Choosing the right suture material

The ideal suture would be totally biologically inert and cause no tissue reaction. It would be very strong but simply dissolve in body fluids and lose strength at the same rate that the tissue gains strength. It would be easy for the surgeon to handle and knot reliably. It would neither cause nor promote complications. Whilst there have been very great improvements in suture materials in the recent past and modern sutures are very close to above ideal, no single suture is ideal in all circumstances.

Different tissues have differing requirements for suture support, some needing only a few days eg muscle, subcutaneous tissue, skin; whilst others require weeks or even months eg fascia and tendon. Vascular prostheses require longer term, even permanent support. The surgeon must be aware of the differences in the healing rates of various tissues when choosing a suture material. Individual patient variation further complicates the decision. Healing of wounds is delayed by a range of factors such as infection, debility, respiratory problems, obesity, collagen disorders, malnutrition, malignancy, drugs eg cytotoxics and steroids. The surgeon wants to ensure that a suture will retain its strength until the tissue regains enough strength to prevent separation. Some tissues heal slowly and may never regain preoperative strength. Some may be placed under natural tension such as a tendon repair so the surgeon will want suture material that retains strength for a long time. In rapidly healing tissue, the surgeon may use a suture that will lose its tensile strength at about the same rate as the tissue gains strength and that will be absorbed by the tissue so that no foreign material remains in the wound. With all sutures, acceptable surgical practice must be followed with respect to drainage and closure of infected wounds. Excess tissue reaction to the suture encourages infection and slows healing. When taking all these factors into account, the surgeon has several choices of suture material available. Subjective preferences such as familiarity with the material and availability need also to be taken into account. source

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Absorbable and Non-absorbable

Sutures can conveniently be divided into two broad groups : absorbable and non absorbable. Regardless of its composition, suture material is a foreign body to human tissue and will elicit a foreign body reaction to a greater or lesser degree. Two major mechanisms of absorption result in the degradation of absorbable sutures. Sutures of biological origin such as surgical gut are gradually digested by tissue enzymes. Sutures manufactured from synthetic polymers are principally broken down by hydrolysis in tissue fluids and are preferred. Non absorbable sutures, made from a variety of non biodegradable materials, are ultimately encapsulated or walled off by fibroblasts.

Non absorbable sutures ordinarily remain where they are buried within the tissues. This can cause late complications such as the development of gall stones around non-absorbable sutures in the common bile duct or bladder stones in the urinary bladder. In these situations it is best to use absorbable materials. Improvements in absorbable sutures mean that they can be used in a variety of situations where previously surgeons would have recommended non-absorbable materials. Polyglycolic acid is used for bowel anastomosis in place of silk and polyglactin is used in closure of the abdominal muscles in place of nylon or prolene. It could be said that it is always best to use an absorbable suture unless there is a good reason not to. When used for skin closure, non-absorbables must be removed or they will lead to chronic sepsis.

Absorbable sutures

Natural

- Collagen: This comes from the submucosa of sheep intestine or the serosa of beef intestine.
- Surgical gut, plain: Tensile strength is maintained for 7-10 days postimplantation (variable with individual patient characteristics). Absorption is complete within 70 days. This type of suture is used for (1) repairing rapidly healing tissues that require minimal support, (2) ligating superficial blood vessels, and (3) suturing subcutaneous fatty tissue.
- Surgical gut, fast-absorbing: This type of suture is indicated for epidermal use (required only for 5-7 d) and is not recommended for internal use.
- Surgical gut, chromic (treated with chromium salt): Tensile strength is maintained for 10-14 days. The absorption rate is slowed by chromium salt (90 d). This type of suture may be used in the presence of infection. Tissue reaction is due to the noncollagenous material present in these sutures. Also, patient factors affect rates of absorption and make tensile strength somewhat unpredictable.

Synthetic

Chemical polymers are absorbed by hydrolysis and cause a lesser degree of tissue reaction following placement.

