A TEMPORARY IMPLANT AND METHOD FOR TENDON SURGERY

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ABSTRACT

A temporary implant for tendon surgery which comprises a generally cylindrical tube of a continuous filamentary material, said cylindrical tube having openings on the surface thereof defined by said filamentary material; a generally flat planar member composed of a resilient yieldable filamentary material, which member can be used as a temporary implant in tendon surgery; a generally cylindrical tube in the form of a continuous filamentary material, which material runs in an undulating, sinuous path, the apex and the nadir of the path of the filamentary material being brought toward one another in a generally facing relationship to define a substantially enclosed area having spaces between the filamentary material; a transplant comprising a substantially enclosed generally cylindrical object constructed of a filamentary material, which filamentary material runs continuously in an arcuate path from a point of said cylindrical object to a point substantially 360° away on the surface of said object, at which point it reverses its direction and travels in an arcuate path substantially 360° away on the surface of said object, at which point it reverses itself; an improvement in surgically repairing broken tendons which comprises disposing about the junction of the repaired tendon a temporary implant comprising a generally cylindrical tube of a continuous filamentary material, said cylindrical tube having openings on the surface thereof defined by said filamentary material, and after the junction in the tendon has substantially healed, removing said cylindrical tube by pulling an end of said filamentary material to thereby sever adhesions formed between the tendon and neighboring tissue material; in a process for the surgical correction of at least one severed tendon where the tendon is disposed close to but out of contact relationship to a second tendon, the improvement for surgically repairing said tendon which comprises disposing between the severed tendon and the adjoining tendon a generally flat planar member composed of yieldable filamentary material, allowing the junction of the severed tendon to heal, and, thereafter, removing said generally flat planar member by pulling an end of said filamentary material.

27 Claims, 13 Drawing Figures
A TEMPORARY IMPLANT AND METHOD FOR TENDON SURGERY

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 297,145, filed Oct. 12, 1972, entitled "A Temporary Implant for Tendon Surgery"; and now abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to the surgical repair of broken or severed tendons. This invention is especially directed to a temporary implant employed in the region of the tendon being surgically repaired, which temporary implant can be withdrawn to thereby sever adhesions which occur either between the tendon and neighboring tissue or between the tendon being repaired and an adjoining tendon. This invention is also directed to the method of effecting such surgical repair employing such temporary implant.

DISCUSSION OF THE PROBLEMS AND THE PRIOR ART

Tendon repair surgically presents considerable difficulty. When a severed tendon is surgically repaired the severed ends initially are brought together in end-to-end abutment relationship to permit the same to heal and to rejoin one another. During the natural, normal healing of a severed tendon, there is caused to grow fibrous adhesions between the tendon undergoing healing and juxtaposed tendons or adjacent tissues. The tendon undergoing healing generally sets in a trough or enclosed in a sheath, especially in respect to tendons in the hand.

When the severed tendon has healed at its junction, these fibrous adhesions cement the healed tendon to its adjacent tissues and thereby prevents the natural glide of the tendon which is necessary for good function. For example, when the tendon in the hand is repaired surgically, the surgeon initially joins the severed tendon. Thereafter, the severed tendon, which sets in a trough defined by neighboring tissues, becomes connected to the neighboring tissues through fibrous adhesions. By the time the healing of the tendon itself is complete, the fibrous adhesions which grow into the injured tendon from the adjacent tissues to bring nourishment, cause the healing tendon to stick to the adjacent tissues. If the tendon adheres to the adjacent tissues it is unable to glide in its trough and thereby loss of function of the tendon occurs. For example, if a healed tendon in a finger is adherent to the adjoining tissues, one cannot make a fist with this finger because its tendon is unable to glide and thereby unable to bend.

It has heretofore been suggested that the problems discussed above can be avoided by completely ensheathing the tendon during surgical repair. The purpose of completely ensheathing the tendon was to avoid the creation or growth of these tendinous adhesions. However, it was found that such means was unsuitable because the tendon was insufficiently repaired by the natural healing process which includes the above-described growth of fibrous adhesions from adjacent tissues.

