ISSN 2456-4400

Sahoo et al., Int J Med Lab Res 2017, 2(2): 46-52

REVIEW ARTICLE INTERNATIONAL JOURNAL OF MEDICAL LABORATORY RESEARCH (IJMLR)

A DISCUSSION ON SUTURE AND LIGATURE

Chinmaya Keshari Sahoo*[1], D.Venkata Ramana[2], Kokkula Satyanarayana[3]

[1]*Associate Professor, Department of Pharmaceutics, Malla Reddy College of Pharmacy, Maisammaguda, Secunderabad, Telangana-500014,*
[2]*Professor, Department of Pharmaceutical Technology,Netaji Institute of Pharmaceutical Sciences,Toopranpet,Yadadri Bhongir, Telangana-508252,*
[3]*Professor, Department of Pharmacognosy, Princeton College of Pharmacy, Korremula, Ghatkesar, Telangana-500088,*

Received:8 May, 2017/Accepted:29 May, 2017

ABSTRACT: The aim of the study was to give information on properties of suture and ligature materials in order to assist surgeons in their selection of adequate sutures for specific surgical applications. The essential requirements and characteristics of suturing materials effects on properties of surgical sutures and ligatures. Suturing consists of ensuring good adaptation of body tissues for proper wound healing. Suturing is a skill that requires good technique and the right material. A ligature is a thread used to constrict and seal off a blood vessel, vein or artery hence to ligate. Absorbable suture is used to close the edges of a wound or incision and to repair damaged tissue. Non-absorbable sutures are designed to either be left permanently in the body or are to be removed after a certain healing period.

KEYWORDS: Suture, ligature, absorbable, non-absorbable

INTRODUCTION:

The history of sutures is largely a reflection in miniature of the major phases in the history of surgery itself. The earliest known text on surgery is found in the Edwin Smith papyrus (circa 3000 E.C.) where it is recorded that the ancient Egyptians were already aware of the importance of approximating the edges of a created wound. For this purpose they used strips of linen cloth. In India about this time- dried animal intestines were being used as ligatures while in China silk threads were employed for the same purpose. Even the origin of modern skin clips is hallowed ·in antiquity. In surgery Susruta (1500 B.C.) records the use of ligatures for tying umbilical cord and Celsus in the first century A.D. describes the ligatures of ancient origin. Galen (A.D. 200) used silk and hemp cords as ligatures and also recommended the use of animal gut.About the year 1000 B.C. giant ant or beetle were used, in India, to clip wound margins together these were the original skin clips. By the sixth century B.C. several materials had been modified and adapted for use as sutures, including cotton, silk, animal tendons, strips of leather and horse hair. Hippocrates (500 B.C.) stressed the importance of closing wounds and he further advocated the ligation of bleeding vessels. Galen, whose teachings were destined to

***Address of correspondence:**
Chinmaya keshari sahoo
Associate Professor, Department of Pharmaceutics, Malla Reddy College of Pharmacy, Maisammaguda, Secunderabad, Telangana-500014.

dominate the practice of surgery, for the next fifteen centuries, also ligated arteries and makes special mention of catgut:"Select from those materials that substance which *is* least putrescible, such as very ,thin catgut which rots easily and quickly falls from the vessels."In the thirteen century A.D. there was reawakening of interest in the techniques of wound suture and vessel ligation.Theodoric (1205 - 1296 A.D.) and Mundinus (1275 - 1326 A.D.) both wrote extensively on the subject. Ambroise Pare (1510 - 1590) whose extensive experience of war wounds was unparalleled, advocated the cleaning and dra;nage of wounds and the arrest of bleeding by ligature rather than cauterising with boiling tar or hot irons as was then customary.

