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Results of Evaluation of the Physical and Mechanical Properties of a New Suture Material with Miramistin Coating

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Abstract

Background: The imperfection of surgical sutures, from the point of view of insufficient prevention of microbial contamination in the area of suturing, is one of the urgent problems in modern practical healthcare. In this connection, one of the promising areas at the present time is the study of suture material under conditions of its coating with various antiseptics. This study aimed to evaluate the physical and mechanical properties of the suture material impregnated with miramistin for further application in experimental studies on animals.

Methods and Results: By applying a two-layer polymer coating on absorbable polyglycolide threads, the threads were given antimicrobial properties. In the amount of 10% or 20% by weight of the polymer, miramistin was introduced into both coatings.

The breaking load and elongation data in the surgical suture knot were evaluated by immersing the samples in a phosphate buffer solution (pH=7.4), maintaining a constant temperature of 37°C by a thermostat. Threads from the solution were extracted on Days 1, 3, 7, 14, and 21 of the experiment. Further, the studied samples of the suture material were subjected to stretching to rupture on a universal tensile testing machine of the domestic company Metrotest. Physical and mechanical properties were evaluated by the dynamics of the breaking load and elongation at a break in the node after being in a phosphate buffer solution. Coating of polyglycolide thread, which is a suture material, with miramistin at a concentration of 10% and 20% does not lead to loss of strength even in the long term of the experimental study, which, in turn, meets the standards for suture material.

Conclusion: The results obtained allow us to recommend a suture material impregnated with miramistin for further research, the ultimate goal of which will be the possibility of active use of this material in practical medicine, in particular in surgery to prevent microbial contamination in the area of suturing and infection of wounds. (**International Journal of Biomedicine. 2022;12(2):308-310.**)

Key Words: miramistin • suture material • microbial contamination • breaking load • breaking elongation

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Introduction

One of the important directions in modern medicine is the development of surgical suture material. The rate of occurrence of the wound and postoperative complications requires new trends in this area. Quite often, practicing surgeons are faced with imperfect surgical threads, which means low prevention of microbial contamination in the area of suturing.[1-3] This is due to a local disorder of microcirculation of tightened tissues, partial necrosis of cells, and accumulation of inflammatory exudate. To solve this problem and reduce the risk of suture failure, various drugs have been applied to the surface of the suture material, such as proteolytic enzymes, antibiotics, antiseptics, analgesics, etc. Thanks to the development of an antibacterial coating in the area of surgical intervention, it is possible to create an environment that can stop the growth of pathogenic microorganisms and reduce the dose of general antibiotic therapy, which is important for

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immunocompromised patients, as well as elderly patients.[4-6] In practical surgery, both biodegradable (absorbable) suture material and non-absorbable suture material are used. The latter often remains forever in the area of operation and can, in some cases, become a source of chronic inflammation. To date, among domestic modern surgical threads, only a small number can be considered both biodegradable and having an antibacterial component on their surface, which indicates the relevance of scientific research aimed at creating and studying the characteristics of such suture materials.[7-9] Antiseptics remain the most promising substances in this direction, given the frequent side effects that occur when using antibiotics, as well as a decrease in the sensitivity of pathogenic microflora. Miramistin can be regarded as the universal antiseptic. Its wide range of uses in various fields of medicine opens up prospects for the development of surgical suture material.

This study aimed to evaluate the physical and mechanical properties of the suture material impregnated with miramistin for further application in experimental studies on animals.

Materials and Methods

The experimental study was carried out in the department "Experimental Surgery and Oncology of the Research Institute of Experimental Medicine" at the Kursk State Medical University.

