

PATENT SPECIFICATION

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(54) SUTURES COATED WITH AN ABSORBABLE COATING COMPOSITION, AND METHOD FOR IMPROVING THE TIE-DOWN CHARACTERISTICS OF SUTURES

(71) We, ETHICON, INC., a Corporation organised under the laws of the State of New Jersey, United States of America, of Somerville, New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

BACKGROUND OF THE INVENTION *Field of Invention*

This invention relates to sutures, as herein defined, coated with an absorbable composition useful as a coating and lubricating finish for the sutures. The invention also relates to a method for improving the tie-down characteristics of multifilament sutures, as herein defined, by coating the sutures with an absorbable lubricating composition.

The "sutures" referred to in the present description and claims are Surgical Suture Strands and Surgical Suture threads.

Description of Prior Art

Suture materials are generally classified as either absorbable or non-absorbable, with each type of suture material being preferred for certain applications. Absorbable suture materials are preferred for internal wound repair in which the sewn tissues will hold together after healing without suture reinforcement and in which a non-absorbed suture may promote tissue irritation or other adverse bodily reaction over an extended period of time. In the present description and claims, the word "absorbable" is employed to refer to a material which will disappear from tissue sewn therewith, by being assimilated by the body, within about a year after surgery; many absorbable suture materials, however, will disappear within shorter periods.

The earliest available absorbable suture materials were catgut and extruded

collagenous materials. More recently, absorbable sutures derived from synthetic polymers have been developed which are strong, dimensionally uniform, and storage-stable in the dry state. Typical of such polymers are lactide homopolymers and copolymers of lactide and glycolide such as those disclosed in United States Patent No. 3,636,956, and glycolide homopolymers such as those disclosed in United States Patent No. 3,565,869.

Monofilament synthetic absorbable suture materials are generally stiffer than their catgut or collagen counterparts, and synthetic absorbable sutures are therefore usually employed in a multifilament, braided construction in order to provide the desired degree of softness and flexibility. Such multifilament sutures exhibit a certain degree of undesirable roughness or "grabiness" in what has been termed their "tie-down" performance, i.e. the ease or difficulty of sliding a knot down the suture into place.

Multifilament non-absorbable sutures such as braided sutures of polyethylene terephthalate, for example, can be improved with respect to tie-down performance by coating the external surface of the suture with solid particles of polytetrafluoroethylene and a binder resin as disclosed in United States Patent No. 3,527,650. This procedure, however, is undesirable as applied to absorbable sutures because polytetrafluoroethylene is non-absorbable and sutures coated therewith would leave a polymer residue in the sewn tissue, after the suture had been absorbed.

Multifilament, non-absorbable sutures can also be improved with respect to tie-down performance by coating them with a linear polyester having a molecular weight between about 1,000 and about 15,000 and at least two carbon atoms between the ester linkages in the polymer chain as disclosed

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in United States Patent No. 3,942,532. This patent discloses that the aforementioned polyesters may also be used to coat absorbable synthetic sutures but does not consider that such coated sutures would not be totally absorbable.

The aforementioned U.S. patent No. 3,942,532 discloses that the synthetic absorbable sutures described therein may be coated with conventional suture coating materials such as a silicone or beeswax in order to modify the handling or absorption rate of the sutures. These coating materials are not readily absorbable, however, and will accordingly leave an undesirable residue in the tissue after the suture itself is absorbed.

It is accordingly an object of the present invention to provide an absorbable, lubricating coating for multifilament sutures of braided, twisted or covered construction. It is a further object of this invention to provide an absorbable coating to improve the tie-down properties of such multifilament sutures. It is a yet further object of this invention to provide a wholly absorbable coated synthetic multifilament suture having good knot tie-down properties.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a synthetic multifilament suture, as herein defined, said suture being absorbable, as herein defined, and being coated with from 2 to 15% by weight of a composition comprising a mixture of a substantially water-insoluble salt of a C₈ or higher fatty acid and a film-forming component, as herein defined, said salt and said component being absorbable, as herein defined, and the ratio of said salt to said component being from 1:4 to 4:1. The coating composition is preferably applied to the suture from a solution to provide a final coating add-on of from 2 to 10% by weight of the suture.

The invention also includes a method for improving the tie-down characteristics of a multifilament suture, as herein defined, which comprises coating said suture with from 2 to 15% by weight of a composition comprising a mixture of a substantially water-insoluble salt of a C₈ or higher fatty acid and a film-forming component, as herein defined, said salt and said component being absorbable, as herein defined, and the ratio of said salt to said component being from 1:4 to 4:1.

