Sutures, ligatures and knots

Rishabh Singh

William Hawkins

Abstract

The ability to correctly choose a suture material, appropriately suture a wound and ligate a structure are fundamental in any surgical speciality. These are index skills that a junior surgeon must master before progressing on to more complex procedures. This article discusses factors to consider when choosing suture material, techniques for closure of a wound, and knots used to ligate a structure. With use of minimally invasive techniques now widespread, the article also discusses laparoscopic methods for performing such tasks.

Keywords Laparoscopic; ligate; surgical knot; surgical needle; suture

Background

More often than not, wound closure is the first skill a junior surgeon learns. Also, it is often the first skill that senior, supervising colleagues observe junior trainees perform. A great deal of information about a trainee can be learned by assessing their performance of wound closure.

The skill requires consideration of appropriate materials and methods for closing the wound, a firm grasp on the technique employed, and attention to detail. Most importantly, a meticulously closed wound will leave the patient with a positive impression of the level of care taken with the entire operation.

This article will focus mostly on wound closure, more specifically suturing. It will also deal with other critical aspects of any good surgeon's skill set: knot tying and techniques employed for ligation of a vessel. Much as with wound closure, a senior colleague will determine much about a trainee's attitude and capability towards his chosen surgical speciality on watching them tie their first knot.

Many basic procedures are now carried out laparoscopically, and a section on laparoscopic methods of performing basic skills is also included.

Practice and repetition are key to good performance, as with any aspect of surgery. Attendance at basic surgical skills courses is invaluable but practice should ideally be continued in a simulated environment with the help and guidance of senior colleagues until confident and competent enough to complete the task on a patient.

Rishabh Singh *MRCS is an ST4 Registrar in General Surgery at St Richards Hospital, Chichester, UK. Conflicts of Interest: none declared.*

William Hawkins *FRCS DipMedEd is a Consultant Upper Gastrointestinal and Bariatric Surgeon at St Richards Hospital, Chichester, UK. Conflicts of interest: none declared.*

Suture materials and sizes

The perfect suture for all occasions does not exist. Suture materials used today are for the most part synthetically derived; indeed materials such as catgut are seldom, if ever, used. Desirable characteristics for any suture, however, include:

- versatility
- high tensile strength
- comfortable and natural handling
- knots securely
- tissue reaction minimal
- should not favour bacterial growth, sterile
- non-allergenic/carcinogenic
- inexpensive
- predictable rate of absorption.

It should be noted that a characteristic that is desirable in one situation may be a hindrance in another. An example is that an absorbable suture, while often desirable for skin, may be inappropriate in many clinical situations.

Sutures are commonly categorized by absorbability, being either a monofilament or braided, being natural or synthetic, or being dyed or un-dyed.

The different characteristics of commonly used sutures are provided in Table 1. Owing to their common use, the trade names of products by companies Ethicon and Medtronic have been used.

Non-absorbable sutures remain in the body life-long, with the exception of silk. Absorbable sutures are categorized by the remaining tensile strength in a knot after a given period of time. Vicryl Rapide™ and Velosorb™, sutures commonly used for skin closure, lose half their strength within a week. PDS™ and Maxon™, often used for laparotomy closure, retain approximately a third of their strength after 42 days.

A monofilament suture is made of one fibre, a braided suture made of interlocking fibres. A monofilament suture causes less tissue damage and reaction. It can also reduce the risk of harbouring infection but requires more throws of a knot for security.

An un-dyed suture is desirable in certain situations, for example skin where aesthetic appearance is paramount. A dyed suture is desirable in situations where suture spacing and visualisation of a suture line is critical, for example a bowel or vascular anastomosis, especially when performed laparoscopically. Innovative types of suture are always being created. Examples include barbed sutures that eliminate the need for knot tying, most often used in laparoscopic surgery. There are also many types of suture that are impregnated with antimicrobial agents. They have been shown to have some success in reducing infection in certain clinical situations; however, the available evidence is far from conclusive at present.[1,2]

The size (diameter) of suture material is defined by the United States Pharmacopeia (USP) system. Initially sized from 1 to 6 (the bigger the number the wider the diameter), with improved technology came the ability to make ever smaller diameters of suture. The naming convention dictates that the more '0's' in the name, the thinner the suture: 2-0 (as used for simple tissue apposition) is a wider diameter than 12-0 (used in ophthalmic surgery). With regards to actual size, a '1' suture has a maximum permitted diameter (in terms of engineering tolerances) of 0.499 mm, A 2-0 suture of 0.339 mm, and a 12-0 suture a scarcely

