There are experimental studies on the effectiveness of using Evicel fibrin glue in the surgical treatment of distal hypospadias in children [12].

BioGlue glue is an aqueous solution of purified bovine serum albumin and glutaraldehyde placed in separate containers of a double syringe. Surgical biological glue is designed to seal surgical sutures, thereby preventing the flow of fluids (exudate, lymph, urine, gastric juice) and / or air through them. A. V. Timoshenkova, M. V. Kuzmin, E. S. Katanov in the experiment of evaluating the biliostatic properties of modern topical hemostatic agents and the developed glue composition for medical purposes, including BioGlue, used in liver surgery, concluded that glue compositions, such as BioGlue, have higher adhesion and withstand a higher limit level of pressure compared to sponges and plates [13]. Therefore, it performs adhesive properties and functions.

Bio-glue lab. As a result of scientific and experimental studies, the possibility of obtaining a stable gel based on gelatin with a spiralized molecular structure and with varying degrees of destruction (low and high molecular weight), crosslinked with aldehydes as the basis of bio-artificial medical glues, has been proved for the first time. It has been experimentally proven that the use of glue helps to increase regenerative and reparative processes in tissues by increasing the number of cells and the growth of collagen, as well as that it is repeatedly biodegradable, biocompatible, non-toxic and pyrogenic. A distinctive feature of the developed glue is its ability to stop bleeding in conditions of high humidity without preparing the tissue surface before implantation. During the animal experiment, the use of fibrin glue “Bio-glue lab” for sealing gastrointestinal anastomoses showed absolute safety and high efficiency [14].

More than 10 years later, biological cement and Kryptonite-X glue appeared. This glue starts working when three components are mixed:

- Component A – Prepolymer (phenylisocyanate 73%), castor oil polyol 24% and 3% polypropylene carbonate;
- Component B – castor oil polyol 96%, 4% ricinolic acid and catalyst 1%;
- Component C – potassium carbonate 33% and barium sulfate 67%.

It is non-toxic, adopts bone properties, adhesive and osteoconductive. Unfortunately, this glue also has a negative property. The period of its formation and solidification is quite long, up to 30 minutes. But for modern orthopedics and traumatology, an example of biological cement is quite interesting [15].

Conclusion

1. One of the most important issues of treatment of traumatological and orthopedic patients is the rate of callus formation and fracture consolidation. The faster this process occurs, the faster the patient returns to the normal rhythm of life.
2. The search for new materials and techniques for consolidating bone fragments is one of the most important problems of modern medical science, namely orthopedics and traumatology. The materials must be biological, properly adapted to the tissues and not foreign to the human body in any way, because our body is alive and adequately perceives only such elements of being. Substances that are included in the biological glue must contain elements of strength (for holding fragments), looseness of the structure (for germination of capillaries between fragments), natural antibiotic (for antibiotic prevention), activators of hematopoiesis processes (for the fastest callus), organic and inorganic substances (for the building material of bone tissue).
3. There are enough experimental and insufficient clinical studies on the use of glues, especially in orthopedics and traumatology.

Perspective for further research. Therefore, further research and implementation of these technologies in practice is relevant prospects for further research in this area: we plan to work on the use of glues in orthopedics and traumatology in the experiment.

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ИСПОЛЬЗОВАНИЕ БИОЛОГИЧЕСКИХ КЛЕЕВ В ОРТОПЕДИИ И ТРАВМАТОЛОГИИ

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Резюме. *Цель:* исследовать метод остеосинтеза с помощью биологических клеев.

Материалы и методы. Проведены систематический поиск и анализ литературы по проблеме использования в ортопедии и травматологии биологических клеев при проведении современных высокотехнологических методов остеосинтеза.