The film-forming component may be a film-forming polymer, preferably a copolymer of lactide and glycolide, while the fatty acid salt is preferably a calcium salt of a C₈ to C₂₂ fatty acid. The ratio of film-forming component to fatty acid salt in the coating composition may for example be between 1:2 and 2:1. This ratio is

expressed in parts by weight. The coating composition is particularly useful for improving the tie-down smoothness of braided sutures prepared from homopolymers and copolymers of lactide and glycolide, and other absorbable polymers.

DESCRIPTION OF PREFERRED EMBODIMENT

The coating compositions employed in accordance with the present invention may be applied to any suture strand or suture thread where it is desired to improve fibre lubricity, suture tie-down characteristics, or the like. The coating is used with synthetic absorbable multifilament sutures such as polylactide, polyglycolide, copolymers of lactide and glycolide, poly(p-dioxanone), poly(alkylene oxalate), and mixtures of such polymers with each other and with other compatible absorbable compositions as those described for example in United States Patents Nos. 3,636,952 and 2,683,136. Preferred suture compositions derived from polymers of lactide and glycolide are sometimes referred to herein as simply homopolymers and copolymers of lactide and glycolide.

In a preferred embodiment of the present invention, the coating composition is applied to the suture surface as a solution and/or dispersion of the film-forming component and fatty acid salt in a volatile solvent such as acetone, and solidification of the coating on the suture is accomplished by volatilizing the solvent. The coating may be applied to the suture by any suitable process such as passing the suture through a solution of the coating composition, or past a brush or applicator wetted with the solution, or past one or more spray nozzles dispensing the solution as droplets. The suture wetted with the coating solution is subsequently passed through or held in a drying oven for a time and at a temperature sufficient to volatilize the solvent.

In place of a coating solution, the coating composition may be applied as a melt of the constituents thereof, and in this case solidification takes place by cooling. The melt of the coating composition should, of course, be at a temperature below the melting temperature of the suture material.

The coating composition may also be applied to the suture as a solid by passing the suture over or between solid blocks of the coating composition which is then transferred to the surface of the suture by a rubbing action, possibly accompanied by localized melting.

In coating multifilament sutures with the compositions employed in accordance with this invention, it is not necessary that every filament within the suture be individually or completely coated. In most instances, however, the coating composition will pene-

trate into the suture structure, particularly when the coating composition is applied as a solution.

5 The term "film-forming component", in the present description and claims, embraces (a) film-forming polymers and (b) the triglycerides mentioned below. The film-forming polymers of category "(a)" include homopolymers and copolymers of lactide and glycolide (i.e., polylactide, polyglycolide, and copolymers of lactide and glycolide with each other and with other reactive monomers); poly(*p*-dioxanone), poly(alkylene oxalate), copolymers of vinyl acetates with unsaturated carboxylic acids (e.g. crotonic, acrylic, and methacrylic acids); water soluble or dispersible cellulose derivatives (e.g. methyl cellulose, hydroxymethyl cellulose and carboxymethyl cellulose); natural gums; ethylene oxide polymers; polyacrylamide; collagen; gelatin; poly-amino acids; polyvinyl alcohol; and polyvinyl-pyrrolidone. The triglycerides of category "(b)" are absorbable conjugated 10 15 20 25 30 35 40

45 The fatty acid salts useful in the coating compositions employed in accordance with the present invention include the calcium, magnesium, barium, aluminium, and zinc salts of C₈ and higher fatty acids, particularly those having from 12 to 22 carbon atoms, and mixtures thereof. The calcium salts of stearic, palmitic and oleic acids are particularly preferred for use in the present invention.

55 The ratio of the film-forming component and the fatty acid salt in the coating composition may vary depending upon the specific ingredients selected and the particular suture being coated. As already indicated, the preferred ratio of film-forming component to salt is within the range of 60 2:1 to 1:2 by weight, although useful coating compositions are obtained over a broad range of from 1:4 to 4:1 parts by weight.

65 With sutures composed of homopolymers or copolymers of lactide and glycolide, the

film-forming component in the coating composition is preferably polylactide or a copolymer of lactide and glycolide containing at least 15% lactide, and preferably having different solubility characteristics from the suture. For example, a suture made of a lactide-glycolide copolymer containing about 10% of dilactyl residues may be coated with a composition containing, as a film-forming component, a lactide-glycolide copolymer containing about 65% of dilactyl residues, which copolymer is more readily soluble in common organic solvents than the suture material; the fatty acid salt in this composition may for example comprise a mixture of calcium palmitate and calcium stearate.