Therefore, it became desirable to provide a means which can be disposed within the body which would enable the tendon itself to heal normally and yet which could cope with the problems presented by the creation of fibrous adhesions. Stated another way, it was desirable to provide, for the first time, a surgical technique which would allow the ready repair of tendons, especially in the hand, while permitting the hand, after the tendon has been repaired, to have the desired mobility. Thus it was desirable to provide a means whereby the adverse effects of the fibrous adhesions affecting movement in the region of the tendon could be counteracted. This is achieved by the surgical implant of the present invention which allows the naturally occurring adhesions to form to facilitate the tendon repair while providing a means for severing the same once they have served their purpose. Thus the implant provides a simple technique of cutting the fibrous adhesions and freeing the healed tendon to allow it to glide in its trough. By severing the adhesions around the tendon, good mobility of the body part, e.g., finger, can be achieved.

SUMMARY OF THE INVENTION

Broadly, this invention contemplates a temporary implant for use in surgical tendon repair, which implant comprises a generally cylindrical tube of a continuous filamentary material, said cylindrical tube having openings on the surface thereof defined by said filamentary material.

This invention further contemplates a temporary implant useful in the surgical repair of tendons, which implant can be disposed between a tendon being surgically repaired and an adjoining tendon in out-of-contact relationship therewith, which implant comprises a generally flat planar member composed of continuous filamentary material.

This invention further contemplates an improvement in the surgical repair of a severed tendon wherein the severed ends of the tendon are joined together, which improvement comprises disposing about said tendon a temporary implant of a generally cylindrical tube of a continuous filamentary material, said cylindrical tube having openings on the surface thereof defined by said filamentary material, allowing said tendon to substantially heal, and thereafter removing said generally cylindrical tube by pulling an end of said filamentary material.

In another specific embodiment of this invention, there is contemplated an improvement in the method of surgical repair of a severed tendon, which severed tendon is disposed adjacent to but in out-of-contact relationship with a second tendon, wherein the ends of the severed tendon are joined together, which improvement comprises disposing between said severed tendon and said second tendon a generally flat planar member composed of a continuous filamentary material, allowing said severed tendon to substantially heal, and thereafter removing said generally flat planar member by pulling an end of said filamentary material. Preferably said filamentary material of said generally planar member runs in a sinuous path with the peaks and troughs being formed on either side of the generally planar member.

In a preferred embodiment of this invention, there is contemplated a generally cylindrical tube in the form of a continuous filamentary material, which material runs in an undulating, sinuous path, the apices and nadir of the path of the filamentary material being brought toward one another in a generally facing rela-
tionship to define a substantially enclosed area having spaces between the filamentary material.

The above-stated generally cylindrical tube is useful as a transplant in tendon repair. More specifically, the above-defined cylindrical tube can be used to envelop a tendon being repaired or it can be inserted between a tendon and a series of tendons. More particularly, the generally cylindrical tube is suitably formed by bending a generally flat planar member composed of a continuous filamentary material, which filamentary material runs in a sinuous path with the peaks and troughs being formed on either side of the generally planar member, so that the peaks and troughs are brought into facing relationship so as to convert the generally planar member to one which is generally cylindrical. Accordingly, the temporary transplant can be thought of as one which is a substantially enclosed, generally cylindrical object constructed of a filamentary material, which filamentary material runs continuously in an arcuate path from a point on said cylindrical object to a point substantially 360° away on the surface of said object, at which point it reverses its direction and travels in an arcuate path substantially 360° away on the surface of said object, at which point it again reverses its direction.

From the above, it is seen that the surgical improvement provided by the present invention involves the use of a temporary implant which is positioned about or around the tendon being repaired. The implant can have an overall cylindrical shape with openings on the surface thereof to allow the creation of the aforementioned fibrous adhesions. It has been found that the creation of these fibrous adhesions is natural and, indeed, necessary in the proper surgical repair of the tendon itself for, apparently, such tenodinous adhesions supply the needed body chemicals from the adjoining tissue to the tendon being repaired. The generally tubular implant is left in the region about the junction defined by the severed ends of the tendon until the tendon itself has substantially healed. An end of the implant protrudes slightly through the exterior skin of the patent. When the tendon has substantially healed, the protruding end of the temporary implant is pulled to thereby unravel the temporary implant. As it unravels, it severs the fibrous adhesions. By the time the filamentary material is removed, substantially all of the fibrous adhesions are severed without adversely affecting the healed tendon. The net result is that the patient has a healed tendon without any adverse effects due to the fibrous adhesions which would have affected the movement of the body in the region of the tendon repaired.

