Review of absorbable and non-absorbable sutures used for the closure of surgical incisions

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Abstract:

Sutures and ligatures are fundamental to any surgical technique because they maintain approximation of tissues as the wound heals. All sutures should maintain their strength until the wound has healed and as a general rule should be as strong as the healthy tissue through which they are placed.

Introduction

A good healing result following either a surgical procedure or a traumatic lesion relies on precise approximation of the wound edges and their fixation to the surrounding tissue, in other words immobilisation of the wound area. Some of the aids for this purpose, in the form of suture materials and needles, have been in use for centuries. In conjunction with the advances in surgical techniques, the importance of optimal wound care and suture fixation has greatly increased in recent years. the advantages of microsurgical techniques in the context of plastic-aesthetic surgery. As they showed in study, perfect microsurgical tissue approximation leads to early and rapid revascularisation, which not only speeds up wound healing but also promotes successful treatment Apart from plastic-aesthetic corrections, perfect wound care and suture approximation are extremely important in regenerative methods and in connection with implantation . The aim is always to achieve primary wound healing (1).

Eyed or reusable needles with holes, which are supplied separate from their suture thread, are often used for suture. The suture must be threaded on site, as is done when sewing in a recreational setting. The advantage of this is that any thread and needle combination is possible to suit the job at hand. Swaged, or atraumatic, needles with sutures comprise a pre-packed eyeless needle attached to a specific length of suture thread. The suture manufacturer swages the suture thread to the eyeless atraumatic needle at the factory. The chief advantage of this is that the doctor or the nurse does not have to spend time threading the suture on the needle, which may be difficult for very fine needles and sutures. Also, the suture end of a

swaged needle is narrower than the needle body, eliminating drag from the thread attachment site. In eyed needles, the thread protrudes from the needle body on both sides, and at best causes drag. When passing through friable tissues, the eye needle and suture combination may thus traumatise tissues more than a swaged needle, hence the designation of the latter as "atraumatic".

Suture

The word "suture" describes any strand of material used to ligate (tie) blood vessels or approximate (bring close together) tissues. Sutures are used to close wounds. Sutures and ligatures were used by both the Egyptians and Syrians as far back as 2,000 B.C. Through the centuries, a wide variety of materials—silk, linen, cotton, horsehair, animal tendons and intestines, and wire made of precious metals—have been used in operative procedures. Some of these are still in use today.

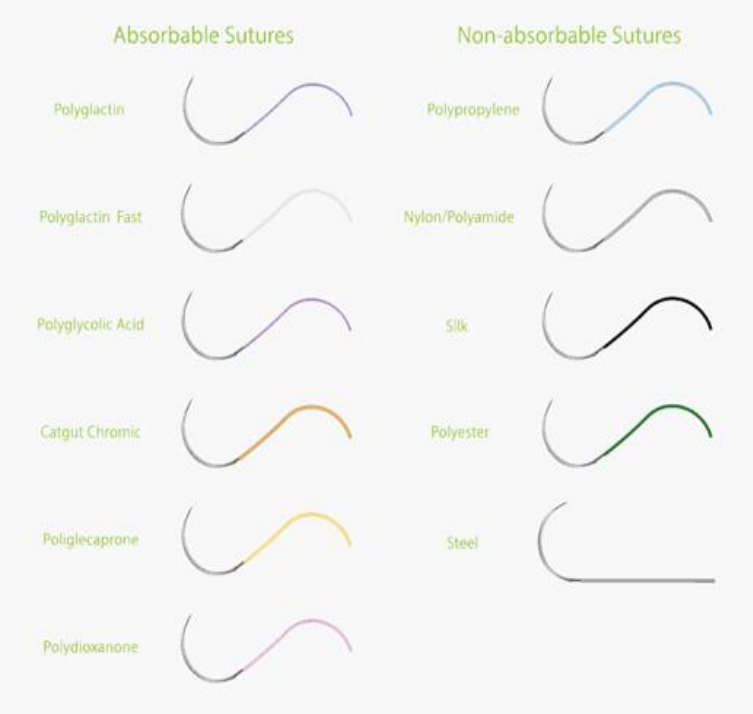
The evolution of suturing material has brought us to a point of refinement that includes sutures designed for specific surgical procedures. Despite the sophistication of today's suture materials and surgical techniques, closing a wound still involves the same basic procedure used by physicians to the Roman emperors. The surgeon still uses a surgical needle to penetrate tissue and advance a suture strand to its
desired location.

