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EC GASTROENTEROLOGY AND DIGESTIVE SYSTEM

Research Article

Influence of Metal Tini-Structure on the Organism of Animals (Rabbits) in the Experiment

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Received: November 12, 2020; **Published:** January 19, 2021

Abstract

The article presents the results of experimental studies to study the formulation and effect of the TiNi-construct of pararectal tissue in rabbits. The results of studies of pararectal fiber in rabbits with the implantation of a TiNi-construct are presented. Titanium nickelide (TiNi) has special physical characteristics: biocompatibility, corrosion resistance, shape memory effect and superelasticity. The TiNi product is a resilient metal structure. The latter does not affect the tissues of the pararectal zone of animals. In the initial martensitic state, the structure is elastic and can change shape at a temperature of 0- + 25 ° C, which ensures elasticity. After placing the structure in the pararectal tissue inside of which the latter is not rejected. Being in a certain area of pararectal tissue does not irritate the animal.

Keywords: *Metal TiNi Structure; Use of TiNi Metal in Medicine*

Introduction

The urgency of the problem. In medicine, the role of metals and alloys as implantable materials is of great importance. In all areas of medicine, metal implants are used as the most important functional elements: in the form of artificial endoprostheses of joints (knee, elbow, hip), fixing elements of bone tissue (screws, nails, plates, ties), dilators, stents and clipping metal structures in vascular surgery, fastening elements for keratoprostheses in ophthalmology.

Information about the first metal implants refers to the time of the appearance of gold and silver in human life. Earrings, knitting needles, artificial gold teeth and, in isolated cases, silver wire elements for fixing fragments of small bones - all this can be found in descriptions and chronicles of ancient Rome. Until the 18th century. silver and gold were used in medical practice. It should be noted that although this application was episodic and exceptional, filling with gold leaf, in which gold was tightly embedded in the carious cavity of the tooth, was used in Europe quite widely as early as the 15th – 16th centuries [1,2].

In developed countries, from 5 to 10 implants per 100 population are used within one year. Note that in Russia the number of metal implants used in dentistry is slightly higher than in the United States, while in traumatology and surgery, on the contrary, is lower. In Ger-

many, the provision of implants in traumatology is even higher than in the USA, and the use of metal implants in dentistry is so widespread that dental implantology is a large, separate branch of medicine and economics [3].

Composition "monolithic titanium nickelide reinforced with titanium fibers", the parameters of the shape memory effect have significant distinctive characteristics. Due to the fact that the reinforcing titanium fibers have a different character of deformation, i.e. deformed at the initial stage according to Hooke's law, and then by plastic shear, the parameters of the manifestation of the shape memory effects of the composite alloy deteriorate in comparison with monolithic titanium nickelide. At the same load, the degree of deformation of the composite is half that of monolithic titanium nickelide. The effect of reinforcement is also reflected in the width of the hysteresis, which is much wider and more diffuse in the composite than in titanium nickelide. This effect is explained by the influence of reinforcing titanium fibers, which do not possess the ability to exhibit the property of reversible deformation, but at the same time have high elastic, plastic and strength characteristics in a wide temperature range. It can be said that two deformation mechanisms occur simultaneously in the composite - by the reversible martensitic and by the mechanism of plastic deformation. Even with a low load, there are deformation areas in the composite where critical stresses reach their limit values. Therefore, the composite material does not completely restore its shape when heated above the range of phase transformations. The result of the influence of titanium fibers is a wide range of recovery of the shape of the composite material in comparison with titanium nickelide and permanent plastic deformation, which has a greater value than that of TiNi. In the practical use of composite alloys based on titanium nickelide, the parameters of superelasticity can also be of great importance. The wider temperature range of superelasticity of the composite material based on titanium nickelide and titanium is explained by the fact that titanium fibers, not participating in the process of elastic deformation accumulation, prevent the martensitic deformation of titanium nickelide in the form of elastic action, thereby broadening the hysteresis. As with titanium nickelide, the deformation of composite materials exhibiting shape memory effects is a complex quantity consisting of elastic deformation, deformation associated with martensitic transformation, and a plastic component of deformation. The contribution of elastic deformation does not exceed 0.1%. The deformation associated with martensitic transformation depends on the level of reinforcement with titanium fibers and in different composite materials is, as a rule, 2 - 4%. The contribution of the plastic component is also different and also depends on the level and nature of the reinforcement [3].

