STUDY OF THE KINETICS OF RELEASE OF DECAMETOXIN FROM MODIFIED SURGICAL SUTURES IN AQUEOUS MEDIUM

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The studies showed that Decametoxin is released from thread in amounts not exceeding the standards issued by the Pharmacological Committee of the USSR Ministry of Health. The rate of release of Decametoxin from the thread decreases in time; according to the data from the extraction-photometric method, the rate of "release" of Decametoxin is constant and maximum for up to 24 h, and according to the calculation based on weight loss, the rate slows according to a logarithmic law and is maximum for up to 6 h. The concentration of Decametoxin in the region of the suture will probably be maximum for two days. Decametoxin does not form chemical bonds with BF-6 adhesive or polycaproamide, but the polymer coating of the thread acts as a microdispenser of the antimicrobial.

The creation of suture material with antimicrobial properties is one trend in the development of surgical suture materials [1].

Surgical suture thread with antimicrobial properties was created at the Institute of Problems of Materials Science, National Academy of Sciences of Ukraine. The antimicrobial effect of the thread was imparted during modification of surgical polycaproamide braided and twisted thread by applying a coating of phenol—poly(vinylacetal) adhesive and a quaternary ammonium compound, Decametoxin.

The kinetics of release of Decametoxin (DMO) from thread was investigated in the present study. This study is necessary for determining the doses of the drug in the area of the surgical suture, since too large a dose can cause undesirable side effects. In addition, it is important to know for how long the thread can release the antimicrobial, i.e., communicate bactericidal properties to the area around the wound.

The kinetics of release of DMO from thread was studied by two methods. The first extraction-spectrophotometric method consisted of direct quantitative photometric determination of DMO released from the thread on contact with the aqueous medium. The second, gravimetric method consisted of determining the weight loss of the thread after remaining in the aqueous medium and integral calculation of the amount of DMO.

The concentration of DMO in the thread was also calculated with data on the dry gain in weight after treatment in the modifying compound.

In addition, the thread was studied before and after contact with the aqueous medium by electron microscopy. A thread sample 5-10 m long was held in distilled water at a temperature of 37±2°C. Water was poured over the thread in the ratio of 1 g of thread per 29 ml of water. It was experimentally established that this amount of water is the minimum for immersing the thread. The duration of extraction was 1.5, 6, 12, 18, 24, 48, and 312 h. The lower limit was restricted by the sensitivity of the instruments and the upper limit corresponds to the average duration of residence of the thread in the region of the surgical suture.

TABLE 1. Kinetics of Release of DMO from Modified Surgical Thread

<table>
<thead>
<tr>
<th>Thread</th>
<th>Amount of DMO released from 1 g of thread in, g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.5 h</td>
</tr>
<tr>
<td>Twisted (N_{arb})</td>
<td>6.598 (10^{-4})</td>
</tr>
<tr>
<td>Twisted (N_{arb})</td>
<td>6.581 (10^{-4})</td>
</tr>
<tr>
<td>Braided (N_{arb})</td>
<td>0</td>
</tr>
<tr>
<td>Braided (N_{arb})</td>
<td>3.480 (10^{-4})</td>
</tr>
</tbody>
</table>

*For thread of arbitrary number \((N_{arb})\): 0.50-0.59 mm in diameter, 170-200 tex linear density; for thread of \(N_{arb}\): 0.60-0.69 mm in diameter, linear density of 250-280 tex.

EXTRACTION-SPECTROPHOTOMETRIC STUDY OF THE KINETICS OF RELEASE OF DMO

The quantitative determination of the concentration of DMO in the extract by the standard photocolorimetric method was based on the reaction of the tertiary nitrogen in the drug with eosin in weakly acid medium in the presence of polyvinyl alcohol according to Provisional Pharmacopeia Article 42-1824-88. The data on release of DMO from the thread in the indicated time intervals are reported in Table 1. Release of DMO increases with an increase in the duration of extraction.

To estimate the rate of release of DMO from the thread, the results were converted into percentages using the ratio to the amount of DMO released after 312 h (Fig. 1). These data show that the rate of release of DMO from the thread varies in the different time periods. In the first interval (up to 24 h), the amount of DMO increased linearly at the rate of approximately 1.72%/h; in the second interval (from 24 to 48 h), release of DMO slowed to 1.66%/h, and in the third interval (from 48 to 312 h), the rate of release of DMO decreased to 0.54%/h. Thus 50% of the total DMO was released from the thread after approximately 30 h, 5.5% was released in the first 3 h, and almost 11% was released after 6 h.

Based on these data, we can hypothesize that the concentration of DMO in the area of the suture will be highest in approximately the 36-48 h interval, when the rate of its release from the thread is highest.

STUDY OF THE KINETICS OF RELEASE OF DMO BASED ON WEIGHT LOSS

Before the tests began, the thread was held in standard climatic conditions (GOST 10681) for a minimum of 10 h. The thread sample was weighed on an analytical balance and held in distilled water using the method described above. The thread was then dried, held in the climatic conditions for a minimum of 2 h, and weighed again.

The weight loss of the thread \((\Delta m)\) after holding in the aqueous medium was calculated with the equation

\[
\Delta m = \frac{m_0 - m}{m_0} \cdot 100,
\]

where \(m_0\) is the initial weight of the sample, g; \(m\) is the weight of the sample after extraction, g.

The experiment was conducted on paired thread samples:

- \(N_{arb}\) 1 twisted thread, coating of BF-6 adhesive; \(N_{arb}\) 1 twisted thread, coating of BF-6 + DMO;
- \(N_{arb}\) 2 braided thread, BF-6 coating; \(N_{arb}\) 2 braided thread, BF-6 + DMO coating.

A graph of the weight loss—duration of extraction curve was plotted with the calculated weight loss values for the pair of samples (Fig. 2). Using a computer, the equations for functions \(y_1Le f_1(t)\) and \(y_2Le f_2(t)\) were selected based on the criterion of the smallest root-mean-square error.

The weight loss of the fibre with the BF-6 coating was due to release of water-soluble components from the adhesive and thread. The amount of water-soluble components in Fig. 2 corresponds to the area delimited by the curve of \(y_1Le f_1(t)\) and the abscissa. The weight loss of the thread with the BF-6 + DMO coating was due to release of DMO from the coating and the