John Hunter and his students favoured the ligation of arteries. Lembert dsscribed the technique of successful suture of the intestine by apposition of serosa to serosa. At this time ligatures were generally non absorbable and, of course, non-sterile.The introduction of antisepsis by Lister revolutionized surgical technique. In 1908, Lister demonstrated that by soaking catgut, in this carbolic solution it could be left ,in the tissues and the wound closed. He first used plain catgut ligatures[1] but after extensive research he developed chromic catgut.

The history of this work applied to surgical sutures and ligatures during the past seventy years is too large a subject for this chapter but the investigations by a host of dedicated workers into hundreds of different procedures has led to the highly efficient methods being employed today. A ligature is a thread used to constrict and seal off a blood vessel, vein or artery hence to ligate. The thread is a suture when it is used to stitch together the edges of various tissues, e.g. skin, fascia, muscle, tendon, peritoneum, etc. Hence a needle is always used for a suture (sewing) but not for ligature.The advances in organic chemistry, in the physical sciences and in engineering technology which characterize the last decades have led to the *in*troduction of an array of new suture materials particularly metallic wires and the synthetic non-absorbable fibres.

Characteristics of suture[2]

1. It should have no delaying effects in the course of healing;
2. It should retain its tensile strength unimpaired for an indefinite period;
3. It should be inert in the tissues.
4. It should cause minimal tissue injury or tissue reaction (ie, non electrolytic, non capillary, non allergenic, non carcinogenic)
5. It should have favorable absorption profile.
6. It should have all-purpose (composed of material that can be used in any surgical procedure) property.

Classification[3-8]

Sutures and ligatures are classified as absorbable and non-absorbable, depending on the materials on which they are made.

Absorbable suture

Absorbable sutures and ligatures are absorbed by the tissues in which they are implanted and the time taken for complete disappearance is dependent on a number of factors, which will be treated more fully later in this chapter. Absorbable materials are catgut (non-boilalable and boilable), reconstituted collagen, synthetic absorbable polymers, kangaroo tendon, ribbon gut and fascia lata.

- **Natural absorbable materials**

1. Surgical catgut

Sterilized surgical catgut consists of a strand prepared from collagen derived from healthy mammals purified and sterilized. The most widely used source is the sub mucosa of the small intestine from sheep or lambs and to a lesser extent, the serosa sheep beef cattle. The

length of ovine intestine is about 20 m and it is desirable in the preparation of surgical catgut that the diameter of the intestine should not be more than 18 mm. A number of factors are important in the selection of suitable intestinal material. Generally the younger the animal the smaller it is intestine and less likely to be affected by feed. A number of manufacturers of catgut use only the first 8 m of intestine measured from the duodenum. In the slaughterhouse the gut is removed from the animal by the gut pullers and is first of all cleaned to remove faecal matter after which it is inspected, measured and the preserved either in a frozen state or salted.

2. Reconstituted collagen

Collagen is available from a large number of sources. It is the major constituent of skin, tendon, ligament, etc. It is partially soluble in acids. The basic process has been to obtain an acidic solution of collagen prepared from hides or tendons which can be extruded into a coagulation solution and the resulting fibers oriented by stretching. The filaments can then either be spun or rolled to make up the necessary sizes of strand required. Reconstituted collagen is produced mainly in the finer sizes 0.5, 1 and 2 for ophthalmic and cuticular surgery.

3. Kangaroo tendon

This absorbable material consists of the tail tendons of the wallaby. The tendons, which were usually preserved with naphthalene, were prepared and graded into various sizes e.g. fine, medium, and stout. Lengths were 30-40 cm. They were sterilized as for catgut and their main use was for hernia repair and bone surgery.

4. Ribbon gut

Ribbon gut is in the form of ribbon approximately 12 mm wide and usually about 45 cm long. Its use is limited but is preferred by some surgeons for the repair of large ventral hernia and in the closure of the kidney after nephrology. The material is prepared from bovine esophagus and is sterilized in the same way as catgut.

5. Fascia lata

This may be excised from the patient, or prepared from bovine thigh muscle, cleaned and sterilized. It is supplied in lengths of about 30 cm × 6 mm wide and is used surgically for hernia repair, urethral slings, etc.

