How to choose a suture

Introduction

A surgeon may request a 6-0 Prolene suture on a cutting needle while closing a wound on the face. What does this actually mean? There is a broad spectrum of suture materials and sizes available, as well as a variety of needles to which they can be attached (Hochberg et al, 2009). This article provides guidance for trainees on how to select an appropriate suture, drawing both on the published evidence base and the authors' experience. Where specific advice is provided, this focuses predominantly on closure of skin (as this is most applicable to the junior trainee), although the general principles are equally applicable to other structures including tendons, vasculature and viscera.

Table 1. Suture sizes and examples of common use

USP size	Diameter (mm)	Use
1	0.40–0.499	Fascia, tendon, ligament in leg
0	0.35–0.399	Abdominal wall wounds
2-0	0.30–0.339	Blood vessel ligation
3-0	0.20–0.249	Leg, abdominal skin and back wounds, flexor tendons, muscle
4-0	0.15–0.199	Extensor tendons
5-0	0.10–0.149	Skin wounds on upper limbs, mucosa
6-0	0.070–0.099	Skin wounds on face
7-0	0.050–0.069	Nail bed lacerations
8-0	0.040–0.049	Nerve repair
9-0	0.030–0.039	Small blood vessels (under microscope)
10-0	0.020–0.029	Ophthalmic procedures, microsurgery

After US Pharmacopeia (2007)

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Size

Sutures were originally developed from natural materials, including hair, gut, metal, linen and silk. Once sutures became manufactured, the smallest originally available was designated as size 1. As finer sutures were produced, they were sequentially described as sizes 0, 00 (2/0 or 2-0), 000 (3/0 or 3-0), and so on as the diameter reduced. Modern sutures range from sizes 10 (rarely, if ever, used in clinical practice) to 11-0 (fine monofilament sutures, used in ophthalmic surgery), as classified by the United States Pharmacopeia (USP). The larger the suture, the greater its tensile strength. *Table 1* indicates the suture diameters that correspond to each USP size, and examples of when each should be requested (Blaydes, 1976; Wadström and Gerdin, 1990; Reiter, 1995; Cordeiro and Santamaria, 1998; Tajirian and Goldberg, 2010).

Material

Suture materials can be absorbable or non-absorbable. Both may be either monofilament or braided, consisting of multiple fine filaments. They each possess characteristics that make them suited to different scenarios (Aston, 1976; Firestone and Lauder, 2010). Commonly used sutures and their properties are described in *Table 2*.

In general, monofilament sutures run smoothly through tissue but knots can be loose. Braided sutures may not run smoothly but knot well (Firestone and Lauder, 2010). Absorbable sutures undergo hydrolysis or enzymatic degradation as they are absorbed, which can cause a local tissue reaction resulting in worse scarring (Kia et al, 2013). Non-absorbable sutures cause less tissue reaction and as such are preferred for areas where cosmetic outcome is more important (e.g. the face). These are then removed if superficial (*Table 3*), or if internal left in situ where they are used to maintain integrity of structures while healing occurs over weeks (e.g. with tendon repairs in the hand).

The tensile strength of healing tissues never returns to 100% of that before injury, and the maximum depends on the structure repaired and anatomical site. There are few data regarding changes in biomechanical properties of open wounds

Table 2. Commonly used sutures and their characteristics

Filament		Material	Appearance	Time to 50% loss of tensile strength
Absorbable	Monofilament	Poliglecaprone (Monocryl), glyconate (Monosyn), glycomer 631 (Biosyn)	Clear or violet	1 week
		Polydioxanone (PDS), polyglyconate (Maxon)	Violet or clear	4 weeks
		Gut/collagen	Undyed	2 weeks
	Braided	Polyglactin (Vicryl), polyglycolic acid (Safil), glycolide/lactide copolymer (Polysorb)	Undyed or violet	3 weeks
		Polyglactin (Vicryl Rapide), polyglycolic acid (Safil quick+)	Undyed	5 days
Non-absorbable	Monofilament	Polypropylene (Prolene, Premilene, Surgipro)	Clear or blue	Not applicable
		Nylon (Ethilon, Dafilon, Dermalon, Monosof)	Clear, blue or black	Not applicable
		Stainless steel	Silver	Not applicable
	Braided	Polyester/Dacron (Ethibond, Surgidac, Ti-Cron)	Green or white	Not applicable
		Silk	Black or white	1 year

