Surgical Sutures - A Review

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Abstract
A good suturing goes a long way in aesthetic as well as effective wound closure. Selection of material varies with the tissue requirements. The sutures have evolved considerably over the years and are classified according to their origin, material used, number of filaments and thickness. In this article the characteristics and uses of various sutures used in ophthalmic surgery shall be discussed.

Keywords: sutures, monofilament, braided, absorbable, non-absorbable

Effective wound closure is important for success of any surgical procedure. An incomplete closure leads to separation of edges, providing a potential pathway for bacterial contamination leading to infection and scarring. Although tissue adhesives and staples are now being used as alternatives, surgical sutures are still the mainstay for a secure wound. There are an increasing number of materials and suturing techniques described in the literature. An understanding of the origin of sutures improves appreciation of use of contemporary sutures. In this article the various suture materials have been discussed highlighting their utility in different procedures and tissues.

Historical Aspects
Suture materials used for treating wounds were originally natural materials, such as animal tendons and cotton fibres. Synthetic suture materials were used from 3000 BCE (Before Common Era). Ancient Egyptians used plant fibres, hair, tendons and wool threads, which have all been found in mumified remains. The earliest document discussing suturing techniques is the Samhita, written by the Indian surgeon Susruta in 500 BCE. He proposed irrigating the wound followed by application of black ants to the margins and then severing the bodies of the ants from their heads. He also described the use of bow string made of sheep upper small intestine as suture for rhinoplasty, tonsillectomy, amputation, and repair of anal fistulae. The process for creating bow strings for musical instruments was called ‘kitgat’ meaning fiddle string. A ‘kit’ was a three-stringed violin and from this word came ‘catgut’.

Edwin Smith (1822-1906) discovered papyrus which is the oldest known text describing sutures. Aurelius Cornelius Celsus (25 BCE–50 CE), came out with the eight-volume De Re Medicina in which he described the use of braided suture. He wrote about controlling haemostasis by ‘making ligatures in many places’ which would twist around the vessels. Later, Galen of Pergamon (131–211) introduced the use of gut string as a suture material to repair damaged tendons in gladiators. Ali Ibn Sina, or Avicenna (980–1037) of Iran noticed rapid dissolution of sutures in the presence of infection and described a natural monofilament suture, pig’s bristles. The absorption properties of the suture material were described by American physician Philip Syng Physick (1768–1837) who noted that fluids escaping from a wound dissolved leather and popularized chromic sutures. Absorbable sutures made of ‘tendons from the ox, moose, reindeer, etc, and the tails of rabbits, opossums, kangaroos and whale were widely used. Silver suture was then employed for closing tissue under tension, for infected surgical fields, and for fistulas.

Standardization Practices
Lister used carbolic acid to clean suture material, instruments and dressing material and developed catgut in 1881. The older methods have been replaced by ethylene oxide and gamma irradiation for suture sterilization nowadays. The concept of antibacterial coating of sutures was studied for Vicryl Plus triclosan-coated sutures in the oral cavity. It was found that Vicryl Plus sutures had the disadvantage of not reducing the number of Gram-negative pathogenic bacteria while reducing the number of protective bacteria of the normal flora. The authors concluded that because of the costs, the possibility of allergy and developing resistance, the use of triclosan-coated sutures is not recommended.

The US Food and Drug Administration (FDA) started the concept of approval of new suture material in the 1970s followed by pre-market approval for manufacturers. A similar protocol is followed by the British Department of Health that after approval, places the CE (Conformité Européenne) mark on suture which conforms to ‘essential requirements’ for consumer safety in the European Economic Area.

Currently used Suture Materials
Catgut, now called plain gut, is prepared from beef in United States and sheep or goats in India and Pakistan. Chromic gut is a modification aimed to extend the time the suture retains its strength in the body, by treating...
the catgut sutures with chromium salts to cross-link the collagen molecules. New synthetic absorbable polymers like polyglycolic acid and polylactic acid were developed.\textsuperscript{14,15} Synthetic suture materials were named according to the corporation, materials, or scientists who formulated them. Mersilene is a combination of Dr George Merson’s name, and Terylene\textsuperscript{®}, a common European trade name for polyester. Ethiflex\textsuperscript{®} suture, is a polyester suture that had a flexible polytetrafluoroethylene coating placed to improve its handling properties. Ethibond\textsuperscript{®} is the trade name for a polyester suture with a coating that is tightly bonded to the suture made by Ethicon, Inc (Somerville, NJ, USA). Early braided polyester sutures were taken over by nylon suture due to better handling.

Davis & Geck (Danbury, CT, USA) produced a synthetic absorbable suture called Dexon\textsuperscript{®}. A coating that lowered the coefficient of friction during suturing was introduced as Dexon II\textsuperscript{®} suture.\textsuperscript{16,17}

**Classification of Suture Materials**

An ideal suture material should be comfortable to handle, incite minimal tissue reaction, should not favour bacterial growth, should have high tensile strength, hold knots securely, easy to sterilize, should have no electrolytic, capillary, allergenic or carcinogenic action and should be absorbed after serving its function. There is no single suture encompassing all these properties and different sutures are required depending upon the tissue involved. The choice of the suture material is based on the biological interaction of the materials employed, the tissue configuration, and the biomechanical properties of the wound.\textsuperscript{17,18} The sutures are available in different colours. The colour acts as an indicator, which can be particularly useful in certain cases (e.g. vascular surgery) for distinguishing the different anatomical structures. The colour enhances suture visibility, even if steeped in blood, making stitch removal easier.\textsuperscript{18,19}

Elasticity is the capacity of a material to regain its initial length after stretching. This property enables the suture to stretch with oedematous tissue but also to regain its original length and shape on remission of the oedema.