It will be noted that a second embodiment of the present invention is directed to an implant which is disposed between a tendon being repaired and an adjoining tendon. It has herefore been found that when a tendon disposed near a second tendon is being repaired, fibrous adhesions form between the tendons. These adhesions are so strong that it is extremely difficult to separate the tendons. Hence, they become virtually locked together and severely adversely affect the movement of the body in the region of the tendon repaired. Hence, in accordance with the invention, there is disposed in the region between the tendons a generally flat planar member composed of a continuous filamentary material. An end of the filamentary material is allowed to protrude slightly from the patient's skin. The tendon is allowed to heal and when healing is substantially complete, the filamentary material is pulled at the protruding end to thereby sever the fibrous adhesions between tendons and unravel the filamentary material. When the same is removed from the body, there is left a healed tendon which is substantially free of fibrous adhesions which so severely affect full movement in that region.

With respect to the embodiment of this invention wherein a prefurred generally tubular cylindrical member is placed around or about the repaired and healing tendon, the filamentary material preferably is wound to form the cylindrical tubular member in an alternating or reversing helical pattern such that there is formed a sinuous weave which reverses itself such that the apex of the sinuous curve alternates, as will be more fully described below. It has been found that this particular weave, especially when of a yieldable material, functions ideally. Through use of such a weave the portion of the filamentary material which extends from the body can readily be pulled to effect an orderly severing of the fibrous adhesions. Stated another way, through use of alternating reversing tubular material, the filamentary material can be unwound without substantial movement of the implant as a whole, as the same time severing the fibrous attachments which limited the gliding action of the tendon. Such is shown in the attached figures to be discussed below.

In the embodiment of this invention employed for use between closely adjacent adhesions, it has been found that a flat planar member composed of a continuous filamentary material in tightly woven sine curve form is particularly suitable. Generally speaking, the sinuous filamentary material will have between 50 and 150 apices per inch of length, preferably between 80 and 100 apices per inch. Generally speaking, the overall dimensions of the flat planar member will vary depending upon the length of the tendon being repaired and the associated area. Similarly, the width of the generally planar member will vary depending upon the size of the tendon or tendons involved. However, it can be stated that, broadly speaking, the temporary implant will be between one and four inches in length, preferably between 1¼ and 2 inches, and will have a width between ¾ and ¼ inches. Generally speaking, the width of the material will be between 1/15 and 1/40 times that of the tendon being repaired, preferably between 1/20 and 1/30 times the tendon being repaired.

The above-described flat planar member has been found to be a suitable object which can be formed into an implant around a severed tendon. For instance, it is possible to take a yieldable, generally flat planar member as described above and to wrap the same around a severed tendon to segregate the severed tendon from adjoining tissue. During such a wrapping operation the sides of the generally flat planar member are brought in general facing relationship to one another so that the planar member is in the general form of a cylinder or other geometric form having a circular or elliptical cross section whereby the implant substantially encloses a given area. When so formed, there is provided within the body itself a transplant which is a substantially enclosed, generally cylindrical object constructed of continuous filamentary material, which filamentary material runs continuously in an arcuate path from a point on the surface of the object to a point substantially on the other side thereof, say about 360° away on the surface of said object, at which point it reverses its
direction and travels in an arcuate path substantially 360° on the surface of said object, at which point it again reverses itself in an ever reversing pattern.

The extent to which the generally flat planar member if formed into a cylindrical shape will depend upon the specific application of the implant within the body. It should be understood that the flat planar member can be deformed from its planar shape into any arcuate shape. Suitably, it is deformed to provide an enclosed area. However, the generally planar member can be deformed into a generally cylindrical form such that the lateral edges of the planar member containing the apices of the sinuous curve of the filamentary material define only a fraction of a circle, such as two thirds of a circle. Stated differently, the generally flat planar member can be deformed so that there is formed an enclosed generally cylindrical object of filamentary material, which filamentary material runs continuously in an arcuate path from a point on said cylindrical object to a point substantially between 270° and 420° away on the surface of said object, at which point it reverses its direction and travels in an arcuate path substantially between 270° and 420° away on the surface on said object, at which point it again reverses its direction. For instance, if the filamentary material runs exactly 360° to the other side of the cylindrical object and then reverses its direction to run another 360° there is formed a perfect circle. If the filamentary material runs 320° and then reverses its direction for another 320° there is provided an object which is an incomplete circle, whereby 320° of the path contain sinuous filamentary material, or the circle is open for approximately 40° or one-ninth of the normal circular path. For that matter, the planar member can be so deformed as to allow for a certain overlap of the edges of the planar member. In such case, the filamentary material runs more than 360° in the arcuate path away from the first point, then reverses its direction to run, for instance, 280° away from the point at which it first reversed its direction. It should be understood that the transplant can also be formed such that there is overlap at alternating apices. The determination as to whether the temporary implant should define a complete circle, a partial circle or should have overlap at the apices is left to the surgeon and will be dependent at least in part upon the type of adhesions which the surgeon expects may be created in the region of the tendon repair.