- **Synthetic absorbable material**

1. Plain surgical gut

Surgical gut is made from the intestinal sub mucosa tissue of sheep. These casings are split into ribbons, which are cleaned chemically as well as mechanically and matched by computers to meet the most exacting demands for diameter and tensile strength. Then an exclusive electronic spinning process creates a strand that is virtually a monofilament for dependable strength and holding power. Finally the strand is polished to size to an accuracy of five thousand of a millimeter to produce an extremely smooth, highly uniform suture. Surgical Gut draws through delicate tissue without sawing, ties down securely and holds uniformly and predictably, until the wound regains tensile strength.

2. Chromic surgical gut suture

Chromic gut is made from the intestinal sub mucosal tissue of sheep. These casing are split into ribbons which are cleaned chemically as well as mechanically and matched by computers in order to meet the most exacting demands for diameter and tensile strength. Then an exclusive electronic spinning process creates a strand that is virtually a monofilament for dependable strength and holding power. Finally the strand is polished to size to an accuracy of five thousand of a millimeter to produce an extremely smooth, highly uniform suture. Surgical gut draws through delicate tissue without ties down securely and holds uniformly and predictably until the wounds regains tensile strength.

3. Coated vicryl (Polyglactin 910)

Available as a braided suture in distinct violet as well as undyed colures coated vicryl (Polyglactin 910) is now the most widely used coated braided synthetic absorbable suture. The

braided construction ensures that handling and knotting are excellent and the unique lubricant coating remains effectively bonded to the material throughout its use, ensuring smooth passage through tissue and easy knot tie down. The unique molecular structure of coated vicryl allows it to retain strength during the critical wound healing period, yet, be absorbed rapidly after the suture has excellent handling characteristic and its distinctive violet colour is highly visible in thewound. Coated vicryl is also available in undyed form, especially for cuticular and plastic surgery.

4. Monocryl (Poliglecaprone 25)

It is monofilament synthetic absorbable suture. Available as a golden colour monofilament.Monocryl (Poliglecaprone 25) is a monofilament, synthetic absorbable suture. A copolymer of 75% glycoside and 25% caprolactone, Monocryl is undyed, presenting as a natural golden coloured monofilament.Monocryl is the most pliable synthetic absorbable monofilament suture ever, has virtually no memory when dispensed and its exceptionally smooth surface ensure tissue glidde when passed through tissue. This added to the fact that it elicts only minimal tissue reaction makes this suture an ideal choice for plastic and cosmetic surgery and for Gastrointestinal surgery.

5. PDS II

It is monofilament synthetic absorbable suture. Available as a distinct violet Suture.PDS II suture is a monofilament synthetic absorbable suture made of polydioxanone.PDS II has the characteristic of extremely high initial tensile strength, coupled with extended wound support. Also being a monofilament handling is extremely easy and knotting is secure. Passage through tissue is smooth, eliminating tissue drag. It is indicated for use in areas such as closure of fascia and sheath, in pediatric cardiovascular surgery, in the gastro intestinal tract, in obstretrics/gynaecology, in orthopedic surgery and for sub cuticular closure.

- **Non-absorbable suture**

Non-absorbable sutures and ligatures are not absorbed by tissue and unless they are on the surface, remain in the body after the wound has healed.