Articles made of titanium nickelide have found wide practical application in medicine. The main property of titanium nickelide is the shape memory effect (SME) (the ability to restore its original shape when heated through the interval of martensitic transformations after preliminary deformation in the low-temperature martensite phase).

Gunther VE., *et al.* (2007) used implantation materials based on titanium nickelide to eliminate connective tissue defects, which behave similarly to body tissues under loading and unloading conditions. One of the promising areas that have found wide application in clinical practice, due to the unique properties of these materials, is the replacement of tissue defects using a super-elastic thin-profile tissue system based on titanium nickelide thread, 50 - 60 μm thick and a cell width of less than 240 μm. Currently, the above-described tissue system is successfully used in the surgery of hernial defects of the anterior abdominal wall of various localization and sizes, the esophageal opening of the diaphragm, in order to prevent the formation of communicating veins in the treatment of trophic ulcers of the leg and foot, developed against the background of varicose veins, elimination of pharyngostomas, defects of bone structures in patients with destructive maxillary sinuitis, traumatic injuries of the bottom of the orbit, clefts of the alveolar process of the upper jaw, hard and soft palate, postoperative palate defects, in reconstructive surgery of the alveolar processes of the jaws in persons with atrophy, chronic forms of periodontitis, and also for the upper jaw, for periodontitis in dental imantology. Titanium nickelide-based tissue implants, after being placed in the defect zone, allow full replacement of connective tissue defects. Due to the biochemical and biomechanical compatibility of titanium nickelide with the tissues of the body, the properties of fluid retention, the connective tissue from the side of the recipient areas grew through the cellular structure of the implant with the formation of tissue regenerate in the area of the former defect, unified with the implantation material, providing a stable satisfactory result [1,3].

Purpose

Under experimental conditions, to evaluate the effect of the TiNi structure on the rabbit organism.

Materials and Methods

The study involved 6 rabbits selected according to the principle of clinical analogues. The weight of the animals was 4 ± 1 kg. All animals in the area of the lateral surface of the femur of the left and right pelvic limbs prepared a surgical field measuring 5x7 cm, the prepared field was processed according to the rules of asepsis. The implant was placed under intravenous anesthesia, and infiltration anesthesia was carried out with a 0.25% solution of novocaine at the incision site, then musculocutaneous wounds (vulnus incisum), 2 - 3 cm long, with violation of the integrity of the skin, subcutaneous tissue, superficial fascia... In this area, titanium nickelide wire was implanted into the subcutaneous tissue with a 1 cm incision (Figure 1).

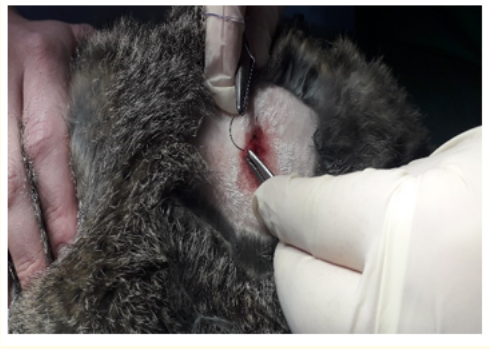

Figure 1: *Implantation of TiNi wire into rabbit subcutaneous fat.*

2 - 3 skin sutures were applied to the wound in rabbits, the surface was treated with Chemi-spray (Figure 2).

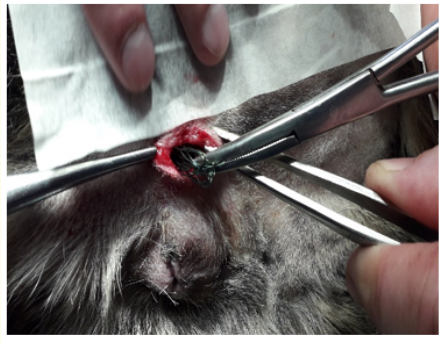

Figure 2: *Implantation of titanium nickelide cone into rabbit pararectal tissue.*

Every day, the general state of the body of the experimental animals was monitored, the amount of water drunk and the amount of food consumed, and clinical parameters were measured in rabbits. All animals at the time of the study were clinically healthy and were kept in individual cages with individual numbers. The conditions of detention corresponded to the sanitary and hygienic standards for this type of animals.