- Polyglactin 910 (Vicryl): This synthetic suture is a braided multifilament suture coated with a copolymer of lactide and glycolide (polyglactin 370). The water-repelling quality of lactide slows loss of tensile strength, and the bulkiness of lactide leads to rapid absorption of suture mass once tensile strength is lost. The suture is also coated with calcium stearate, which permits easy tissue passage, precise knot placement, and smooth tie-down. Tensile strength is approximately 65% at 14 days postimplantation. Absorption is minimal for 40 days and complete in 56-70 days. These sutures cause only minimal tissue reaction and may be used in the presence of infection. Vicryl sutures are used in general soft tissue approximation and vessel ligation. Another similar suture material is made from polyglycolic acid and coated with polycaprolate (Dexon II). This material has a similar tensile strength and absorption profile.
- Poliglecaprone 25 (Monocryl): This synthetic suture is a monofilament suture that is a copolymer of glycolide and E-caprolactone. The suture has superior pliability, leading to ease in handling and tying. Tensile strength is high initially, 50-60% at 7 days, and is lost at 21 days. Absorption is complete at 91-119 days. Poliglecaprone sutures are used for subcuticular closure and soft tissue approximations and ligations.
- Polydioxanone (PDS II): This is a polyester monofilament suture made of poly (p-dioxanone). This suture provides extended wound support and elicits only a slight tissue reaction. Tensile strength is 70% at 14 days and 25% at 42 days. Wound support remains for up to 6 weeks. Absorption is minimal for the first 90 days and essentially complete within 6 months. This material has a low affinity for microorganisms (like other monofilament). PDS II suture is used for soft tissue approximation, especially in pediatric, cardiovascular, gynecologic, ophthalmic, plastic, and digestive (colonic) situations. Another similar suture material is made from polytrimethylene carbonate (Maxon). This material has a similar tensile strength and absorption profile.

The examples listed above represent only some of the available synthetic absorbable sutures. Depending on anatomic site, surgeon's preference, and the required suture characteristics, other types of synthetic absorbable suture are available.

Nonabsorbable sutures

Natural

- Surgical silk: This suture is made of raw silk spun by silkworms. The suture may be coated with beeswax or silicone. Many surgeons consider silk suture the standard of performance (superior handling characteristics). Although classified as a nonabsorbable material, silk suture becomes absorbed by proteolysis and is often undetectable in the wound site by 2 years. Tensile strength decreases with moisture absorption and is lost by 1 year. The problem with silk suture is the acute inflammatory reaction triggered by this material. Host reaction leads to encapsulation by fibrous connective tissue.
- Surgical cotton: This is made of twisted, long, staple cotton fibers. Tensile strength is 50% in 6 months and 30-40% by 2 years. Surgical cotton is nonabsorbable and becomes encapsulated within body tissues.
- Surgical steel: This is made of stainless steel (iron-chromium-nickel-molybdenum alloy) as a monofilament and twisted multifilament. It can be made with flexibility, fine size, and the absence of toxic elements. Surgical steel demonstrates high tensile strength with little loss over time and low tissue reactivity. The material also holds knots well. Surgical steel suture is used primarily in orthopedic, neurosurgical, and thoracic applications. This type of suture also may be used in abdominal wall closure, sternum closure, and retention. This material can be difficult to handle because of kinking, fragmentation, and barbing, which renders the wire useless and may present a risk to the surgeon's safety.

Cutting, tearing, or pulling other patient tissues is also a risk. Surgical steel in the presence of other metals or alloys may cause electrolytic reactions and, therefore, is not a safe choice in these circumstances. The size of the steel wires is classified by the Brown & Sharpe gauge, ie, 18 (largest diameter) to 40 (smallest diameter). Standard United States Pharmacopeia classification is also used to denote wire diameter.