1. Silk

Silk consists of strands prepared from filaments of the cocoon spun by the silk worm of the Bombyx family before it enters the chrysalis stage. Three forms are used in surgery- twisted (sometimes known as Chinese twist). Floss and plaited or braided silk. DSilk in its natural state contains up to 25 percent of natural gum and strands prepared from unbleached, un discharged. Twisted silk suture material is prepared from unbleached, un discharged filaments spun in multiples to the *British Pharmaceutical Codex* range of diameters and may be dyed with non-toxic dyestuffs. The surgical use of twisted silk has very much declined in favor of the braided type.Floss silk is prepared from the coarser filaments on the outer surface of the silkworm cocoon and is used in its spun glossy white form mainly in the repair of hernia. Its use is diminishing fast as the plastic polymer meshes gain in popularity. Plaited or braided silk is the material in large-scale use in modern surgery. It is prepared from discharged silk and the range of sizes is dependent on the number of strands braded together. As the gum has been removed it is not serum proof or non capillary and for most surgical purposes it therefore treated with proofing waxes or silicones.

2. Linen

Linen sutures consist of selected fibers made into a twisted strand from flax (*Linum usitatissinum*). The strand is normally prepared by spinning three cords together, the size of the cords being chosen to produce the ultimate desired gauge of thread. For surgical use it must be firmly and evenly spun and free from fuzziness. Linen may be dyed with any non-toxic dyestuff but although a certain amount of black thread is used the majority of surgeons

prefer off-white or ivory colour. It is extensively used in many surgical techniques and frequently needs to be non capillary and serum proof by treatment with suitable proofing agents similarly to braided silk.

3. Polyamides[9]

In the U.K. these polymers are better known by the word Nylon but as this is a registered trademark in certain European countries, it is likely that the word polyamide will be used in the future. These compounds are formed from the polymerization of the reaction product of an acids and an amine. All the polyamides and suture materials are produced by an extrusion process, the size of the orifice on the extruder head determining the size of the filament. The bulk of the material used in surgery is produced in the form of monofilament. Its main use is in skin suturing although it is sometimes used internally. Polyamide mesh finds a use in hernia repair.Finer filament of polyamide is braided together to form braided nylon on nonabsorbable surgical sutures.

4. Polyester

This suture material is usually prepared in the plainted or braided form and consists of filaments prepared by polymerizing the ester formed by a combination of ethylene glycol and terephthalic acid. In its commercial form it is known under the trademarks Terylene (I.C.I.) and Dacron (Dupont). The number of filaments in the braid determines the size of the completed strand.The polymer has a softening temperature of not less than 255 degree and may be sterilized by autoclaving, ethylene oxide or radiation treatments, in order to improve its visibility in tissue it is often dyed or pigmented with non-toxic materials.

5. Monofilament Polyamide

The suture use in this product is an extremely strong, very pliable surgical nylon produced by a special, closely controlled extrusion and polishing process that assures uniformity throughout its length. It has high in-vivo tensile strength, does not support bacterial growth and has the further advantages of being minimally irritating to tissue and remarkably smooth and easy to handle. The smoothness of suture makes it suitable for closing skin and sub cuticular layers. Its high degree of elasticity contributes to its great strength in the fine sizes, enabling the plastic surgeon; the micro surgeon and the ophthalmologist to tie secure knots.

6. Mersilene Braided and Monofilament Polyester

Mersilene suture is made from fine filaments of pure polyester, an extremely strong synthetic material. It is specially processed to render it non capillary. A special process to produce a tight, smooth, uniform strand braids it. The tensile strength of mersiline suture is considerably higher than that of natural non-absorbable sutures. It is not weakened by wetting. It has excellent handling characteristics, draws easily through tissue and knots hold securely with standard synthetic knotting technique.

7. Polybutylate coated braided polyester suture

It is available as a highly visible green or white coated braided suture. Suture is made of fine filaments of polyester fiber, braided by a special process to produce a firm suture that remains soft and pliable. For added lubricity and smoothness, the suture is coated with a highly adherent, biologically inert Polybutylate. The unique process gives suture a number of advantages. Flaking is virtually eliminated and the suture is smooth to plave and tie down making it an excellent choice for cardiovascular and ophthalmic work. Knots hold securely when standard synthetic technique is used.

Suture is virtually non reactive and will retain its strength in tissue.

