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# A review of Sutures & needles

Edited by  the perioperativeCPD team

## History

Through many millennia, various suture materials were used, debated, and remained largely unchanged. Needles were made of bone or metals such as silver, copper, and aluminium bronze wire. Sutures were made of plant materials (flax, hemp and cotton) or animal material (hair, tendons, arteries, muscle strips and nerves, silk, and catgut).

The earliest reports of surgical suture date to 3000 BC in ancient Egypt, and the oldest known suture is in a mummy from 1100 BC. A detailed description of a wound suture and the suture materials used in it is by the Indian sage and physician Sushruta, written in 500 BC. The Greek father of medicine, Hippocrates, described suture techniques, as did the later Roman Aulus Cornelius Celsus. The 2nd-century Roman physician Galen described gut sutures. In the 10th century the manufacturing process involved harvesting sheep intestines, the so-called catgut suture, and was similar to that of strings for violins, guitar, and tennis racquets.

Joseph Lister endorsed the routine sterilization of all suture threads. He first attempted sterilization with the 1860s "carbolic catgut," and chromic catgut followed two decades later. Sterile catgut was finally achieved in 1906 with iodine treatment.

The next great leap came in the twentieth century. The chemical industry drove production of the first synthetic thread in the early 1930s, which exploded into production of numerous absorbable and non-absorbable synthetics. Today, most sutures are made of synthetic polymer fibres. Silk and, rarely, gut sutures are the only materials still in use from ancient times. In fact, gut sutures have been banned in Europe and Japan owing to concerns regarding Bovine Spongiform Encephalopathy. Silk suture is still used, mainly to secure surgical drains

## Types of Sutures

Sutures, and the needles on which they are mounted, are available in a multitude of shapes, sizes and materials. Each material has its own unique properties, benefits and disadvantages; hence, they are tailored according to the specific requirements of the wound. When closing wounds with sutures, it is important to understand these properties to achieve the best possible healing result.

Sutures can be categorized by whether they are natural or synthetic, absorbable or non-absorbable, or if they are monofilament or braided (see glossary for definitions).

## Absorbable Vs Non-absorbable

Absorbable sutures such as polyglactin (Vicryl), polyglycolic acid(Dexon) and polydioxanone (PDS) are gradually broken down over time by various processes such as hydrolysis and proteolytic enzymatic degradation and absorbed by the body. These sutures are suitable for tissues that heal rapidly such as the stomach, bowel, bladder and subcutaneous tissues. They retain their tensile strength during the initial tissue mending process, and as tissues heal, the suture strength declines at a known rate for each material type (see Table 1). Absorbable sutures are also commonly used for subcuticular wound closure to which if done in appropriate circumstances can produce better cosmetic results.

| **Absorbable Sutures** | | | | | |
|---|---|---|---|---|---|
| **Name** | **Raw materials** | **Type** | **Tensile strength retention in vivo** | **Absorption** | **Tissue reaction** |
| Monocryl | Poliglecaprone 25 | Monofilament | ~50-60% at 1 week<br>~20-30% at 2 weeks<br>0% within 3 weeks | By hydrolysis 90-120 days | Minimal acute inflammatory reaction |
| PDS | Polydioxanone | Monofilament | ~70% at 2 weeks<br>~50% at 3 weeks<br>~25% 4 weeks | By hydrolysis 180-210 days | Slight reaction |
| Vicryl | Polyglactin 910 | Monofilament or braided | ~75% at 2 weeks<br>~50% at 3 weeks | By hydrolysis 56-70 days | Minimal acute inflammatory reaction |
| Vicryl*rapide* | Modified polyglactin 910 | Braided | ~50% at 5 days | By hydrolysis 42 days | Minimal to moderate acute inflammatory reaction |

Table 1: Properties of different absorbable sutures.

Non-absorbable sutures, synthesized from a variety of non-biodegradable materials such as nylon and polypropylene (see Table 2), are indicated for repair of tissues with slow healing times such as ligaments and tendons. They are also used in fixation of hernia meshes to reduce recurrence rates and in blood vessel repair and vascular anastomoses with grafts where loss of tensile strength would have disastrous consequences.

