

TREATED COLLAGEN BASED SURGICAL THREADS

The invention relates to collagen based surgical threads containing a nonionic surfactant which enhances the
5 pliability and, in many cases, the tie down performance of the thread.

BACKGROUND OF THE INVENTION

10 Collagen based surgical threads, in the form of "catgut" sutures and ligatures, have been employed as absorbable surgical threads since Lister's time in the late 19th Century. This invention relates to an improvement in the
15 art of collagen-based surgical threads, whether in the form of surgical gut sutures and ligatures ("gut" sutures and ligatures are actually derived from the intestines of animals such as beef and sheep), or in the form of
regenerated collagen sutures and ligatures which may be derived from the tendons of cattle.

20 Historically, collagen based surgical threads have been supplied to the user in a sterile tube or packet immersed in alcohol containing a small percentage of water. The reason for this is that the liquid was needed in order to
25 impart sufficient flexibility to the thread for it to be readily used by the surgeon.

More recently, it has been proposed to package collagen based sutures containing absorbed liquid that acts as a
30 plasticizer, so that it was not necessary to package the suture immersed in a liquid. For instance, one approach to this is described by Vivien et al., in U.S. Patent No. 3,896,814. In this approach, the collagen based suture is treated with a liquid containing water, a hygroscopic

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agent such as glycerol, and then a coating of a hydrophobic material is placed upon the suture. The hydrophobic material is described as being either a silicone or a lipoid.

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This invention provides a different approach to providing a collagen-based suture and ligature that need not be immersed in liquid as it is supplied to the surgeon. The sutures and ligatures provided by the invention are actually more pliable than the standard surgical gut now employed commercially, and also, in many cases, exhibit enhanced lubricity and tie-down properties.

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BRIEF SUMMARY OF THE INVENTION

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The invention provides a collagen based surgical thread containing absorbed therein an amount of a solution comprising water, a hygroscopic agent, and a nonionic surfactant sufficient to enhance the pliability and, in many cases, the tie down performance of the thread. The invention also provides a package containing such a suture, said package being free of extraneous liquid, as well as a process for producing the collagen based surgical thread which comprises contacting a collagen based surgical thread with a solution of water, a hygroscopic agent, and a nonionic surfactant.

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THE PRIOR ART

30 Vivien et al., in U.S. Patent No. 3,896,814, describe collagen based sutures containing water, a hygroscopic agent, and a coating of a hydrophobic lubricating agent selected from the group consisting of lipoids and silicones.

U.S. Patent Nos. 4,043,344 and 4,047,533, disclose the use of coatings of a bioabsorbable polyoxyethylene/polyoxypropylene copolymer lubricant on the surface of either a synthetic absorbable suture or a non-absorbable suture.

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DETAILED DESCRIPTION OF THE INVENTION

10 The invention is employed with collagen based sutures and ligatures, either gut sutures and ligatures or regenerated collagen sutures and ligatures. Surgical gut is made from the intestines of animals. For instance, the submucosa layer of sheep intestines and the serosa layer of beef intestines are particularly preferred for producing surgical gut. Also, regenerated collagen sutures and ligatures
15 are made from collagen that has been produced from the tendons of beef cattle. The nature and production of such surgical threads are well known in the art, and need not be repeated here. This invention is employed as one of the final steps prior to sterilization and packaging of
20 such collagen based surgical threads.

The treating solution, called "tubing fluid", that is employed in the invention contains water, a hygroscopic agent that is used for the purpose of retaining the water
25 in the surgical thread, and a nonionic surfactant. Preferably it also contains a lower alkanol such as isopropyl alcohol. The hygroscopic agents contemplated are materials that have a high affinity for water and a low level of volatility, and which are biologically
30 acceptable materials. Such materials include trihydric alkanols, glycols, and low molecular weight polyoxyethylene glycols. Glycerol is the preferred hygroscopic agent, although other materials such as diethylene glycol, propylene glycol, and polyoxyethylene
35 glycols having molecular weights up to about 300 or 400

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can be employed as the hygroscopic agent. In the aqueous solution of hygroscopic agent, the hygroscopic agent is usually employed in a proportion of from about 20 to 30 weight per cent, based upon total weight of the treating solution. Isopropyl alcohol is usually employed in the treating solution in amounts of from about 25 to 45 weight per cent.

The next ingredient that is employed in the treating solution is a nonionic surfactant. Preferred nonionic surfactants for use in the invention are those materials that are biologically acceptable such as polyoxyethylene/polyoxypropylene block copolymer surfactants, polyoxyethylene monoesters of long chain fatty acids such as polyoxyethylene monolaurate, polyoxyethylene mono-oleate, and other such esters such as polyoxyethylene sorbitan mono-oleate, wherein the fatty acid moiety contains from about 8 to about 20 carbon atoms. The nonionic surfactant is employed in the treating solution in a proportion of from about 1 to about 15 weight per cent, and preferably from about 5 to about 12 weight per cent, based upon the total weight of the treating solution. The polyoxyethylene/polyoxypropylene block copolymers are the preferred surfactants.

The treating solution can also contain other materials such as sodium benzoate and N,N-diethylaminoethanol, which are used as corrosion inhibitors.