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Commonly used suture materials and their properties

Trade names	Material	Absorbable / Non-absorbable	Synthetic / Natural	Braided / Monofilament	Common use	Properties
Chromic Gut™ / **Plain** Gut™	Collagen from animal intestine	Absorbable	Natural	Monofilament	Not used in UK	Marked inflammatory reaction
Monocryl™ / Caprosyn™	Colpolymer – glycolide and capronolactone	Absorbable	Synthetic	Monofilament	Skin – subcuticlar closure	Absorbed in 56 – 119 days
Vicryl™ / Polysorb™	Copolymer – glycolide and lactide	Absorbable	Synthetic	Braided	Soft tissue approximation, ligation of small vessels	Absorbed in 56 – 70 days
Vicryl Rapide™ / Velosorb™	Copolymer – glycolide and lactide – rapid	Absorbable	Synthetic	Braided	Skin	Absorbed in 40 – 50 days, tensile strength zero in 14 days
PDS™	Polydioxanone	Absorbable	Synthetic	Monofilament	Laparotomy closure	Absorbed in 182 – 238 days
Maxon™	Glycolic acid and trimethylene carbonate	Absorbable	Synthetic	Monofilament	Laparotomy closure	Absorbed in 180 days
Perma-Hand™ / Sofsilk™	Silk	Non-absorbable	Natural	Braided	Drain securing	Marked inflammatory reaction
Ethilon™ / Dermalon™	Nylon	Non-absorbable	Synthetic	Monofilament	Interrupted skin closure, hernial mesh stitching	Minimal inflammatory reaction
Prolene™ / Surgipro™	Polypropylene	Non-absorbable	Synthetic	Monofilament	Interrupted skin closure, hernial mesh stitching, vascular anastamoses	Minimal inflmmatory response, easy to pull out
Surgical Steel™ / Steel™	Steel wire	Non-absorbable	Synthetic	Various types	Sternotomy closure	Minimal inflammatory response

Key — Ethicon: Black, Medtronic: Blue.

Table 1

believable 0.009 mm. Indeed, a 12-0 suture requires the use of a microscope.

Needles

As with suture material, the type of needle required will depend on the tissue to be apposed. Needle points may be cutting, tapered or blunt.

Cutting needles are used for tough tissue, for example skin. Cutting needles have three surfaces. Conventional cutting needles have the sharp surface on the concave aspect of the needle. Reverse cutting needles have the sharp edge on the convex surface of the blade — this reduces the chance of 'cut out'. Reverse cutting needles are therefore often used where there is concern about the integrity of the tissue, for example fragile skin.

Tapered needles are designed to minimize trauma and leave the smallest hole. They are thus used for anastamoses and repair of bowel and blood vessels. Tapered needles can be paired with a cutting point, and these are useful when suturing calcified vessels or tendons that are harder to pierce.

Blunt needles are used to maximize safety when a large amount of force is required to penetrate tissue, for example piercing the rectus sheath in laparotomy closure. Some surgeons maintain, however, that the greater force required to penetrate tissue negates the benefit.

This brief summary is far from exhaustive: there are novel types of needles being created regularly, for ever more specific purposes.

Needles used in the UK are most commonly 'atraumatic'. This refers to a suture that is swaged to the needle directly. The alternative is an 'eyed' needle, where a suture must be threaded on to the needle. The resulting knot to stabilize the suture on an 'eyed' needle can cause drag, and thus trauma, in the tissue — hence the term 'atraumatic' for swaged needles.

It is often stated that a needle should be mounted on the needle holder one-third of the distance from the swaged end to maximize control and strength of the needle, but this is not a strict rule and mounting angles and positions may be modified to suit.

Needle safety is of paramount importance. The needle tip should be guarded when passed between any members of the surgical team.

Techniques for wound closure

General principles

There are three main aims when closing a wound: to ensure haemostasis, to minimize the risk of infection, and to make the scar aesthetically pleasing.

Tissue should be handled as little as possible, and when handling skin, toothed forceps that are as fine as practicable should be used. Needle entry to the skin should be at 90 degrees, and the natural arc of the needle should be followed by rotation of the wrist and not forcing the needle through. Following the arc of the needle minimizes tissue damage; poor technique can result in larger puncture holes and potential haemorrhage. Each side of the

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