A suture is a medical device that doctors, and embalmers especially surgeons, use to hold skin, internal organs, blood vessels and all other tissues of the human body together, after they have been severed by injury, incision or surgery. Similar to other methods of wound closure, surgical suture closure creates an opportunity for wound healing. Tissues are held together until enough healing occurs to withstand stress without mechanical support. (2) There are many kinds of sutures, with different properties suitable for various uses. Sutures can be classified into two groups: absorbable sutures and non-absorbable sutures. An absorbable suture breaks down in tissue after a given period of time. It degrades as a wound or incision heals. A non-absorbable suture resists the body’s attempt to dissolve it. Non-absorbable sutures may be removed by a surgeon after a surface incision has healed. Sutures must be

strong (so they do not break), non-toxic and hypoallergenic (to avoid adverse reactions in the body), and flexible (so they can be tied and knotted easily). In addition, sutures must lack the so called “wick effect”, which means that sutures must not allow fluids to penetrate the body through them from outside, which could easily cause infections. (3)

Type of suture

We can classify sutures into two types– those which are absorbable and will break down harmlessly in the body over time without intervention and those which are non-absorbable and must be manually removed if they are not left indefinitely. The type of suture used varies on the operation, with the major criteria being the demands of the location and environment and depends on the discretion and professional experience of the Surgeons. Surgical sutures to be placed internally would require re-opening if they were to be removed. Suture materials which lie on the exterior of the body can be removed within minutes, and without re-opening the wound. As a result, absorbable sutures are often used internally; non-absorbable externally. Certain Sutures may need to be placed in a stressful environment, for example the heart (constant pressure and movement) or the bladder (adverse chemical presence) may require specialized or stronger materials to perform their role; usually such sutures are either specially treated, or made of special materials, and are often non-absorbable to reduce the risk of degradation (4). (Fig 1 : Type of sutures)



Types of absorbable sutures

- **Gut.** This natural monofilament suture is used for repairing internal soft tissue wounds or lacerations. Gut shouldn't be used for cardiovascular or neurological procedures. The body has the strongest reaction to this suture and will often scar over. It's not commonly used outside of gynecological surgery.
- **Polydioxanone (PDS).** This synthetic monofilament suture can be used for many types of soft tissue wound repair (such as abdominal closures) as well as for pediatric cardiac procedures.
- **Poliglecaprone (MONOCRYL).** This synthetic monofilament suture is used for general use in soft tissue repair. This material shouldn't be used for cardiovascular or neurological procedures. This suture is most commonly used to close skin in an invisible manner.
- **Polyglactin (Vicryl).** This synthetic braided suture is good for repairing hand or facial lacerations. It shouldn't be used for cardiovascular or neurological procedures.

Types of non-absorbable sutures

Some examples of nonabsorbable sutures can be found below. These types of sutures can all be used generally for soft tissue repair, including for both cardiovascular and neurological procedures.

- **Nylon.** A natural monofilament suture.
- **Polypropylene (Prolene).** A synthetic monofilament suture.
- **Silk.** A braided natural suture.
- **Polyester (Ethibond).** A braided synthetic suture.