The material of which the temporary implants of the present invention are prepared is important. These materials should be readily formable and yieldable so that they unravel from their preformed shape during removal from the body. Preferably, they are made of light-weight materials so that upon removal from the body, they assume generally linear form. The filamentary material can suitably be notched, serrated or sharpened at its edges to define minute cutting surfaces which will assist in cutting the fibrous adhesions upon withdrawal of the implant. Similarly, the number of serrations per inch will be between 25 and 250, preferably between 50 and 100. It is to be understood that the number of serrations per inch refers to the number of serrations per inch of filamentary material, independent of the overall dimensions of the temporary implant. These values apply to both the cylindrical tubular implant and to the generally planar flat implant disposed between neighboring tendons.

Preferably, the material of the temporary implants is made of a metal wire, especially a stainless steel wire. However, it should be understood that other metal wires can be used, notably those made of metals such as iron, aluminum, magnesium, nickel, cobalt, tin, copper, silver, gold, and the like, and alloys thereof. If the specific composition of the metal itself might react with the body chemicals or adjoining tissue adversely, it can be suitably coated with an inactive substance, such as a polymeric material, notably light-weight polymers of alpha olefins, polyvinyl chloride, chlorinated polyethylene, polyvinyl alcohols, polyurethanes, polyamides, polyimides, and other thermostable and thermosetting resins.

Alternatively, the entire composition of the filamentary material can be made of a polymeric material either in serrated or smooth form. Suitable polymers include cellulosic materials, acetate rayons, silk materials, nylon, orlon, polyesters, especially phthalic acid derived polyesters, protein fibers, silk fibers, rayon, wool, cotton, jute, hemp, floss and floss silk, Manila, Manila hemp, binding twine, catgut, lace, polyolefins, phenolic resins, phenylene oxide polymers, allyl resins, cellulosic molding compounds containing reinforcing agents, and other thermostable and thermosetting resins. Desirably, in its preferred form, the filamentary material is made from a stainless steel having a thickness between 0.005 and 0.02 inches, preferably between 0.008 and 0.012 inches. It will be appreciated that the thickness of the filamentary material employed will be dependent upon the size of the fibrous adhesions expected and the nature of the materials employed. It should be further noted that the present invention can be used employing a continuous thread which forms a generally tubular cylindrical form having gaps therein defining openings or perforations through which the fibrous adhesions grow during the healing process. As indicated above, the existence of these fibrous adhesions is important, as these fibrous adhesions apparently serve as a vehicle for the proper nutrients from the body, being fed en route to the healing tendon.

The present invention further contemplates an apparatus for use in such tendon surgery employed to readily dispose about a free end of a tendon to be repaired a cylindrical tube of the present invention characterized by having openings in the periphery thereof. This improvement comprises a generally continuous inner sleeve, preferably constructed of a smooth plastic substance of the types defined above, which sleeve carries said generally cylindrical tube of continuous filamentary material. Such a sleeve can be used during tendon repair wherein the sleeve carrying the generally cylindrical tube is disposed over the free end of a severed tendon, the plastic tubing being removed to deposit the cylindrical tube about the tendon to be repaired. After the tendon has been repaired at the point of the broken joint or section, the generally cylindrical tube is brought down so that it lies generally on either longitudinal side of the joint of the healing tendon.