The film-forming component in the coating composition may, if desired, be of the same composition as the suture, provided that precautions are taken to avoid dissolving the suture when the coating composition is applied. This can be done by utilizing a coating composition in which the film-forming component is a finely divided suspension in a non-solvent liquid, or by utilizing a coating composition in which the film-forming component is in solution at substantially saturation levels and the contact time of the suture with the coating composition, before the solvent is driven off, is short.

Where the compositions of the suture and the film-forming component are identical, and in other instances where the suture material may be subject to some surface dissolution and/or surface swelling or softening by reason of the action of the film-forming component solvent thereon, there may be a gradual transition between the substrate composition and the coating composition rather than a sharp interface between them. There may also be some weakening of the suture accompanying the application of such coating compositions.

The coating composition may, if desired, also contain constituents, other than those discussed above, for other useful purposes including dyes, antibiotics, antiseptics, anesthetics and anti-inflammatory agents.

The amount of coating composition applied to the fiber, or the coating add-on, will vary depending upon the construction of the fiber, e.g., the number of filaments and tightness of braid or twist, and the nature of the coating material, e.g., melt, solution or solid. In general, the coating composition applied to a braid will constitute from 5 to 10% by weight of the coated fiber, but coating composition add-on may range from as little as 2% by weight to as much as 15% or higher in some cases. As a practical matter, and for reasons of economy and

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general performance, it is generally preferred to apply the minimum amount of coating composition consistent with good tie-down performance, and this level of add-on is readily determined experimentally for any particular fiber-coating system.

The improvement in tie-down properties imparted to synthetic absorbable sutures may be determined semi-quantitatively by comparing the feel of coated and uncoated sutures during the act of tying down a single throw knot. Such comparisons are preferably made on both wet and dry sutures since many suture materials have different tie-down properties when tested wet or dry. Suture tie-down roughness is graded from 0 to 10 with 0 being comparable to an uncoated suture and 10 indicating no detectable roughness.

Suture tie-down properties are evaluated dry after the sutures have been conditioned for at least 2 days in a vacuum drying oven at room temperature and 100 microns absolute pressure, and wet after being immersed in water at 25°C. for 1 minute. Roughness values above 4 are considered acceptable, while values of 7 or higher are comparable to conventional silicone coated silk and are considered fully satisfactory.

The following examples are provided to further illustrate and demonstrate the method and product of the present invention. Unless otherwise stated, all parts and percentages are by weight; " η inh" and "HFIP" in the examples stand for "inherent viscosity" and "hexafluoroisopropanol", respectively.

Example 1

Forty-five parts of a low molecular weight (η inh 1.5 in HFIP) lactide/glycolide copolymer [65 mol % L(-) lactide and 35 mol % glycolide] and forty-five parts of calcium stearate* were placed in a porcelain pebble mill with 810 parts of 1,1,2-trichloroethane. Dissolving of the lactide/glycolide copolymer and dispersion of the calcium stearate were accomplished simultaneously by milling the mixture for two days. The solution/dispersion (Brookfield viscosity of 218 cP at 35°C.) was then transferred to a suture coating bath. A size 3-0 braided suture of 90/10 (weight per cent) glycolide/lactide copolymer was coated with the composition by passing the suture through the mixture while using a folded felt pad to wipe excess material from the suture as it exited from the coating bath. The suture was coated at a speed of 8 feet per minute which provided an immersion time of about 5 seconds in the coating bath. After passing through the coating bath and the felt wiping pads, the suture immediately entered a drying tower where enough solvent was removed to render the suture tack-free by the time

the first guide was contacted. Drying was completed by winding the coated braid on a spool and keeping it in vacuum at 100 microns for two days. The coating solids pick-up was determined to be 5.3% of the uncoated braid. The suture was finished by winding the coated braid on an annealing rack under mild tension and heating 10 minutes at 110°C.

Using the afore-described semi-quantitative smoothness-of-tie-down test, the coated braid in a single throw knot tie-down rated 8-9 dry, and 8 wet. The tensile strength of the coated braid was 9.9 lbs. under straight tension and 5.4 lbs. knotted, while in the uncoated control, tensile strengths were 9.9 lbs. and 5.8 lbs., respectively. Braided synthetic absorbable sutures coated in a similar manner were sterilized with ethylene oxide and implanted in animals. After 21 days, the strength of the coated braid was the same as in the uncoated control, and absorption was almost complete at 90 days, indicating that the coating composition or method of application had no significant effect on suture tensile strength or absorbability.