Absorbable suture

Collagen sutures are derived from the submucosal layer of ovine small intestine or the serosal layer of the bovine small intestine. This collagenous tissue is treated with an aldehyde solution, which crosslinks and strengthens the suture and makes it more resistant to enzymatic degradation. Suture materials treated in this way are called plain gut. Natural-fiber absorbable sutures have several distinct disadvantages. First, they tend to fray during knot construction. Second, there is considerably more variability in their retention of tensile strength than is found with the synthetic absorbable sutures. A search for a synthetic substitute for collagen sutures began in the 1960s. Soon, procedures were perfected for the synthesis of high-molecular-weight polyglycolic acid, which led to the development of the polyglycolic acid sutures . (5)

Absorbable threads are divided into several types, namely:

1-**gut filaments (gut):** This single strand is natural in material. It is used to repair internal soft tissue wounds or lacerations. This type of suture should not be used on heart, vascular or

nerve sutures. The body reacts strongly to this thread and it often leaves a scar at the site of the thread.

2-**Polydioxanone (PDS) sutures**: This synthetic monofilament is made of material. This type of suture is used in the suturing of soft tissues, such as closing the abdominal incision.

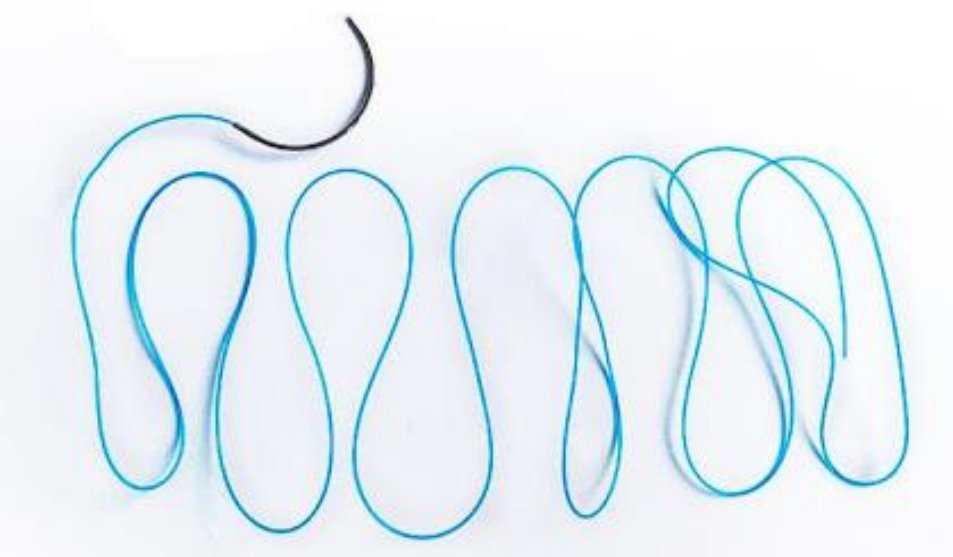
3- **Poliglecaprone (MONOCRYL) yarn**: These are synthetic monofilaments in terms of material. It is used for general use in the repair of soft tissues. These threads should not be used in cardiovascular surgery or neurological diseases. This thread is widely used to close the skin in a transparent, invisible way.

4- **The polyglactin (Vicryl) filament**: This is a double strand or synthetic braided in terms of material of manufacture. Used to repair hand or face tears. These sutures should not be used in cardiovascular or nerve surgery.

non-absorbable suture

While it's considered to be a non-absorbable, silk sutures do degrade in about two years. Its soft structure is comfortable for patients and makes it gentle on delicate tissues. On the downside, silk tends to become infiltrated with the cells it is suturing, making it difficult and painful to remove, however, it is available coated with silicone or specialty wax to limit capillarity. Silk also has low tensile strength, making it likely to break under high tension. It's often used to suture mucosal tissues or to close intertriginous areas. Because of its easy handling, silk is also helpful as a temporary suture during surgery. (6)

Twisted linen sutures are also easy to work with. Linen has high tensile strength, unlike silk, and its strength increases in a moist environment. However, they lose 50 percent of their strength over a six to nine-month period. They are most useful for procedures where tissue support is unnecessary for an extended period, The main drawback is that the linen strands produce high tissue reaction and are of high capillarity, which can promote infection. Because of this, linen is not recommended if an infection is present.