With respect to the sheathing material which carries the generally tubular implant composed of filamentary material, it can be made of any light-weight smooth material, such as polyamides, especially nylon 6 and nylon 6,6, poly alpha olefins, especially polyethylene and polypropylene, and polyesters, especially those based upon a phthalic acid residue. Similarly, polyethers can
be employed in solid form. Additionally, it will be apparent that one can use soluble materials of a smooth nature which dissolve under the influence of the body chemistry and yet allow the temporary implant to be disposed about the healing tendon. Especially suitable materials include cat gut and compressed “polysaccharides,” i.e., glucose and cellulose.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to more fully appreciate and understand the invention, reference is made to the accompanying drawing, in which:

FIG. 1 is an expanded enlarged view of an alternating reversing helically wound generally tubular temporary implant of the present invention in serrated form;

FIG. 2 is an enlarged side view of a finger showing a skeletal cross section of the bones of the finger and a single tendon under repair with the generally cylindrical member of FIG. 1 in place about a tendon during the process of healing. In this view there can be seen the fibrous adhesions which grow radially outward from the tendon itself;

FIG. 3 is an isometric view of a sleeve member adapted to carry and insert into place the generally tubular member of FIG. 1;

FIG. 4 is an enlarged cross sectional elevation of a single tendon about which is placed the sleeve member of FIG. 3 carrying the tubular member of FIG. 1, the section being taken through the top of the sleeve in FIG. 3 and taken before such time as the sleeve of FIG. 3 is removed from a tendon, as more fully described below;

FIG. 5 is another embodiment of the present invention shown in generally planar view, the same being for use between two neighboring tendons. The device is at least partially serrated;

FIG. 6 shows in place the implants of FIGS. 1 and 5, the implant of FIG. 5 being disposed between tendons, and the implant of FIG. 1 being disposed about the two tendons, the ends of each implant extending outwardly toward the exterior of the patient;

FIG. 7 is a sectional view taken along the lines 7—7 of FIG. 6;

FIG. 8 is a view similar to FIG. 7 limited to the implants depicted in FIG. 6;

FIG. 9 is an isometric view similar to FIG. 5 showing the disposition of the generally planar transplant of FIG. 5 on a piece of adhesive;

FIG. 10 shows the manner in which the temporary implant of FIG. 9 is disposed about a tendon to be repaired through the assistance of the adhesive strip shown in FIG. 9;

FIG. 11 is an enlarged side view similar to FIG. 10 showing the disposition of the various apices of the sinuous material whereby they meet at a line such that the sinuous material travels substantially about 360° and reverses itself to travel about 360° in the opposite direction before again reversing itself;

FIG. 12 is an enlarged side view, similar to FIG. 11, showing an overlap of the apices caused by the fact that the filamentary material travels in excess of 360° before it reverses itself; and

FIG. 13 is an enlarged view similar to FIGS. 11 and 12 which shows the generally planar member folded so as to define an enclosed area only a portion of which contains filamentary material, such being caused by the fact that the filamentary material travels less than 360° before reversing itself.

DISCUSSION OF PREFERRED EMBODIMENTS

Preferred embodiments of the present invention are illustrated in FIGS. 1 through 8 in which FIG. 1 is an enlarged isometric view of the present invention. The embodiment shown therein is a reversing or alternating helical wire member 2 having a first helix 4 which reverses at 6 to form an oppositely directed helix which in turn reverses once again to form a convolution or helix 8 of the same configuration as helix 4. The alternating helical form of the implant of FIG. 1 is continuous through its length from right to left. The helical temporary implant of the present invention has a protruding end member 10 adapted to extend through to the surface of the patient, said member having a lip 12. In practice, this minute member, generally made of a stainless steel wire having a diameter between 0.008 and 0.012 inches, is placed, through the use of the tubular sleeve 14 of FIG. 3, over one end of a severed tendon. It must be remembered that tubular member 14 assists in placing the implant 2 over the area to be healed. It is disposed about a particular edge or end of the tendon under repair. The sleeve 14 is withdrawn, leaving the implant 2 over a continuous portion of tendon. The remaining helical tubular member is then moved to overlay the joint formed by abutting ends of severed tendon being repaired.

Referring to FIG. 4, there is shown the cross sectional elevation of the sleeve 14 underlying and carrying the generally tubular implant 2 disposed over an end 16 of a tendon. At this stage, the sleeve 14 is withdrawn, and the helical member 2 is disposed so that approximately half is on one side of the tendon suture (repair) line and half on the other side, all as seen in FIG. 2.

In FIG. 2 there are also seen the adhesions 20 which grow radially outward from the tendon of which portion 16 is proximate one end to be joined to an opposing end 18. It can be seen that a natural sheath envelopes the tendon and it is between this sheath and the tendon that the fibrous adhesive grows. Normally, the tendon rides smoothly within this sheath. However, if there are lateral adhesions present, the rideability during flexing is severely inhibited.