Non-absorbable sutures are sometimes used for skin closure, particularly where skin opposition is placed under tension or at risk of infection. In these cases, interrupted suturing technique is more frequently used as the removal of one or two stitches would not affect the wound healing process of the rest of the wound. However, non-absorbable sutures for skin closure will require removal post-operatively, usually between three to fourteen days depending on the healing potential of the patient and the location of the wound (discussed in more detail below).

| Non-absorbable sutures | | | | | |
|---|---|---|---|---|---|
| **Name** | **Raw materials** | **Type** | **Tensile strength retention in vivo** | **Absorption** | **Tissue reaction** |
| Silk | Fibroin (organic protein) | Braided | Progressive degradation may lead to gradual loss of tensile strength over time. | Gradual encapsulation by fibrous tissue | Acute inflammatory reaction |
| Wire | 316L Stainless steal | Monofilament or multifilament | Indefinite | Non-absorbable, remains encapsulated in tissue. | Minimal acute inflammatory reaction |
| Nylon | Polyamide 6 and 6/6 | Monofilament | Progressive hydrolysis may lead to gradual loss of tensile strength. | Gradual encapsulation by fibrous tissue | Minimal acute inflammatory reaction |
| Ethilon | Polyamide 6 and 6/6 | Monofilament | Progressive hydrolysis may lead to gradual loss of tensile strength. | Gradual encapsulation by fibrous tissue | Minimal acute inflammatory reaction |
| Prolene | Stereoisomer of polypropylene | Monofilament | No degradation or weakening by tissue enzymes. | Non-absorbable, remains encapsulated in tissue | Minimal acute inflammatory reaction |
| Expanded PTFE | Polytetrafluroroethylene | Monofilament | No degradation or weakening by tissue enzymes. | Gradual encapsulation by fibrous tissue | Minimal acute inflammatory reaction |

Table 2: Properties of different non-absorbable sutures.

## Monofilament Vs multifilament

Monofilament describes a suture made from a single strand. They glide smoothly through tissues with minimal friction, and more importantly, they do not have pockets in which microorganisms can harbour. Monofilament sutures are particularly favoured in vascular, tendon and nerve repairs. However, monofilament sutures can be difficult to handle, especially those with memory (see glossary) as they have a tendency to spring back to their original form. In order to reduce chances of knots unravelling, a minimum of five throws are required as opposed to the usual three throws in a normal surgical tie.

Multifilament or braided suture composes of several strands that are twisted together. Braided sutures have the best handling qualities, and are preferred in bowel surgery. However, their interstices can be ideal for bacteria growth that can become problematic as the suture may encourage bacteria to track into the wound. This is known as suture track sepsis. This setback can be greatly reduced by coating the sutures.

## Wire sutures

Stainless steel wire sutures are only used in special circumstances such as orthopaedic bone fixation or the closure of sternotomy wounds in cardio-thoracic surgery. Stainless steel is virtually inert, but rate of steel suture breakages are relatively high due to metal fatigue.

## Suture Gauge

Suture gauge or diameter of the thread was described traditionally when sutures were thicker and size 1 described the finest suture. However, as sutures became finer, the description system was taken backwards as smaller sutures were called size '0', then size '00' (2/0), '000' (3/0) and such like. In time, these sizes were known by the United States Pharmacopeia (U.S.P.) classification system where 10/0 is extremely fine and used for delicate ophthalmological operations and size '0' are thicker sutures for closing the abdominal wall. The suggested gauge of skin sutures for different body areas are described in Table 3 and the suggested suture gauge for different types of tissue repair are presented in Table 4.

| Body Site | Recommended Suture Gauge | Removal of Sutures |
|---|---|---|
| Face and Neck | 5/0 – 6/0 | 3 – 5 days |
| Scalp | 3/0 | 5 - 7 days |
| Limbs | 4/0 | 7 – 10 days |
| Trunk | 3/0 | 10 – 14 days |
| Back | 2/0 – 3/0 | 10 – 14 days |

Table 3: Suggested suture gage for different body areas and respective timings of suture removal.

| Tissue Repair | Type of Sutures* | Suture Gauge* |
|---|---|---|
| Subcuticular closure | Monocryl, Vicryl Rapide | 3/0, 4/0, 5/0 |
| Arterial Repair | Prolene | 5/0, 6/0 |
| Bowel Repair | PDS / Maxon | 2/0, 3/0 |
| Microvascular Repair | Prolene | 7/0, 8/0 |
| Nerve Repair | Nylon | 8/0, 9/0, 10/0 |
| Closure of laparotomy wounds | PDS | 1/0 |

**Table 4:** Suggested suture type and gauge for different types of tissue repair.

* Examples only. Some surgeons may have other preferences.