8. Monofilament stainless steel suture

Available as sterile monofilament eyeless needled sutures.Surgical stainless steel is made from premium grade steel, formulated specifically for surgical use. This grade of surgical stainless steel must undergo many more quality control steps than ordinary commercial

steel. Surgical steel is the strongest suture material that makes. It offers the ultimate in knot security. As a inert material it will elicit virtually no tissue reaction.

9. Prolene mono filament polypropylene

It is available as a bright blue monofilament suture. Prolene polypropylene[10] suture is made from a polymer of propylene, which is extruded by the special ethicon a very strong, smooth, uniform suture. The unique combination of qualities in the suture material itself makes prolene suture one of the most versatile non-remarkable smoothness remarkable smoothness absorbable sutures available. It makes it desirable as a cosmetic suture. The same quality is valuable in cardiovascular work. It is un wetted by blood, un weakened by tissue enzymes, offers prolonged tensile strength even in infected areas. prolene suture is pliable, ties securely and handles well because of its controlled elongation.

10. Perma-hand

It is available as a black braided suture. Perma hand surgical silk begins as a filament of natural silk. Natural silk is composed of approximately 70 % protein fibers and 30% extraneous material or gum. A specially developed degumming process removes extraneous material amounting to 30% of the original volume of raw silk. This process is essential for a compact braid whilst ensuring that the filaments retain their natural body and elasticity. These filaments are then tightly braided at a slow controlled rate and electronically inspected during the processing.

CONCLUSION:

Proper designing of sutures make it possible to sharply reduce the percentage of postoperative complications and correspondingly to reduce the number of repeated operations. The ideal suture material would be a perfect union of easy sterilization, adequate tensile strength, handling ease, absence of foreign body reaction, and complete tissue absorption. Simultaneously, the time for treating surgical patients will be shortened and expenses for treatment will be reduced.

REFERENCES:

1) Patel KA, Thomas WEG. Sutures, ligatures and Staples. The Medicine Publishing Company, Surgery 2005;2:23.

2) Srinivasulu K, Dhiraj Kumar N. A review on properties of surgical sutures and applications in medical field. IMPACT: International Journal of Research in Engineering & Technology 2014; 2(2):85-96.

3) Ajmeri JR, Ajmeri CJ. Surgical Sutures: The Largest Textile Implant Material.Proceedings of Medical Textiles and Biomaterials for Health care. Edited by Anand SC, Kennedy JF, Miraftab M, Rajendran S.1999.

4) Azhahia Manavalan R , Mukhopadhyay A. Surgical sutures:Performance, development and use. Journal of biometics, Biomaterials and tissue engg. 2008;1:1-36.

5) Tomihata K, Suzuki M,Oka T, Ikada Y. A New Resorbable Monofilament Suture. Polymer Degradation and Stability 1998;59:13-19.

6) Wollinaa U, Heideb M, Müller-Litzb W, Obenaufb D, Ashc J. Functional Textiles in Prevention of Chronic Wounds, Wound Healing and Tissue Engineering. Textiles and the Skin. Curr Probl Dermatol. Basel, Karger 2003;31:82.

7) Carcia paez JM etal. Resistance and Elasticity of the Suture Threads employed In Cardiac Bioprostheses.Biomaterials 1994; 15(12):981-984.

8) Mckenzie AR. An Experimental Multiple Barbed Suture for the Long Flexor Tendon of the Palm and Finger, Preliminary Report. Journal of Bone Joint Surg Br1967;49(3): 440.

9) Hockenberger AS, Karaca E. Effect of Suture Structure on the Knot Performance of Polyamide Sutures. Indian Journal of Fiber and Textile Research, 2004;29:271-277.

10) Faulkner BC, Tribble CG, Thacker JG, Rodeheaver GT, Edlich RF, Knot Performance of Polypropylene Sutures, Journal of Biomedical Materials Research 1996; 33:187-192.

CONFLICT OF INTEREST: Authors declared no conflict of interest.