Stainless steel wire sutures are most commonly used for abdominal wound closure, hernia repair, sternal closure and orthopedic procedures. The most significant advantage is that it does not promote infection. Even infected tissues can be repaired using stainless steel. For example, a burst abdomen with the presence of sepsis could be repaired with this suture. Other advantages are that it is inexpensive, hypoallergenic for most patients, has optimum strength and flexibility, and offers excellent knot security. While it is soft and malleable, the wire's springy nature can make it difficult to work with.

Polyamide or nylon is the most commonly used non-absorbable suture. It is most often used as a percutaneous suture because of its low tissue reactivity. It is excellent for general soft tissue approximation or ligation, including use in cardiovascular, ophthalmic and neurological procedures. It has high tensile strength but loses it over time when buried in tissue. When used as a multifilament, it retains no tensile strength after being in the tissue for six months. Monofilament forms maintain two-thirds of their original strength for about 11 years. Nylon is stiff, making handling and tying difficult. However, multifilament forms have better handling properties.

Polypropylene (Prolene) is the suture of choice for long-term dermal support because gradual absorption does not occur. It accommodates tissue swelling, making crosshatching less likely than in other materials. However, as wounds heal, the suture will remain loose. It is stiff and has a high memory, making knot security poor. Clinicians often use thermocautery to fuse knots.

Polyethylene (courlene) sutures are flexible, nonabrasive and have a silk-like feel, making them gentle on tissues and gloves. Orthopedic clinicians and cardiovascular surgeons prefer it because of its knot properties, including tighter knot security during the tying process, a low knot profile to allow precise placement and a smooth tie down, and superior knot break strength.

Dissolvable Sutures

Dissolvable sutures are made of materials which are broken down in tissue after a given period of time, which depending on the material can be from ten days to eight weeks. They are used therefore in many of the internal tissues of the body. In most cases, three weeks is sufficient for the wound to close firmly. The suture is not needed any more, and the fact that

it disappears is an advantage, as there is no foreign material left inside the body and no need for the patient to have the sutures removed. Most resorbable sutures dissolve in the body by a process called hydrolysis.

Dissolvable sutures were originally made of the intestines of sheep, the so called catgut. The manufacturing process was similar to that of natural musical strings for violins and guitar, and also of natural strings for tennis racquets. Today, gut sutures are made of specially prepared beef and sheep intestine, and may be untreated (plain gut), tanned with chromium salts to increase their persistence in the body (chromic gut), or heat-treated to give more rapid absorption (fast gut). However, the majority of absorbable sutures are now made of synthetic polymer fibres, which may be braided or monofilament; these offer numerous advantages over gut sutures, notably ease of handling, low cost, low tissue reaction, consistent performance and guaranteed non-toxicity. In Europe and Japan, gut sutures have been banned due to concerns over bovine spongiform encephalopathy (mad-cow disease), although the herds from which gut is harvested are certified BSE-free. Each major suture manufacturer has its own proprietary formulations for its brands of synthetic absorbable sutures; various blends of polyglycolic acid, polylactic acid or caprolactone are common.

The time it takes for dissolvable stitches to disappear can vary.

Most types should start to dissolve or fall out within a week or two, although it may be a few weeks before they disappear completely. Some may last for several months. Depends on the type of stitches you have been used and how long they should take to dissolve.

Suture Classification

Sutures may be classified in terms of their origin, their structure, and their absorbability.(7)

1- Natural and synthetic

Natural sutures can be made of collagen from mammal intestines or from synthetic collagen (polymers). Tissue reaction and suture antigenicity lead to inflammatory reactions, especially with natural materials. Synthetic sutures are made of artificial polymers.