After the healing is substantially complete, i.e., after the surgeon has performed the usual surgical technique on the severed tendon, the lip 12 is disposed slightly exterior of the patient, as shown in FIG. 2. The wound is allowed to heal until the junction between the ends of the tendon is substantially repaired. Thereafter, the lip 12 is pulled, thereby unraveling the filamentary material which severs the fibrous adhesions as it is removed.

In FIG. 5, there is illustrated an embodiment of the present invention for use as a temporary implant between a healing tendon and a neighboring tendon in out-of-contact relationship therewith. This temporary implant generally is constructed of the same material as the implant of FIG. 1 is constructed. This implant has a tight sinus curve with a protruding member 20 with a lip 22 adapted to be directed outwardly from the patient's body. FIG. 6 shows the same in position with its lip 22 disposed proximate lip 12 of the generally tubular implant 2.

Again, with respect to the assembly of FIG. 6, it should be noted that generally speaking, after the same
have been put in place, immediately following the joining of the severed ends of the tendon, the lips 12 and 22 are brought just slightly through the surface of the patient. The patient’s curing processes are allowed to commence, which, indeed, cause fibrous adhesions between tendons 24 and 26. In fact, the tendons grow through the perforations or slits defined by the sinuous curve of the generally flat member 19 of FIG. 5. After healing is substantially complete, the tip 22 is pulled to unravel the flat member 19 while it severs adhesions disposed between tendon 24 and tendon 26. Thereafter, the lip 12 is pulled to unravel the alternating and reversing helical tubular member 2 which severs the adhesions 20 disposed between the tissues within the finger and the tendons 24 and 26. Only a small covering, such as an adhesive bandage, need be applied over the minor opening through which the filamentary material constituting the temporary implant is removed.

A preferred form of the present invention is illustrated in FIGS. 9 to 13, inclusive. Referring to FIG. 9, there is shown a generally continuous filamentary transplant of the type shown in FIG. 5 having apices 34 on one end thereof and nadirs 36 on the other. The generally flat planar material designated by reference numeral 38 is disposed on an adhesive substrate 40. The generally planar member has endpieces 42 and 44, at least one of which will be disposed through the exterior skin of the patient.

The implant of FIGS. 9 and 13 is employed by wrapping the adhesive material containing the sinuous continuous filamentary material about a tendon 48 so that the adhesive is on the exterior side, as shown in FIG. 10. The adhesive is thereafter removed after the planar member is deformed to define a generally cylindrical temporary implant. When removed, the implant takes the configuration shown in FIG. 11 where the apices and troughs in alternating sequence touch the same imaginary line drawn parallel to the tendon 46. In FIGS. 10 and 11 the cylindrical temporary implant substantially completely envelopes the tendon.

On the other hand, in FIG. 12 there is shown the configuration provided if the planar member 38 of FIG. 9 is wrapped more tightly around the tendon 46, the net result being that the apex of one side becomes disposed within the open area on the opposite side thereof between two troughs. The use of such temporary implant of FIG. 12 is the same as that of FIG. 11. It should be recognized that such an embodiment will insure the severing of virtually all of the tendonous adhesions caused to grow between the tendon and adjoining tissue. In certain instances, however, it is desirable to dispose the planar member such that it only partially envelops or surrounds the tendon 46. Such configuration is depicted in FIG. 13. It may well be that such a configuration will be provided around one severed tendon which is adjacent an unsevered tendon. The opening provided on the surface, owing to the fact that the generally flat planar member does not define a full cylinder, may allow for the disposition of a second flat planar temporary implant of the type depicted in FIG. 5 in the region of the opening so that intertendonous adhesions can be severed after the patient has undergone the healing process.

In order to more fully illustrate the nature of the invention and the manner of practicing the same, the following Example is set forth:

EXAMPLE

An insertion was made in the surface of a dog which had revealed, upon diagnosis, a severed flexor tendon of the second digit. The area about the severed tendon was cleared of tissue. An alternating reversing helical temporary implant having the configuration of FIG. 1 was slid over one end of the tendon. The other end of the tendon was placed in mating relationship with the first end of the tendon and medically sutured to commence healing and joining of the tendon longitudinally. The implant was then slid downward so that it was half over each end of the severed tendon. The end or lip of the tendon implant was permitted to protrude through the surface of the dog which was covered by a suitable adhesive bandage or other protective covering. The dog’s exterior wound was repaired. Several weeks later, after sufficient time had elapsed to permit healing of the tendon, the lip of the implant was pulled so that it severed fibrous adhesions which grew between the tendon under repair and adjoining tissue. The entire filamentary material of the temporary implant was withdrawn. The dog’s tendon was completely repaired and there were substantially no movement restrictions noted due to the creation of fibrous adhesions, which occur in dogs as well as in humans, during the healing of tendons. Without the severence of these fibrous adhesions, the loss of function of the tendon and therefore the body part occurs.