For the second experiment, 6 rabbits were selected according to the principle of clinical analogues. The weight of the animals was 14.5 ± 1.5 kilograms. All animals at the time of the study were clinically healthy and were kept in individual cages with individual numbers. The conditions of detention corresponded to the sanitary and hygienic standards for this type of animals. All animals in the pararectal area prepared an operating field of 5x7 cm, the prepared field was processed according to the rules of asepsis. The implant was placed under intravenous anesthesia, and infiltration anesthesia was carried out with a 0.25% solution of novocaine at the incision site, then musculocutaneous wounds (vulnus incisum), 2 - 3 cm long, with violation of the integrity of the skin, subcutaneous tissue, superficial fascia... In this area, a cone-shaped structure made of titanium nickelide was implanted into the subcutaneous tissue with a 1 cm incision (Figure 2).

2 - 3 musculocutaneous sutures were applied to the rabbit's wound, the surface was treated with Chemi-spray (Figure 3).

Figure 3: *Suturing the wound in the pararectal region.*

After suturing the wound, a control radiography of the pelvic region of the animal was performed (Figure 4).

Figure 4: *Control X-ray of the pelvic region of the animal after implantation of a construction in the form of a cone made of TiNi into pararectal tissue (1 day).*

Every day, the general state of the body of the experimental animals was monitored, the amount of water drunk and the amount of food consumed, and clinical parameters were measured in rabbits.

During the experiments, all animals were kept on a standard vivarium diet. All studies were carried out in full accordance with modern principles of bioethics, including the "European Convention for the Protection of the Rights of Vertebrate Animals" (adopted in Strasbourg on March 18, 1986) and the "Universal Declaration of Animal Rights" "Adopted by the International League for Animal Rights on 23 September 1977 in London and announced on 15 October 1978 at the headquarters of UNESCO in Paris).

Statistical processing of the obtained research results was carried out using the Statistical software package (Version 6-Index, Stat Soft Inc., USA). To identify significant differences, the nonparametric Mann-Whitney U-test was used. To compare the reliability of changes in the frequencies of a binary feature in two independent groups, $\chi 2$ was used with Yates' correction for continuity.

Results and Discussion

During the experiment, all rabbits showed swelling around the wound on the first two days, on the third day the swelling disappeared and swelling was observed in one rabbit. Clinical parameters were within the physiological norm. Sutures were removed from all rabbits on the seventh day. For the reliability of the experiment and confirmation of the presence of the wire in the subcutaneous tissue, an X-ray was performed (Figure 5).

Figure 5: *X-ray examination of the rabbit.*

After 1.5 months, a biopsy of the subcutaneous tissue was subjected to histomorphological examination, where the wire was placed. There were no changes in the fiber side (Figure 6).

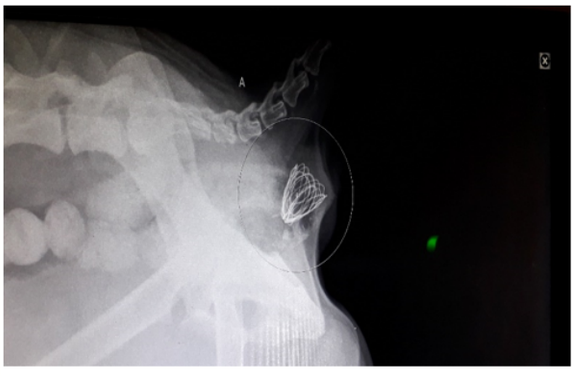

Figure 6: *Control X-ray of the pelvic region of the animal after implantation of a construction in the form of a cone made of TiNi into the pararectal tissue (7 days).*

During the experiment, in all rabbits in the first two days there was swelling around the wound, on the third day the swelling disappeared. Clinical parameters were within the physiological norm. Sutures were removed from all animals on the seventh day. For the reliability of the experiment and confirmation of the presence of the wire in the subcutaneous tissue, an X-ray was performed (Figure 6).

After 1.5 months, a biopsy of the subcutaneous tissue was subjected to histomorphological examination, where the wire was placed. No changes in fiber were found.

Conclusions

As a result of the experiment, which consisted of implanting titanium nickelide wire into the subcutaneous tissue of rabbits, the latter does not cause a negative effect on the animal organism, does not cause tissue infection, rejection was not observed in all animals.

As a result of the experiment, which consisted in implanting a structure in the form of a titanium nickelide cone into the pararectal tissue of rabbits, the latter did not cause a negative effect on the animal organism, did not cause tissue infection, and rejection was not observed in all animals.

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Volume 8 Issue 2 February 2021