By applying a two-layer polymer coating on absorbable polyglycolide threads, the threads were given antimicrobial properties. In the amount of 10% or 20% by weight of the polymer, miramistin was introduced into both coatings. The samples of suture material used in the experiment were provided by Lintex LLC. All experimental material was divided into three groups. An inert suture material was used in Group 1 (control group, n=10), a polyglycolide thread coated with miramistin at a concentration of 10% in Group 2 (comparison group, n=10), and a polyglycolide thread coated with miramistin at a concentration of 20% in Group 3 (experimental group, n=10). The breaking load and elongation data in the surgical suture knot were evaluated by immersing the samples in a phosphate buffer solution (pH=7.4), maintaining a constant temperature of 37°C by a thermostat. Threads from the solution were extracted on Days 1, 3, 7, 14, and 21 of the experiment. Further, the studied samples of the suture material were subjected to stretching to rupture on a universal tensile testing machine of the domestic company Metrotest. Physical and mechanical properties were evaluated by the dynamics of the breaking load and elongation at a break in the node after being in a phosphate buffer solution.

Statistical analysis was performed using Microsoft Excel 2020. The mean (M) and standard error of the mean (SEM) were calculated. Differences of continuous variables were tested by the Mann-Whitney *U*-test. A probability value of $P \leq 0.05$ was considered statistically significant.

Results and Discussion

As a result of the study to determine the breaking load in the knot, it was found that the initial breaking load of all samples of suture material met the standards for absorbable surgical sutures. At the same time, it should be noted that the gradual decrease in the strength of the samples is directly proportional to the duration of their immersion in the buffer solution. In particular, by the end of the experiment (on Day 21), the breaking load of the threads decreased, without reaching, at the same time, zero values. The degree of decrease in indicators at all periods of the experiment in the second and third groups was almost equal. At the same time, the lowest indicator of values was noted in the first group of suture material samples, which did not contain an antiseptic coating on their surface. The results obtained are presented in Table 1.

Table 1.

Breaking load in a simple knot of absorbable suture materials (n)

Day	Group 1	Group 2	Group 3
1	13.42±0.254	14.61±0.142*	15.4±0.141* ^
3	12.7±0.15	14.05±0.184*	14.5±0.133* ^
7	11.3±0.142	13.5±0.144*	13.6±0.08* ^
14	10.72±0.072	11.7±0.07*	12.6±0.104* ^
21	6.4±0.154	7.33±0.106*	7.62±0.114*

** - P≤0.05 when compared with Group 1; ^ - P≤0.05 when compared with Group 2*

In the second stage of this work, the breaking elongation of the thread in a simple knot was carried out under the conditions of placing the threads in a buffer solution and keeping them there for Days 1, 3, 7, 14, and 21. The results obtained are presented in Table 2.

According to the data obtained, in all samples of suture materials, there was a gradual decrease in the elongation index when the thread broke in a simple knot. It should be noted that the value of this indicator in the early stages of the experiment was greater in Group 1 on Days 1, 3, and 7 than in Group 2 and Group 3. By Day 21 of the experiment, the elongation of the breaking load of the threads decreased but did not reach zero values. The degree of decrease in indicators at all periods of the experiment was approximately equal in Groups 2 and 3.

Table 2.

Elongation data in the surgical suture knot (%)

Day	Group 1	Group 2	Group 3
1	23.63±0.14	19.42±0.115*	19.53±0.135*
3	22.33±0.114	18.5±0.1*	18.6±0.114*
7	20.6±0.14	17.6±0.1*	17.5±0.1*
14	15.5±0.28	14.7±0.16	14.34±0.09*
21	10.4±0.101	10.6±0.2	10.8±0.106

** - P≤0.05 when compared with Group 1*

One of the main requirements for a surgical suture is to maintain its strength. For absorbable threads, this indicator should correspond to the time of complete healing of tissues in the area of surgical intervention to form a postoperative scar. The elongation index in a simple knot, according to the standard applied to the suture material, should not exceed 40%. Thus, the new samples of the studied suture material, which have miramistin in their coating at a concentration of 10% and 20%, meet the regulatory requirements.

Conclusion

The polyglycolide thread coated with miramistin at a concentration of 10% and 20% did not lose its strength even on the last days of the experiment, which meets the standards for suture material and allows us to recommend it for further research.

Competing Interests

The authors declare that they have no competing interests.

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