2- Monofilament and multifilament

Monofilament suture material is made of a single strand; this structure is relatively more resistant to harboring microorganisms. It also exhibits less resistance to passage through tissue than multifilament suture does. However, great care must be taken in handling and tying a monofilament suture, because crushing or crimping of the suture can nick or weaken it and lead to undesirable and premature suture failure.

Multifilament suture material is composed of several filaments twisted or braided together. It generally has greater tensile strength and better pliability and flexibility than monofilament suture material, and it handles and ties well. However, because multifilament materials have increased capillarity, the increased absorption of fluid may facilitate the introduction of pathogens, which increases the risk for wound infection and dehiscence.

Multifilament suture material is less stiff than monofilament suture material, but because the individual filaments of a multifilament suture are braided together, an increased coefficient of friction is created when the suture is passed through tissue. Multifilament sutures are often treated with special coatings to facilitate tissue passage and reduce subsequent tissue damage.

3- **ABSORBABLE** and **NONABSORBABLE**

Sutures are classified according to their degradation properties.Sutures that undergo rapid degradation in tissues, losing their tensile strength within 60 days, are considered absorbable sutures. Sutures that generally maintain their tensile strength for longer than 60 days are nonabsorbable sutures. Absorbable sutures may be used to hold wound edges in approximation temporarily, until they have healed sufficiently to withstand normal stress. These sutures are prepared either from the collagen of healthy mammals or from synthetic polymers. Some are absorbed rapidly, while others are treated or chemically structured to lengthen absorption time. They may also be impregnated or coated with agents that improve their handling properties, and colored with an FDA-approved dye to increase visibility in tissue. Natural absorbable sutures are digested by body enzymes which attack and break

down the suture strand. Synthetic absorbable sutures are hydrolyzed—a process by which water gradually penetrates the suture filaments, causing the breakdown of the suture's polymer chain. Compared to the enzymatic action of natural absorbables, hydrolyzation results in a lesser degree of tissue reaction following implantation. During the first stage of the absorption process, tensile strength diminishes in a gradual, almost linear fashion. This occurs over the first several weeks postimplantation. (8) The second stage often follows with considerable overlap, characterized by loss of suture mass. Both stages exhibit leukocytic cellular responses which serve to remove cellular debris and suture material from the line of tissue approximation. The loss of tensile strength and the rate of absorption are separate phenomena. A suture can lose tensile strength rapidly and yet be absorbed slowly—or it can maintain adequate tensile strength through wound healing, followed by rapid absorption. In any case, the strand is eventually completely dissolved, leaving no detectable traces in tissue. Although they offer many advantages, absorbable sutures also have certain inherent limitations. (9)If a patient has a fever, infection, or protein deficiency, the suture absorption process may accelerate, causing too rapid a decline in tensile strength.

In addition, if the sutures become wet or moist during handling, prior to being implanted in tissue, the absorption process may begin prematurely.

They are made from a variety of nonbiodegradable materials and are ultimately encapsulated or walled off by the body’s fibroblasts. Nonabsorbable sutures ordinarily remain where they are buried within the tissues. When used for skin closure, they must be removed postoperatively. Nonabsorbable sutures may be used in a variety of applications:

• Exterior skin closure, to be removed after sufficient healing has occurred.

• Within the body cavity, where they will remain permanently encapsulated in tissue.

•Patient history of reaction to absorbable sutures, keloidal tendency, or possible tissue hypertrophy.

• Prosthesis attachment (i.e., defibrillators, pacemakers, drug delivery mechanisms).

Nonabsorbable sutures (10) are composed of single or multiple filaments of metal, synthetic, or organic fibers rendered into a strand by spinning, twisting, or braiding. Each strand is substantially uniform in diameter throughout its length, conforming to the United States Pharmacopeia Non absorbable sutures .

According to their composition. In addition, these sutures may be uncoated or coated, uncolored, naturally colored, or dyed with an FDA approved dye to enhance visibility.

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