Example 2

Using a coating solution/dispersion identical in composition to that in Example 1 except that total solids were 6% rather than 10%, the glycolide/lactide braided suture was coated by the same method. After vacuum drying, the coating solids pick-up was found to be 2.9% based on the uncoated braid.

As in Example 1, the suture was finished by heating the dry coated braid on an annealing rack at 110°C. for 10 minutes. After ethylene oxide sterilization, smoothness-of-tie-down was 7 dry and 6 wet. Tensile strengths were 10 lbs. and 5.4 lbs. straight and knot, respectively. Implantation in animals showed the same strength retained at 21 days as for the uncoated control. At 90 days post implantation, absorption was complete and tissue reaction was minimal throughout the test period.

Example 3

The procedure of Example 2 was repeated by coating a size 4-0 braided suture comprised of poly(*p*-dioxanone) with the 6% solids coating solution/dispersion composition. The coating solids pick-up was about 4% based on the weight of the uncoated suture. After drying, suture tie-down was tested and rated as excellent, being comparable to standard waxed silk suture material.

* Calcium stearate, a commercial food grade product consisting of about $\frac{1}{3}$ C₁₈ and $\frac{2}{3}$ C₁₈ fatty acid, with small amounts of C₁₆ and C₂₂ fatty acids.

Example 4

Twenty-five parts of a low molecular weight (η_{inh} 1.5 in HFIP) lactide/glycolide copolymer [65 mol % L(-) lactide and 35 mol % glycolide] and twenty-five parts of magnesium stearate were placed in a flask with 360 parts of 1,1,2-trichloroethane and 90 parts by weight of chloroform. Solution of the polymer and dispersion of the stearate were obtained by stirring the mixture for about one week, resulting in a mixture having Brookfield viscosity of 299 cP.

Using the methods described in example 1, the glycolide/lactide braided suture was coated, and dried, and coating pick-up was determined to be 8.1% based on the uncoated suture. Using the smoothness-of-tie-down test described in Example 1, the dry and wet both rated 4-5.

Example 5

Twenty-five parts of a low molecular weight (η_{inh} 1.5 in HFIP) lactide/glycolide copolymer [65 mol % L(-) lactide and 35 mol % glycolide] and twenty-five parts of zinc stearate were placed in a flask with 360 parts of 1,1,2-trichloroethane and 90 parts by weight of chloroform. Solution and dispersion were obtained as in Example 3 to yield a coating composition having a viscosity of 139 cP.

Using the methods described in Example 1, the glycolide/lactide braided suture was coated with 6.1% of coating solids based on the uncoated suture. Using the smoothness-of-tie-down test, the dry suture rated 5 while the wet suture rated 4.

Example 6

Seven and one-half parts of the same lactide/glycolide copolymer described in the above examples and seven and one-half parts of calcium palmitate were placed in a flask containing 108 parts of 1,1,2-trichloroethane and 27 parts of chloroform. The polymer and palmitate salt were dissolved and dispersed by stirring vigorously several days.

Using methods of application and finishing described in Example 1, the glycolide/lactide braided suture was coated with the solution/dispersion, and after drying, was found to have picked up 5.4% coating solids.

Using the smoothness-of-tie-down test, the dry and wet sutures rated 8 and 7, respectively.

Example 7

Seven and one-half parts of the same lactide/glycolide copolymer described in the above examples and seven and one-half parts of calcium oleate were placed in a flask containing 108 parts of 1,1,2-trichloroethane and 27 parts of chloroform. The polymer and oleate salt were dissolved and dispersed by stirring

vigorously several days.

Using methods of application and finishing described in Example 1, the glycolide/lactide braided suture was coated with the solution/dispersion, and after drying, was found to have picked up 9.8% coating solids.

Using the smoothness-of-tie-down test, the dry and wet sutures rated 5½ and 4½, respectively.

Example 8

Calcium salts of C_6 (caproic), C_8 (caprylic), C_{10} (capric), C_{11} (undecylenic) and C_{12} (lauric) fatty acids were prepared and substituted for the calcium stearate in the composition applied to the glycolide/lactide braided suture in the procedure described in Example 1. After drying, suture tie-down properties were found to be significantly improved over the uncoated suture material. Metal salts of C_6 and higher saturated and unsaturated fatty acids are thus shown to be efficacious in the practice of the present invention.