Synthetic

- Nylon: This is a polyamide polymer suture material available in monofilament (Ethilon/Dermalon) and braided (Nurolon/Surgilon) forms. The elasticity of this material makes it useful in retention and skin closure. Nylon is quite pliable, especially when moist. Of note, a premoistened form is available for cosmetic plastic surgery. The braided forms are coated with silicone. Nylon suture has good handling characteristics, although its memory tends to return the material to its original straight form. Nylon has 81% tensile strength at 1 year, 72% at 2 years, and 66% at 11 years. The material is stronger than silk suture and elicits minimal acute inflammatory reaction. Nylon is hydrolyzed slowly, but remaining suture material is stable at 2 years, due to gradual encapsulation by fibrous connective tissue.
- Polybutester (Novofil): This monofilament suture is made of a copolymer of polyglycol terephthalate and polytrimethylene terephthalate. This material is very elastic and has a very low coefficient of friction. These properties are ideal for surface closure, permitting adequate tissue approximation while allowing for tissue edema and detumescence. Polybutester does not lose tensile strength or become absorbed.
- Polyester fiber (Mersilene/Dacron [uncoated] and Ethibond/Ti-cron [coated]): This suture material is formed from polyester, a polymer of polyethylene terephthalate. The multifilament braided suture also comes coated with polybutilate (Ethibond) or silicone (Ti-cron). The coating reduces friction for ease of tissue passage and improved suture pliability and tie-down. The suture elicits minimal tissue reaction and lasts indefinitely in the body. Polyester fiber sutures are stronger than natural fibers and do not weaken with moistening. The material provides precise consistent suture tension and retains tensile strength. This suture is commonly used for vessel anastomosis and the placement of prosthetic materials.
- Polypropylene (Prolene): This monofilament suture is an isostatic crystalline stereoisomer of a linear propylene polymer, permitting little or no saturation. The material does not adhere to tissues and is useful as a pull-out suture (eg, subcuticular closure). Polypropylene also holds knots better than other monofilament synthetic materials. This material is biologically inert and elicits minimal tissue reaction. Prolene is not subject to degradation or weakening and maintains tensile strength for up to 2 years. This material is useful in contaminated and infected wounds, minimizing later sinus formation and suture extrusion.

Monofilament and Multifilament

A further subdivision of suture materials is Monofilament and Multifilament. A monofilament suture is made of a single strand. It resists the harboring microorganisms and it ties smoothly, which can ease the judgment of the tightening of a knot but can also lead to knot slippage. A multifilament suture consists of several filaments twisted or braided together. This gives good handling and tying qualities.

Natural and synthetic

Natural sutures such as silk and catgut are largely being replaced by synthetic materials. There is a case for suggesting that they should no longer be used.

Suture diameter and strength

The sizes and tensile strengths for all suture materials are standardized by U.S.P. Regulations. Size denotes the diameter of the material. Stated numerically, the more zeroes in the number, the smaller the size of the strand. 00000 is referred to as 5-0 for example which is smaller than a size 4-0. The smaller the diameter, the less tensile strength. Tensile strength of a suture is the measured pounds of tension that the strand will withstand before it breaks when knotted. To avoid an excess tissue reaction the surgeon should choose the smallest diameter suture with sufficient strength for the task.

Some typical examples

Polyglactin (coated vicryl) is braided. It is commonly used for bowel anastomosis, as a general tie for vessels and as a subcuticular suture for skin. It has 75% of its strength at 2 weeks and 50% at three weeks. It causes a minimal tissue reaction and is very close to being the ideal suture for almost all purposes. A more rapidly absorbing version (Vicryl Rapide) is now produced which loses all strength within 14 days.

Polydioxanone (PDS) is monofilament. It absorbs slowly and there is minimal absorption until about 90 days. However, its in vivo tensile strength reduces more quickly to 70% at 2 weeks, 50% at four weeks and 25% at six weeks. It is widely used for abdominal wall muscle closure where is has replaced nylon/prolene as it does not cause chronic suture sinuses which occur with non-absorbable materials.

Nylon (eg ethilon) is a synthetic monofilament material widely used for skin suture. Polypropylene (prolene) is often preferred to nylon as it is thought to be slightly more inert. It is widely used for abdominal wall closure.