in vivo throughout the entire healing process, although experimental studies have used animal models to investigate variations in tensile strength during normal healing (Hamilton et al, 1970). In these models, approximately 50% of skin tensile strength is restored by day 21 following injury (Chao et al, 2013), but with progressive increases up to 80 days after wound closure (Hamilton et al, 1970). There was also considerable inter-animal variability in recovery of tensile strength, attributed to factors such as age, quality of wound edge apposition, possible unrecognized haematomas and presence of needle tracts. Nonetheless, based on these models, skin sutures can be appropriately removed 1–2 weeks after closure depending on the site (as the healing wound has become sufficiently robust and tensile strength will continue to rise as the scar remodels). Other tissues that take longer to heal (e.g. tendons) require non-absorbable sutures to maintain integrity while healing takes place over a longer time course.

In terms of suture colour, dyed material enables clear visualization of its location during surgery (Albertini, 2001). This is particularly useful during procedures such as tendon repair. However, if the suture is buried close to the skin, the colour may be visible from the surface, and when absorbed could leave permanent pigmentation. Therefore, in superficial tissues, dyed buried sutures should be avoided. For skin surface sutures to be removed within 1–2 weeks, use of dyed material is appropriate.

Needle shape

Historically, suture material was threaded through the eye of the needle, comparable to a domestic sewing needle. Today, suture material is embedded onto the swage of the needle during the manufacturing process. This minimizes trauma as it passes through tissue. It is important not to grasp the needle at this site with needle holders, as this can dislodge the attachment and the suture will fall out.

Needles are made in a variety of shapes, sizes and tip design, each suited to different purposes. The characteristics of the needle are indicated on the suture packaging (*Figure 1*). Commonly used needle shapes include straight, ¼ circle, ⅜ circle, ½ circle and half curved (J-shaped). There are a variety of suture–needle pairs, although not every possible combination is available. The needle length is often shorter and curve greater as the suture size becomes finer, as these are better suited to repairing smaller structures (such as blood vessel walls). When a suture comes in a variety of possible needle lengths and curvatures, the shorter the needle and more acute the curvature, the greater the manoeuvrability and the easier it is to acquire finer bites of tissue (Firestone and Lauder, 2010). Needle shape may also be chosen to suit the shape of the structure being repaired. For example, a straight groin skin incision may be readily closed using either a straight or curved needle, but it is easier to use a curved needle when closing a round wound.

Needle cross-sectional design

The needle tip guides the needle and suture through the tissue, and its selection depends upon the structures in question (Firestone and Lauder, 2010; Lam et al, 2003). Commonly used needle designs are shown in *Table 4*.

Table 3. Timing of removal for non-absorbable skin sutures

Location	Time to removal of sutures
Face	5–7 days
Scalp	10 days
Torso	10 days
Hand	14 days
Upper limb	14 days
Lower limb	14 days

Figure 1. Information regarding needle and suture characteristics on suture packaging.