## Choosing the Correct Suture

When selecting sutures, the surgeon takes many factors into account such as anatomical location, the type of wound and amount of stress the wound would be enduring after surgery. As discussed above, the type of material is important. In addition, the smallest gauged suture with sufficient tensile strength to support the wound should be selected. Where cosmesis is particularly important, for example wounds on the face, several finer gauge sutures will give a better cosmesis than fewer heavier gauged sutures.

## Time for Removal of Sutures

The duration that non-absorbable skin sutures are left insitu is dependent on the part of the body that the wound is located, as various parts such as the face have a better blood supply and will heal at a faster rate, hence sutures would be required to be removed at an earlier stage (between 3-5 days). Other body parts such as the back have a poorer blood supply and tougher skin, hence sutures are left in-situ for between 10–14 days. Other aspects which influence the rate of healing include patient factors such as age, nutritional status, general health and immunological compromise; surgical factors include the surgical technique, the choice of suture and suture material. The recommended times for the removal of sutures in other parts of the body are suggested in Table 3.

## Needles

Surgical needles are required to guide sutures through the tissues. Needles must be sharp enough to penetrate the tissue, but not cause inappropriate damage, hence an understanding of different needle types is essential for making the correct choice when suturing.

## Parts of the needle

The needle is made up of various parts as illustrated in Figure 1. The point is the part of the needle that extends from the tip to where the cross-section reaches its maximum width. The body forms the majority of the needle, and the swage is where the suture is attached and is continuous with the suture. The arc length is the length of the curve of the needle and is the measurement given on suture packages. The cord length, also known as the bite width, is the distance from the point to the swage (see Figure 2). The radius is the distance from the needle body to the centre of the circle along which it curves.

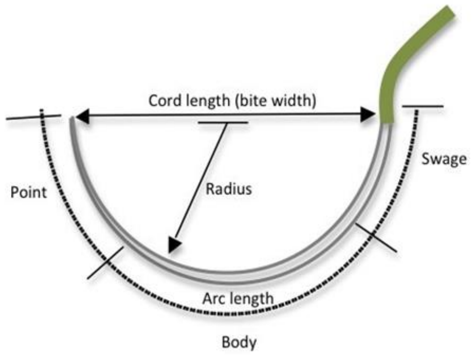


**Figure 1:** The parts of a needle.

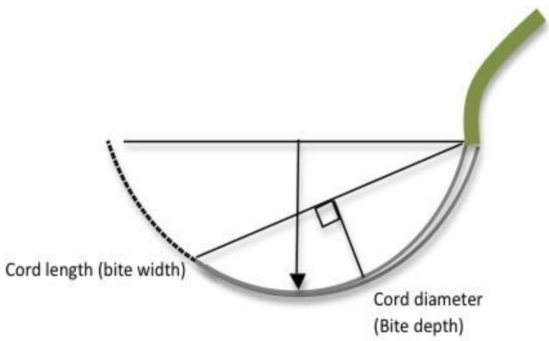


**Figure 2:** The anatomy of the needle illustrating bite depth & bite width.

## Needle types

Needle types and shape vary considerably as seen in Figure 3, and their uses are described in greater detail below. Needles also come in different sizes. In general, smaller needles are required for finer work, whilst larger needles are required for penetrating and taking large bites of tissues such as closure of the abdominal wall.

## Curved needles

Curved needles are usually mounted on a needle holder, and are used for most types of suturing. Some of the different types of curved needles are as follows:
1/2 circle needles - used for most purposes
3/8 circle needles - most commonly used for skin closure
1/4 circle needles - used for microvascular anastomoses
5/8 circle needles - used for hand closure of the abdominal wall
J-needle - used for closure of laparoscopic port wounds.

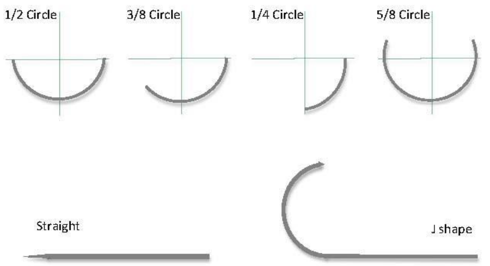


Figure 3: Types of needle curves and bodies.