Suture glide is the capacity of the suture thread to pass smoothly through the tissue during placement, and is a function of its coefficient of friction. Threads with a high coefficient of friction can have a saw effect as they pass through the tissues. Therefore, a low coefficient of friction is preferable, but has the disadvantage of slipping. Monofilament threads usually glide very well, whereas braided threads with their uneven surface have a higher coefficient of friction. To minimise tissue trauma caused by braided threads, they are usually ‘coated’. Absorbable monofilament sutures have good glide characteristics and cause minimal tissue damage because of the smooth structure of the thread and its gradual bio-absorption. Sutures are classified as absorbable or non-absorbable, monofilament or multifilament and whether they are made from natural or synthetic material. Braided or multifilament sutures have a number of strands woven together. The non-braided sutures cause less reactivity in the body and are less prone to becoming infected because they lack grooves and rough surface for things to adhere but have the disadvantage to loosen at the surgical knot with the lack of grip.

Sutures that undergo rapid degradation lose their tensile strength early, are considered absorbable. Absorption can occur enzymatically, as with catgut, or hydrolytically, as with the absorbable synthetic polymers. Half-life is defined as the time required for the tensile strength of a material to be reduced to half its original value. Dissolution time is the time that elapses before a thread is completely dissolved. These times are influenced by a large number of factors including thread thickness, type of tissue, and the general condition of the patient.

Non-Absorbable Sutures

Non absorbable sutures made from natural fibres are silk sutures. Silk sutures are made from threads of cocoon of silkworm. It may be virgin or braided, relatively inelastic and because it produces tissue necrosis resulting in early release of the wound, it induces less with the rule astigmatism.
Absorbable Sutures

The commonly used absorbable sutures are Vicryl, plain catgut, chrome catgut, dixon and collagen. Suture characteristics of some of the sutures are given in Table 1.

Size of Sutures

Size of sutures is measured by its width or diameter. The bigger the number the smaller the size of suture. The United States Pharmacopeia (USP) decimal classification is used as the standard for defining the thread gauge. The other widely used system of classification is that of the United States Pharmacopeia (USP) . (Table 2)

| Suture    | Material            | Duration   | Characteristics                        |
|-----------|---------------------|------------|----------------------------------------|
| Collagen  | Homogeneous dispersion of bovine tendon | 16-25 days with decrease in tensile strength by 15 days | Loses strength like catgut, but is less irritating |
| Plain catgut | Submucosal layer of sheep intestine or serosal layer of beef intestine | Half life is 5-7 days and loses all its effective strength by 15 days | Pale straw coloured |
| Chromic catgut | Plain catgut tanned in chrome salts | Half life is 17-21 days and loses all its effective strength by 30 days | Dark brown in colour. Causes lesser reaction then plain catgut |
| Vicryl | Polyglactin 910 (copolymer of glycolide and lactide) | 60-90 days and tensile strength remains for 30 days | Extremely high initial tensile strength. Can be used in all situations where absorbable suture need to be used. It is commonly used for suturing nasal mucosal flaps in dacryocystorhinostomy, muscle reinsertion in squint surgery and lid margin repair. |
| Dexon | Polyglycolic acid | 2-3 weeks | Mild reaction, high tensile strength |

Table 2: Classification of sutures according to thickness

| USP | Decimal | Thread gauge in mm |
|-----|---------|--------------------|
| 12-0 | 0.01   | 0.001-0.009        |
| 10-0 | 0.2    | 0.020-0.029        |
| 8-0  | 0.4    | 0.040-0.049        |
| 6-0  | 0.7    | 0.070-0.099        |
| 5-0  | 1      | 0.10-0.149         |
| 4-0  | 1.5    | 0.15-0.199         |
| 3-0  | 2      | 0.20-0.249         |
| 2-0  | 3      | 0.30-0.349         |
| 0    | 3.5    | 0.35-0.399         |
| 1    | 4      | 0.40-0.499         |
| 2    | 5      | 0.50-0.599         |
| 3+4  | 6      | 0.60-0.699         |
| 5    | 7      | 0.70-0.799         |
| 6    | 8      | 0.80-0.899         |
| 7    | 9      | 0.90-0.999         |
| 8    | 10     | 1.00-1.099         |
| 9    | 11     | 1.10-1.199         |
| 10   | 12     | 1.20-1.299         |

Metallic steel sutures (30µ) have no elasticity. It was used earlier for corneoscleral suturing.
Conclusions

Surgical suture material can be classified on the basis of the characteristics like absorability, origin of material and thread structure. In the last few decades, a wide variety of sutures have been developed and the natural threads though still being used, have largely been replaced by synthetic sutures. Standardization of packaged suture material has effectively reduced suture related complications.

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