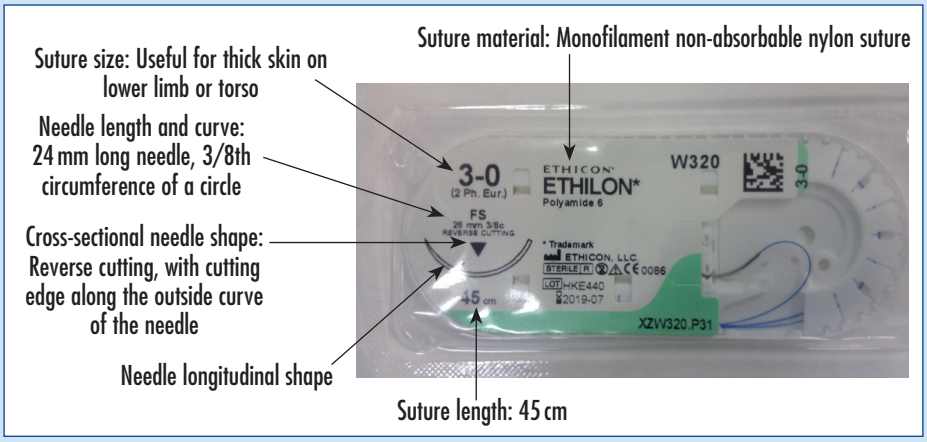

Table 4. Needle shape

Cross-sectional shape	Symbol	Shape	Description and use
Cutting			The needle body is triangular in cross-section and has a sharp cutting edge on the inner (concave) curvature along the length of the needle. This is suitable for tough structures, such as skin
Reverse cutting			This is also triangular, but the cutting edge is on the outer (convex) curvature. This minimizes trauma to the tissue, and is suited to ocular surgery and closure of mucosal wounds
Taper			The round needle body tapers smoothly to a point. This avoids cutting structures and other sutures as the needle is passed. This is appropriate for tendon repair, microvascular surgery and repair of bowel mucosa
Trocar/taper cut			The needle body is round and tapered, but ends in a small triangular cutting point. This is useful for harder tissues, including cartilage
Blunt			Used for suture of friable tissues, such as liver

Choosing a suture material

When deciding which suture to use, it is therefore important to consider:

- Wound site
- Wound cleanliness
- Tension present across the wound edges
- Duration needed for the suture to hold the wound edge. The time of maintenance of tensile strength, or to absorption of absorbable sutures, must be greater than the healing time. This is very important for procedures such as tendon repair
- Suture removal and issues of practicality. Absorbable sutures may be preferable in extremes of age (e.g. for young children unlikely to tolerate a second procedure to remove sutures, or poorly mobile or cognitively impaired elderly patients in whom scarring is often less of a concern and who would find attendance for wound management more difficult).

In general, absorbable sutures cause greater local reactions in healing tissue than non-absorbable sutures (removed 1–2 weeks postoperatively), and consequently result in increased scarring (Kia et al, 2013). Hence, for facial wounds, it is preferable to use non-absorbable sutures, in as small a size as possible, to bring the wound edges together with minimal tension; these can be removed in 1 week. In contrast, absorbable sutures may be appropriately used to achieve tissue apposition of the dermis before skin closure, to reduce tension across the wound edge. For further guidance on closing skin wounds, see Miyagi et al (2011).

Finally, note that if a wound is actively infected, it is not suitable for closure. Contaminated wounds, or those at high risk of developing infection, should be closed with monofilament non-absorbable sutures. Braided sutures may allow bacteria to seep through, and buried absorbable sutures can become foci of infection (Masini et al, 2011).

Conclusions

Although the array of sutures available may seem overwhelming, this article reviews the principles underlying selection of different material and needle types. The key factors are location, size and shape of the wound or structures to be sutured, duration for which tension is required, and practicalities related to the individual patient. If you are still uncertain about which suture to use, ask an experienced surgeon about his/her preference in the scenario, and learn how and why he/she made that decision. **BJHM**

Conflict of interest: none.

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TOP TIPS

- Use 3-0 or 4-0 sutures for closing skin wounds on the lower limb or torso, 5-0 for upper limbs, and 6-0 for visible wounds on the face.
- Use non-absorbable sutures for skin wounds where cosmetic outcome is important, as these cause less scarring. Only use absorbable material if you anticipate problems in achieving suture removal (occasionally an issue in patients at the extremes of age).
- Monofilament sutures run more smoothly through tissue but braided sutures knot better.
- Do not use dyed materials for superficial buried sutures: colour may be visible through the skin and absorption can result in permanent pigmentation.
- The shorter and more acutely curved the needle, the greater the manoeuvrability.
- A cutting needle tip (triangle symbol on packaging) is generally most appropriate for closing skin wounds.
- If a wound is contaminated or at high risk of infection, close using monofilament, non-absorbable sutures. Do not attempt to close an actively infected wound.
- If you are uncertain which suture to use, ask an experienced surgeon and learn how he/she made that decision.

KEY POINTS

- Suture size is classified using the United States Pharmacopeia system. The greater the number of zeroes, the smaller the suture.
- Smaller sutures are appropriate for closure of skin wounds and microsurgical procedures; larger sutures have greater tensile strength.
- Absorbable sutures cause greater tissue reaction and more scarring.
- Dyed sutures are easier to visualize, but may impair cosmetic outcome if used for superficial buried structures.
- The ideal needle shape varies according to the shape, size and location of the structure being sutured.
- Type of needle tip selected depends on the calibre of tissue being sutured.