While the foregoing description in Examples 1-8 has been directed to the coating of certain absorbable multifilament braided sutures, it will be readily appreciated that the method of the present invention may likewise be used with good results on other multifilament sutures.

In the above examples, the coating solution was applied to the final suture structure in order to provide a substantially continuous coating on at least the outward-facing surfaces of the outermost filaments of the braid. It is to be understood, however, that the coating solution may be applied, if desired, to the individual filaments before they are formed into strands or to the individual strands before they are formed into the final suture structure. Also, while Examples 1, 2 and 4-8 were conducted with size 3-0 braided suture prepared from a 90/10 weight per cent glycolide/lactide copolymer, this was for the sake of convenience only, and it is to be understood that the invention is not limited as to suture size or composition, but may be practised for example with sutures from size 9-0 to size 2 and larger, and with other suture materials. The foregoing examples are intended to be merely illustrative, and many modifications and variations thereof will be apparent to those skilled in the art.

WHAT WE CLAIM IS:—

1. A synthetic multifilament suture, as herein defined, said suture being absorbable, as herein defined, and being coated with from 2 to 15% by weight of a composition comprising a mixture of a substantially water-insoluble salt of a C_6 or higher fatty acid and a film-forming component, as herein defined, said salt and



Example 4

Twenty-five parts of a low molecular weight (η inh 1.5 in HFIP) lactide/glycolide copolymer [65 mol % L(-) lactide and 35 mol % glycolide] and twenty-five parts of magnesium stearate were placed in a flask with 360 parts of 1,1,2-trichloroethane and 90 parts by weight of chloroform. Solution of the polymer and dispersion of the stearate were obtained by stirring the mixture for about one week, resulting in a mixture having Brookfield viscosity of 299 cP.

Using the methods described in example 1, the glycolide/lactide braided suture was coated, and dried, and coating pick-up was determined to be 8.1% based on the uncoated suture. Using the smoothness-of-tie-down test described in Example 1, the dry and wet both rated 4-5.

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Using the methods described in Example 1, the glycolide/lactide braided suture was coated with 6.1% of coating solids based on the uncoated suture. Using the smoothness-of-tie-down test, the dry suture rated 5 while the wet suture rated 4.

Example 6

Seven and one-half parts of the same lactide/glycolide copolymer described in the above examples and seven and one-half parts of calcium palmitate were placed in a flask containing 108 parts of 1,1,2-trichloroethane and 27 parts of chloroform. The polymer and palmitate salt were dissolved and dispersed by stirring vigorously several days.

Using methods of application and finishing described in Example 1, the glycolide/lactide braided suture was coated with the solution/dispersion, and after drying, was found to have picked up 5.4% coating solids.

Using the smoothness-of-tie-down test, the dry and wet sutures rated 8 and 7, respectively.

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Using methods of application and finishing described in Example 1, the glycolide/lactide braided suture was coated with the solution/dispersion, and after drying, was found to have picked up 9.8% coating solids.

Using the smoothness-of-tie-down test, the dry and wet sutures rated 5½ and 4½, respectively.

Example 8

Calcium salts of C₆ (caproic), C₈ (caprylic), C₁₀ (capric), C₁₁ (undecylenic) and C₁₂ (lauric) fatty acids were prepared and substituted for the calcium stearate in the composition applied to the glycolide/lactide braided suture in the procedure described in Example 1. After drying, suture tie-down properties were found to be significantly improved over the uncoated suture material. Metal salts of C₆ and higher saturated and unsaturated fatty acids are thus shown to be efficacious in the practice of the present invention.

While the foregoing description in Examples 1-8 has been directed to the coating of certain absorbable multifilament braided sutures, it will be readily appreciated that the method of the present invention may likewise be used with good results on other multifilament sutures.

In the above examples, the coating solution was applied to the final suture structure in order to provide a substantially continuous coating on at least the outward-facing surfaces of the outermost filaments of the braid. It is to be understood, however, that the coating solution may be applied, if desired, to the individual filaments before they are formed into strands or to the individual strands before they are formed into the final suture structure. Also, while Examples 1, 2 and 4-8 were conducted with size 3-0 braided suture prepared from a 90/10 weight per cent glycolide/lactide copolymer, this was for the sake of convenience only, and it is to be understood that the invention is not limited as to suture size or composition, but may be practised for example with sutures from size 9-0 to size 2 and larger, and with other suture materials. The foregoing examples are intended to be merely illustrative, and many modifications and variations thereof will be apparent to those skilled in the art.