Результаты. Широкую экспериментальную клиническую апробацию прошли цианокрилатные клеи, положительными характеристиками которых являются способность склеивать живые ткани во влажной среде, скорость полимеризации, аутостерильность, бактерицидность, отсутствие гистотоксичности, гемостатическое действие. Сульфакрилат применяется для лечения свищей желудочно-кишечного тракта у пациентов любого возраста, начиная от новорожденных, независимо от патогенеза заболевания. Фибриновый клей Venaseal применяется для достижения гемостаза и герметизации в хирургии, например при операциях на сосудах, при резекции почки и нейрохирургических вмешательствах, при хирургическом лечении дистальной гипоспадии у детей. Клей BioGlue предназначается для герметизации хирургических швов, тем самым предотвращая протекание через них жидкости (экссудат, лимфа, моча, желудочный сок) и / или воздуха, также применяется в хирургии печени.

В настоящее время применение костного цемента является самым распространенным вспомогательным методом при хирургических вмешательствах. Однако его побочные эффекты могут привести к летальному исходу больного на операционном столе или в послеоперационном периоде в реанимации вследствие аллергической реакции немедленного или замедленного типа. Применение в хирургической практике биологических клеев является предпочтительным из-за их низкой токсичности и выраженности аллергических реакций, и соответственно меньшего количества осложнений.

Выводы. Поиск новых материалов и техник для консолидации костных отломков является одной из важнейших проблем современной медицинской науки, а именно ортопедии и травматологии.

Вещества, входящие в биологический клей, должны быть биоинертными, содержать элементы прочности (для удержания отломков), рыхлости структуры (для возможности прорастания капилляров между обломками), иметь свойства природного антибиотика (для антибиотико-профилактики), активаторов процессов гемопоэза (для быстрого формирования костной мозоли), содержать органические и неорганические вещества (как строительного материала костной ткани).

Ключевые слова: биологический клей, костная ткань, консолидация, ортопедия и травматология.

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ЗАСТОСУВАННЯ БІОЛОГІЧНИХ КЛЕЇВ В ОРТОПЕДІЇ ТА ТРАВМАТОЛОГІЇ

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Резюме. *Мета:* дослідити метод остеосинтезу за допомогою біологічних клеїв.

Матеріали та методи. Проведено систематичний пошук і аналіз літератури з проблеми використання в ортопедії і травматології біологічних клеїв при проведенні сучасних високотехнологічних методів остеосинтезу.

Результати. Широку експериментальну клінічну апробацію пройшли ціанокрілатні клеї, позитивними характеристиками яких є здатність склеювати живі тканини у вологому середовищі, швидкість полімеризації, аутостерильність, бактерицидність, відсутність гістотоксичності, гемостатична дія. Сульфакрілат застосовується при лікуванні свищів шлунково-кишкового тракту у пацієнтів будь-якого віку, починаючи від новонароджених, незалежно від патогенезу захворювання. Фібриновий клей Venaseal застосовується для досягнення гемостазу і герметизації в хірургії, наприклад, при операціях на судинах, при резекції нирки і нейрохірургічних втручаннях, при хірургічному лікуванні дистальної гіпоспадії у дітей. Клей BioGlue призначається для герметизації хірургічних швів, тим самим запобігаючи протікання через них рідини (ексудат, лімфа, сеча, шлунковий сік) і / або повітря, також застосовується в хірургії печінки.

В даний час застосування кісткового цементу є найпоширенішим допоміжним методом при хірургічних втручаннях. Однак його побічні ефекти можуть викликати смерть хворого на операційному столі або в післяопераційному періоді в реанімації внаслідок алергічної реакції негайного або уповільненого типу. Застосування в хірургічній практиці біологічних клеїв є більш перспективним через їх низьку токсичність і вираженість алергічних реакцій, і відповідно меншої кількості ускладнень.

Висновки. Пошук нових матеріалів і технік для консолідації кісткових уламків є однією з найважливіших проблем сучасної медичної науки, а саме ортопедії і травматології.

Речовини, що входять до складу біологічних клеїв, повинні бути біоінертними, містити елементи міцності (для утримання відламків), пухкості структури (для можливості проростання капілярів між уламками), мати властивості природного антибіотика (для антибіотико-профілактики), активаторів процесів гемопоезу (для швидкого формування кісткової мозолі), містити органічні і неорганічні речовини (як будівельного матеріалу кісткової тканини).

Ключові слова: біологічний клей, кісткова тканина, консолідація, ортопедія та травматологія.

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