From the above, it is seen that the device of the present invention improves the functional results after tendon repair. Desirably, the device is a porous stainless steel temporary implant placed around and between the tendons, the site of the suture line at the time of repair. The implant remains in this position until sufficient time is allowed for healing of the tendon to occur. After the tendon has healed, the device is simply removed percutaneously as two lengths of straightened wire, e.g., stainless steel wire. In the process of removal, the implant acts as a cutter of adhesions which have grown between the tendon and adjacent tissues and juxtaposed tendons. This eliminates one of the major causes of poor functional results after tendon repair due to the proliferation of fibrous adhesions disposed between the tendon and adjacent tissues created during the healing process. These adhesions can cement the tendon to the adjacent tissues and thereby inhibit the gliding action of the tendon so necessary for good functional results. To be able to break the adhesions which cement the tendon in a fixed non-glidig position improves the functional results by improving the gliding action and mobility of the tendon. The present invention provides a simple, inexpensive means of breaking the peri- and inter-tendonous adhesions which develop in the process of healing. Through use of appropriately dimensioned implants, severed tendons in sensitive, difficult-to-repair areas of the body, for example, the limbs and especially the hands, can be repaired with substantially full recovery of all movement. This is particularly surprising, as surgical methods presently available do not adequately repair severed tendons in many areas of the body. The use of such a device is simple and can be performed by any orthopedic surgeon or the like and does not require special training.

The above invention has been described with particular emphasis upon the use of a stainless steel implant having a thickness between 0.008 and 0.012 inch.
Broadly speaking, however, the implant can have a thickness between $\frac{1}{8}$ and $\frac{3}{4}$ inch, preferably between $\frac{1}{6}$ and $\frac{1}{4}$ inch. The thickness will depend upon the nature of the material, it being clear that the same must be able to assume a shape, e.g., helical or flat planar, and yet be such that when pulled, it assumes a generally straightened form.

Generally speaking, when the implant is in the form of a sinuous continuous filament having apices at the edge thereof, the distance between such apices will be between 0.25 and 5 mm, preferably between 1 and 2 mm. The cross section of the filamentary material can have any suitable configuration such as triangular, elliptical, rectangular, trilobal or circular. A triangular cross section for the filament is particularly desired because such configuration lends itself to a severing function. The cross section of the entire implant generally assumes for the implant of FIG. 1 either a circular, elliptical or triangular cross section.

What is claimed is:

1. A temporary implant for tendon surgery which comprises a generally cylindrical tube of a continuous yieldable filamentary material, said cylindrical tube having openings on the surface thereof defined by said filamentary material, said cylindrical tube being in the shape of an alternating and reversing helix which has a diameter between $\frac{1}{8}$ and $\frac{3}{4}$ inch and a length between 1 and 4 inches.

2. A temporary implant according to claim 1 wherein said cylindrical tube has a circular cross section.

3. A temporary implant according to claim 1 composed of stainless steel.

4. A temporary implant according to claim 1 wherein said continuous filamentary material is serrated.

5. A temporary implant according to claim 4 wherein the serrations have an amplitude between 0.0001 and 0.001 inch and there are between 25 and 250 serrations per inch.

6. A temporary implant according to claim 1 wherein the filamentary material is between 0.005 and 0.020 inch thick.

7. A temporary implant for tendon surgery according to claim 1 wherein the continuous filamentary material runs in an undulating, sinuous path, the apices and nadirs of the path of the filamentary material being brought toward one another in a general facing relationship to define a substantially enclosed area having spaces between the filamentary material.

8. A temporary implant according to claim 1 wherein the filamentary material runs continuously in an arcuate path from a point on said cylindrical tube to a point substantially between 270° and 420° away on the surface of said tube, at which point it reverses its direction and travels in an arcuate path between 270° and 420° away on the surface of said tube, at which point it again reverses its direction.

9. A temporary implant according to claim 8 wherein the continuous filamentary material runs continuously in an arcuate path from a point on the cylindrical tube to a point substantially 360° away on the surface of said tube, at which point it reverses its direction and travels in an arcuate path substantially 360° away on the surface of said tube, at which point it again reverses its direction.