WHAT WE CLAIM IS:—

1. A synthetic multifilament suture, as herein defined, said suture being absorbable, as herein defined, and being coated with from 2 to 15% by weight of a composition comprising a mixture of a substantially water-insoluble salt of a C₆ or higher fatty acid and a film-forming component, as herein defined, said salt and



- said component being absorbable, as herein defined, and the ratio of said salt to said component being from 1:4 to 4:1.
2. A suture of Claim 1, wherein the fatty acid salt is the salt of calcium, magnesium, barium, aluminum, or zinc.
3. A suture of Claim 1, wherein said higher fatty acid is selected from C₁₂ to C₂₂ fatty acids and mixtures thereof.
4. A suture of Claim 3, wherein the fatty acid salt is the salt of calcium or magnesium.
5. A suture of Claim 4, wherein the fatty acid comprises a mixture of stearic and palmitic acid.
6. A suture of Claim 1, wherein said film-forming component is selected from homopolymers and copolymers of lactide and glycolide, poly(*p*-dioxanone), poly(alkylene oxalate), copolymers of vinyl acetate with unsaturated carboxylic acids, water soluble or dispersible cellulose derivatives, natural gums, ethylene oxide polymers, polyacrylamide, polyvinyl alcohol, polyvinyl-pyrrolidone, gelatin, collagen, polyamino acids, absorbable conjugated unsaturated triglycerides which are precursors of polymers formed *in situ*; and mixtures thereof.
7. A suture of Claim 1, wherein said film-forming component is a copolymer of lactide and glycolide containing from 15 to 85 mol % of dilactyl residues.
8. A suture of Claim 7, wherein said lactide/glycolide copolymer has an inherent viscosity (η_{inh}) of 1.0 to 4.0 measured as a 0.1% solution in hexafluoroisopropanol at 25°C.
9. A suture of Claim 8, wherein the lactide/glycolide copolymer contains about 65 mol % dilactyl residues.
10. A suture of Claim 9, wherein the fatty acid salt comprises a mixture of calcium palmitate and calcium stearate.
11. A suture of Claim 10, wherein the ratio of the fatty acid salt to lactide/glycolide polymer is between 1:2 and 2:1.
12. A suture of Claim 11, coated with from about 5 to 10% of the said mixture.
13. A suture of Claim 1, which is comprised of homopolymers or copolymers of lactide and glycolide.
14. A suture of Claim 13, which is comprised of a copolymer of 10 weight % lactide and 90 weight % glycolide.
15. A suture of Claim 1, which is composed of poly(*p*-dioxanone).
16. A suture of claim 14 or 15, which is a braided multifilament suture.
17. A method for improving the tie-down characteristics of a multifilament suture, as herein defined, which comprises coating said suture with from 2 to 15% by weight of a composition comprising a mixture of a substantially water-insoluble salt of a C₈ or higher fatty acid and a film-forming component, as herein defined, said salt and said component being absorbable, as herein defined, and the ratio of said salt to said component being from 1:4 to 4:1.
18. The method of Claim 17, wherein the fatty acid salt is the salt of calcium, magnesium, barium, aluminum, or zinc.
19. The method of Claim 17, wherein said higher fatty acid is selected from C₁₂ to C₂₂ fatty acids and mixtures thereof.
20. The method of Claim 17, wherein said film-forming component is selected from homopolymers and copolymers of lactide and glycolide, poly(*p*-dioxanone), poly(alkylene oxalate), copolymers of vinyl acetate with unsaturated carboxylic acids, water soluble or dispersible cellulose derivatives, natural gums, ethylene oxide polymers, polyacrylamide, polyvinyl alcohol, polyvinyl-pyrrolidone, gelatin, collagen, polyamino acids, absorbable conjugated unsaturated triglycerides which are precursors of polymers formed *in situ*; and mixtures thereof.
21. The method of claim 17, wherein said suture is composed of a synthetic polymer which is absorbable, as herein defined, and which is selected from homopolymers and copolymers of lactide and glycolide.
22. The method of Claim 17, wherein said suture is composed of poly(*p*-dioxanone).
23. A coated suture, as herein defined, according to claim 1, substantially as described in the foregoing Examples.

For the Applicants,
CARPMAELS & RANSFORD,
Chartered Patent Agents,
43 Bloomsbury Square,
London WC1A 2RA.