The collagen based surgical threads that are treated in accordance with the process of the invention are immersed in the above described fluid for a period of time sufficient for the threads to absorb fluid. Normally this will be from about 5 to about 60 minutes, and preferably from about 20 to 40 minutes. The treatment can be carried out at room temperature, i.e., from about 20° to 30°C.

After the surgical thread has been immersed in the treating fluid long enough for it to absorb the fluid, the threads are then removed, drained, and then sealed in a foil package or other similar package and sterilized, preferably by exposure to gamma radiation.

The actual amount of the treating solution that is absorbed by the thread is very difficult to determine with accuracy. However, the desired amount will be absorbed if the foregoing treating instructions are followed.

The following examples illustrate the invention:

Example 1

A treating solution is prepared by mixing the following ingredients:

Table I

	<u>Parts by Weight</u>
Water	34
Glycerol	24
Isopropyl Alcohol	31
"Pluronic" F-68 ⁽¹⁾	10
Sodium Benzoate	0.5
N,N-diethylaminoethanol	0.5

(1) A polyoxyethylene/polyoxypropylene block copolymer surfactant. It has a molecular weight of about 8350, and is an ABA-type block copolymer. The two A blocks each contain about 75 oxyethylene units; the B block contains about 30 oxypropylene units. "Pluronic" is a registered Trade Mark

Surgical gut threads are immersed in this fluid for about 30 minutes at room temperature. They are then removed,

drained, sealed in a foil package, and sterilized by exposure to Co⁶⁰ irradiation (total dose-about 2.5 mrads).

- 5 The surgical gut threads so treated are much more pliable than the present commercial surgical gut threads that are produced in the standard way and packaged in water/isopropyl alcohol solution, as is indicated by a significantly reduced Young's Modulus ($75,000 \pm 25,000$ psi versus
- 10 $300,000 \pm 10,000$ psi).

Example 2, and Controls 1 and 2

- Paper folders containing Size #1 chromic surgical gut
- 15 sutures are soaked in the fluids indicated in Table II, below, for 30 minutes at room temperature, are then drained to remove excess fluid, packaged in foil packages, and are sterilized by Co⁶⁰.

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TABLE II

<u>Component</u>	<u>Example 2</u>	<u>Control 1</u>
Isopropyl alcohol	5.1 liters	5.1 liters
25 Distilled Water	3.75 liters	3.75 liters
Glycerol	2.0 liters	2.0 liters
Sodium Benzoate	5.0 grams	5.0 grams
Silicone Emulsion ⁽²⁾ (1%)	--	100 ml
Diethylaminoethanol	5.0 ml	5.0 ml
30 "Pluronic" F-68 (2%)	200 grams	-

(2) Dow Corning 365 Emulsion

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These sutures, along with standard production Size #1 chromic gut sutures packaged in water/isopropyl alcohol (Control 2), are subjected to the tie down-roughness test described in Hunter et al., U.S. Patent No. 3,942,532, the disclosure of which is incorporated herein by reference. The results are displayed in Table III:

TABLE III

	<u>Example 2</u>	<u>Control 1</u>	<u>Control 2</u>
Tiedown-Roughness,			
grams	165	440	454

(Each value given in the table is the average of three tests.)

As the foregoing data illustrate, the polyoxyethylene-polyoxypropylene block copolymer surfactant yields a significantly smoother suture that is easier to tie down than either of the two controls.

Example 3

The procedure of Example 2 is followed, except that the porportion of the "Pluronic" F-68 in the tubing fluid is varied from 2 weight per cent to 10 weight per cent. The tie down-roughness test performance of the gut sutures so treated is shown in Table IV:

Table IV

	<u>2% F-68</u>	<u>4% F-68</u>	<u>10% F-68%</u>
Tie Down-Roughness,			
grams	220	206	192



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CLAIMS

1. A collagen-based surgical thread containing absorbed therein an amount of a solution comprising water, a hygroscopic agent, and a nonionic surfactant
5 sufficient to enhance the pliability of said thread.
2. The collagen-based thread of claim 1 wherein said thread is a surgical gut suture or ligature.
3. The collagen-based surgical thread of claim
10 1 or claim 2 wherein said hygroscopic agent is glycerol.
4. The collagen-based surgical thread of any one of claims 1 to 3 wherein the thread also contains isopropyl alcohol.
5. The collagen-based surgical thread of any one
15 of claims 1 to 4 wherein said nonionic surfactant is a polyoxyethylene/polyoxypropylene block copolymer.
6. A process for producing a flexible collagen based surgical thread having good pliability properties, which comprises immersing a collagen based thread
20 in a solution of water, a hygroscopic agent, and a nonionic surfactant.
7. The process of claim 6 wherein said solution also contains isopropyl alcohol.
8. The process of claim 6 or claim 7 wherein the
25 surfactant is a polyoxyethylene/polyoxypropylene block copolymer.
9. A sterile package comprising the sterile collagen based surgical thread of any one of claims 1 to 5 contained in a sealed package.



10. A collagen-based surgical thread, substantially as hereinbefore described with reference to the Examples.
 11. A process for producing a flexible collagen-based surgical thread, substantially as hereinbefore described with reference to the Examples.
 12. A sterile suture package, substantially as hereinbefore described with reference to the Examples.
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