10. A temporary implant for tendon surgery which comprises a generally flat planar member composed of a yieldable filamentary material having a thickness between 0.005 and 0.02 inch, said generally flat planar member being in the form of a continuous sine curve, the apices of which range from between 50 and 150 per linear inch of said planar member.

11. A temporary implant according to claim 10 wherein said planar member has a width between $\frac{1}{8}$ and $\frac{3}{4}$ inch.

12. A temporary implant according to claim 11 wherein said filamentary material has serrations on the surface thereof such that there are between 25 and 250 serrations per inch of filamentary material.

13. A temporary implant according to claim 10 wherein the filamentary material is stainless steel having a width between 0.008 and 0.012 inch and having between 50 and 150 apices per linear inch of said implant.

14. An improvement in surgically repairing broken tendons which comprises disposing about the junction of a repaired tendon the temporary implant of claim 1, allowing the tendon to substantially heal at the junction and thereafter removing said implant by pulling an end of said filamentary material to thereby sever adhesions formed between the tendon and neighboring tissue material.

15. The process of claim 14, wherein the temporary implant is carried on a generally tubular sheath material, said sheath carrying said temporary implant is disposed over one severed end of a tendon, said sheath material is removed thereby depositing said temporary implant over said end of said tendon, said end is joined to a severed end and said implant is disposed over both ends of the severed tendon.

16. An improvement in surgically repairing broken tendons which comprises disposing about the junction of a tendon undergoing repair the temporary implant of claim 7, allowing the tendon to substantially heal at its junction and thereafter removing said temporary implant by pulling an end of said filamentary material to thereby sever adhesions formed between the tendon and the neighboring tissue.

17. An improvement in surgically repairing broken tendons which comprises disposing about the junction of a tendon undergoing repair the temporary implant of claim 6, allowing the tendon to substantially heal at its junction and thereafter removing said temporary implant by pulling an end of said filamentary material to thereby sever adhesions formed between the tendon and the neighboring tissue.

18. In a process for the surgical correction of at least one severed tendon where the tendon is disposed close to but in out-of-contact relationship to a second tendon, the improvement for surgically repairing said tendon which comprises disposing between the severed tendon and the adjoining tendon the temporary implant of claim 10, allowing the junction of the severed tendon to heal and thereafter removing said implant by pulling an end of said filamentary material.

19. In a process for the surgical correction of at least one severed tendon where the tendon is disposed close to but in out-of-contact relationship to a second tendon, the improvement for surgically repairing said tendon which comprises disposing between the severed tendon and the adjoining tendon the temporary implant of claim 12, allowing the junction of the severed tendon to heal and thereafter removing said implant by pulling an end of said filamentary material.
20. In a process for the surgical correction of at least one severed tendon where the tendon is disposed closed to but in out-of-contact relationship to a second tendon, the improvement for surgically repairing said tendon which comprises disposing between the severed tendon and the adjoining tendon the temporary implant of claim 13, allowing the junction of the severed tendon to heal and thereafter removing said implant by pulling an end of said filamentary material.

21. A process for the surgical correction of at least one severed tendon which comprises disposing adjacent to said tendon a temporary implant which comprises a continuous yielding filamentary material having openings on the surface thereof defined by said filamentary material, allowing the tendon to substantially heal and withdrawing the implant and substantially simultaneous therewith severing tenuous adhesions which are connected to said tendons by impingement of said filamentary material.

22. A temporary implant according to claim 10 wherein said generally flat planar member is disposed upon a generally flat adhesive substrate.

23. A temporary implant according to claim 22 wherein the adhesive substrate is transparent.

24. An improvement is surgically repairing a broken tendon which comprises disposing about the junction of a repaired tendon the temporary implant of claim 22, deforming said implant so that it is in the form of a generally cylindrical object, removing said adhesive substrate to thereby form a generally cylindrical tube, and pulling an end of said filamentary material to thereby sever adhesions formed between the tendon and neighboring tissue material.

25. An improvement according to claim 24 wherein the filamentary material is carried on a transparent adhesive substrate, said transparent adhesive substrate is removed after the generally cylindrical object of filamentary material is formed.

26. A temporary implant according to claim 1 wherein said continuous filamentary material is notched.

27. A temporary implant according to claim 1 wherein said continuous filamentary material has sharpened edges.