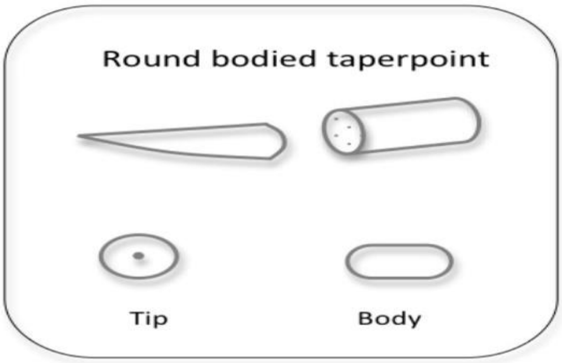


Figure 4: Needle tips - round bodied taperpoint

## Straight needles

Straight needles are hand-held and are used for mainly for subcuticular skin suturing, and securing of surgical drains. It is often quicker and more efficient to use the straight needle in closing skin wounds, but there is a slightly increased risk of needle stick injuries.

## Needle tips

Round-bodied needles (Figure 4) have a smooth pointed tip that is designed to guide sutures into tissues by parting the tissue fibres to either side. They can be used for most soft tissues, such as the gut, fat or muscle. After the needle has passed through the tissue, the defect caused by the needle is filled by the suture material, which reduces leakage and is therefore useful particularly in intestinal or cardio-vascular operations.

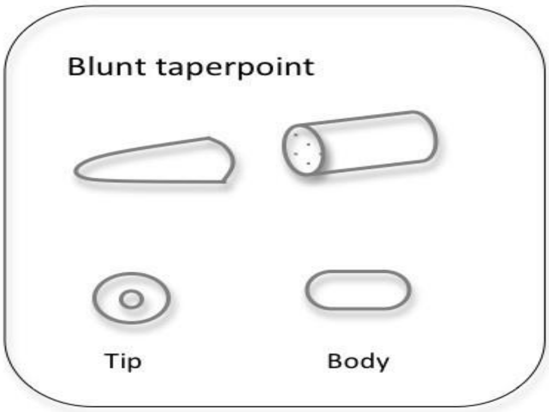


Figure 5: Needle tips - blunt taperpoint.

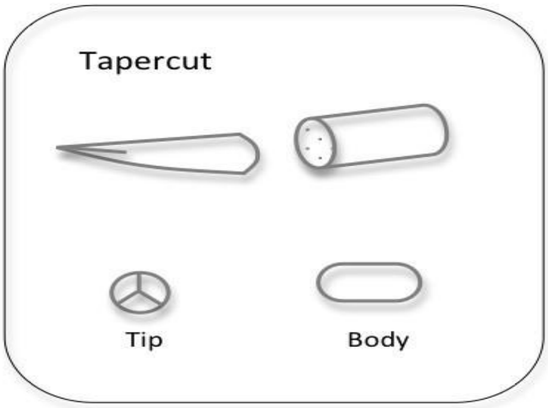


Figure 6: Needle tips -tapercut.

Blunt taper point needles (Figure 5) have been designed to minimise needle stick injury risk, especially in cases where blood-borne viruses are a concern. The point of the needle is sufficient to penetrate muscle and fascia, but not skin.

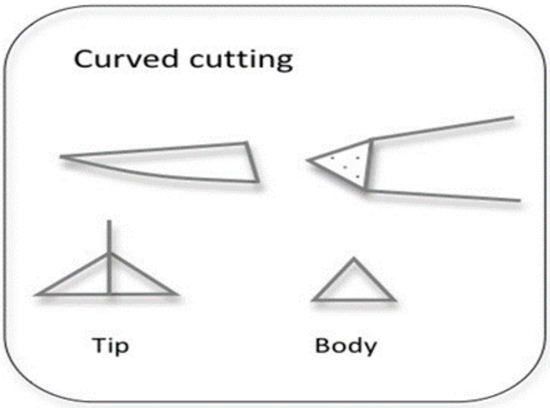


Figure 7: Needle tips - curved cutting.

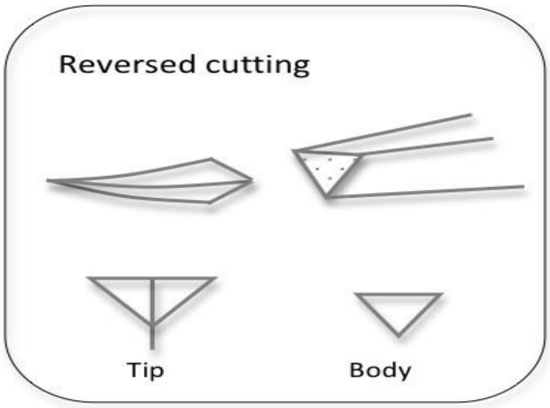


Figure 8: Needle tips - reversed cutting

Tapercut (semi cutting) needles (Figure 6) combines aspects of both the cutting and the round bodied needles. The tip has a triangular profile but the needle then tapers out to that of a smooth round-bodied profile and are used to suture moderately tough tissues, for example atherosclerotic arteries or fascia.

Cutting needles (Figure 7) are used for suturing tough or dense tissues, such as the skin. The curved cutting needle has three cutting edges, is triangular in cross-section with the apex of the triangle on the concave aspect of the curvature (i.e., inside surface of the needle curvature).

The reverse curved cutting needle (Figure 8) is triangular in cross-section with the apex of the triangle on the convex surface (i.e., on the outside surface of the needle curve). The reverse curved cutting needle is stronger than the conventional cutting needle and has less propensity to cause tissue tear as the apex of the cutting edge is directed away from the wound.

## Tissue adhesives

Topical cyanoacrylate adhesives a.k.a. super glue, have been used in combination with, or as an alternative to, sutures in wound closure. The adhesive remains liquid until exposed to water or water-containing substances/tissue, after which it cures (polymerizes) and forms a bond to the underlying surface. The tissue adhesive has been shown to act as a barrier to microbial penetration as long as the adhesive film remains intact. Limitations of tissue adhesives include contraindications to use near the eyes and a mild learning curve on correct usage. They are also unsuitable for oozing or potentially contaminated wounds.

In surgical incisions it does not work as well as sutures as the wounds often break open.

Cyanoacrylate is the generic name for cyanoacrylate based fast-acting glues such as methyl-2-cyanoacrylate, ethyl-2-cyanoacrylate (commonly sold under trade names like Superglue and Krazy Glue) and n-butyl-cyanoacrylate. Skin glues like Indermil and Histoacryl were the first medical grade tissue adhesives to be used, and these are composed of n-butyl cyanoacrylate. These worked well but had the disadvantage of having to be stored in the refrigerator, were exothermic so they stung the patient, and the bond was brittle. Nowadays, the longer chain polymer, 2-octyl cyanoacrylate, is the preferred medical grade glue. It is available under various trade names, such as LiquiBand, SurgiSeal, FloraSeal, and Dermabond. These have the advantages of being more flexible, making a stronger bond, and being easier to use. The longer side chain types, for example octyl and butyl forms, also reduce tissue reaction.

## Staples and clips

While technically not sutures, staples and clips are becoming more common.

Skin stapes are now extremely common. This is due to the fact that they come in affordable multishot disposable applicators. They are quick, easy to insert and remove and leave cosmetically acceptable scars. Their major downside is that they are a lot more uncomfortable on removal.

Occlusive clips are now common in laparoscopic surgery where they save time, are technically easier to use than laparoscopic sutures, and can be used to clip inaccessible structures. Most are stainless steel although there are cases of them becoming dislodged if incorrectly used.

## Summary

There are a variety of different sutures and needles. In order to select the most appropriate type, surgeons must have a working knowledge about the properties of the suture material and the rate of healing of different tissues.  Although reading imparts theoretical knowledge, it is only when working with tissues and sutures that one truly appreciates these aspects.

## Glossary

| Terms | Definition |
|---|---|
| Suture | The thread. |
| Needle | The sharp end to which the suture is attached. It guides the suture through tissues. |
| Gauge | The diameter of the suture. The greater the number, the finer the suture. |
| Tensile Strength | The stress (force per unit area) that a knotted suture can withstand before breaking. |
| Memory | The suture’s inherent propensity to maintain its original form. |
| Braided | Suture made from several strands that are twisted together. |
| Monofilament | Suture made from a single strand. |

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