Part 2: Suture Material Overview

The U.S. Food and Drug Administration categorizes suture material as predominantly a class II medical device. Class II and III medical devices encompass surgically implanted materials that remain as a foreign body inside in the patient's body upon discharge. [6]

Sutures are sized based on metric or United States Pharmacopeia (USP) measurements. Established in 1937, the USP classification system was developed to standardize and compare suture material sizes.[4] Metric sizes are determined by taking the suture diameter as expressed in tenths of a millimeter, while USP sizes can range from 11-0 (ought) to 7 (largest). Stainless steel wire is sized according to the Brown and Sharpe (B and S) wire gauge measurements, and can range from large, 18-gauge (~ USP 7) to the smallest 41-gauge (~USP 7-0) [3,4]

Selecting the appropriate suture size can minimize tissue reaction and the presence of excessive foreign material as well as prevent alteration of tissue architecture. [3] Optimal suture size is determined as the smallest size necessary to achieve a tension-free wound closure. However, if wound tension is high, smaller-diameter sutures may actually damage tissues by cutting through them. Therefore, it is prudent to closely match the tensile strength of the suture with the tissue in which it is being used.[3,4]

Sutures are classified by the number of strands comprising them. Monofilament sutures are made of a single strand of material, while multifilament sutures consist of several filaments (strands) that are spun, twisted or braided together. The simple structure of monofilament suture decreases resistance when passed through tissues and resists harboring organisms, but is at an increased risk of damage when tied, crimped or crushed. Multifilament sutures have greater tensile strength, pliability and flexibility, but cause more tissue drag and provide increased surface area for microorganisms to adhere. [2,4] Sutures may be coated with agents to improve handling properties or colored with an FDA-approved dye to enhance visibility. [2]

Sutures are also classified as either absorbable or nonabsorbable. Absorbable sutures undergo degradation and rapid loss of tensile strength in less than 60 days. Absorbable sutures may be classified as natural fiber absorbable (e.g., catgut, collagen) or synthetic absorbable polymers (e.g., polyglycolic acid suture, polyglactin 910, polydioxanone, polyglyconate, and poliglecaprone). [2,3] Furthermore, some synthetic absorbable sutures may be sub-classified as active sutures based on their ability to inhibit bacterial growth .[5] Nonabsorbable sutures will maintain tensile strength for more than 60 days. [3]

Absorbable suture: Natural fiber absorbable sutures are essentially digested by the body's enzymes, while synthetic absorbable sutures are broken down by hydrolyzation. Hydrolyzation is a process by which water gradually penetrates the suture filaments, thereby causing a breakdown of the suture's polymer chain. [2] Hydrolyzation causes less tissue reaction as compared to enzymatic destruction. [2]

Although there are many advantages of using absorbable sutures it should be noted that the absorption process can become altered in patients with a fever, infection or protein deficiency, resulting in an accelerated decline of tensile strength. Furthermore, the absorption process can begin prematurely if

the sutures are placed in a moist or fluid filled part of the body, or if the material becomes wet or moist during handling or any other time prior to implantation. [2]

Active sutures are another relatively new option in absorbable suture materials (e.g., Polyglactin 910-, Poliglecaprone 25-, Polydioxanone- Plus Antibacterial). Active suture materials are impregnated with a broad-spectrum antibacterial agent such as Irgacare MPTM (triclosan) at concentrations less than 472 ug/m. This agent has been shown to inhibit bacterial colonization of microorganisms along the suture line (e.g., Staphylococcus aureus, Staphylococcus epidermidis, Methicillin Resistant S. aureus, Methicillin Resistant S. epidermidis and Escheria Coli) while eliciting minimal tissue reaction during absorption. [5]

Nonabsorbable suture: Nonabsorbable natural fiber materials include stainless steel, silk and cotton, while non-absorbable synthetic materials may include nylon, polyester, and polyolefin plastics (e.g., polypropylene, polyethylene). [3] The USP classification of nonabsorbable sutures is:

- Class I - Silk or synthetic fibers of monofilament, twisted, or braided construction
- Class II - Cotton or linen fibers or coated natural or synthetic fibers in which the coating contributes to suture thickness without adding strength
- Class III - Metal wire of monofilament or multifilament construction

The most common indications for nonabsorbable sutures includes transient exterior skin closure, patient history of reaction to absorbable sutures (e.g., keloidal tendencies, tissue hypertrophy), permanent use within the body cavity where suture eventually becomes encapsulated in tissue by fibroblasts, or during prosthesis attachment (pacemakers, drug delivery systems.) [2]

Absorbable Suture Materials - Monofilament

Poliglecaprone 25 (Monocryl®): Synthetic material prepared from a copolymer of pglycolide and epsilon-caprolactone. [5] Recommended for ligation or tissue approximation during general soft tissue, oral and urinary bladder surgery, and for subcutaneous closures.[1] Not recommended for use in cardiovascular, neurologic, microvascular or ophthalmic surgery. [5]

Glycomer 631 (Biosyn®): THE strongest monofilament suture in this class, second only to stainless steel. Sixty-percent loss of tensile strength at 21 days, with complete absorption by 90-110 days. Dyed (violet) and undyed versions available. Good handling characteristics with low memory and little tissue drag, but tying secure knots requires a good technique. [7]

Polydioxanone (PDS, PDS II®): Synthetic paradioxanone (p-diaxanone) polymer available in dyed (violet) or undyed versions. Slow and predictable absorption rate is essentially complete at 180 days (6 months). Acceptable to use for abdominal or thoracic wall closure or in the bladder tissue of sterile or infected canine urine. Rarely associated with calcinosis circumscripta in young dogs. [1,7]

Polyglyconate (Maxon®): Monofilament absorbable with properties similar to PDS. Superior effective strength post implantation with absorption complete at 6 months, which is not affected by the presence of infection or inflammation. Versatile material recommended over nylon and polybutester for tendon repair. Ends can be sharp if cut too short. [1,7]

Absorbable Suture Materials - Multifilament

Surgical gut (Chromic Gut®, Gut®): Natural multifilament material made from purified connective tissue derived from either sheep small intestine (submucosa) or bovine small intestines (serosal layer). Available individually packaged or on multiple use reels, but multiple use reels are associated with an increased contamination risk. [1,2,4,7]

Polyglycolic acid, +/- Polycaprolate coating (Dexon®, Dexon II®): Synthetic braided material made from polyester polymerized from hydroxyacetic acid. Suitable for use during intestinal anastamosis, caesarean section and hernia repair as long as extended approximation of tissues under stress is not required. Tolerated in the presence of infected wounds. Avoid use in the oral cavity or urinary bladder, especially in the presence of an alkaline pH. [1,2,4,7]

Polyglactin 910 (Vicryl Plus®, Vicryl®, Vicryl Rapide®): Synthetic braided material composed of a 9:1 ratio of glycolic and lactic acids. Well tolerated in many wound conditions. Avoid prolonged contact with salt solutions, such as those found in the urinary or biliary tract. [5,7]

Lactomer 9-1 (Polysorb®): Lactomer 9-1 has very similar characteristics to polyglactin 910, but a finer filament diameter results in a very complaint strand with less memory than other synthetic absorbable mulitfilaments.[7] May cause calculi when used in urinary or gall bladder tissues. Avoid in cardiovascular or neurologic surgery. [7]

Nonabsorbable Suture Materials

Surgical silk (Mersilk®, Perma-Hand®): Comprised of raw silk spun by silkworms. May be coated with beeswax, oil or silicone to decrease capillarity. Superior handling characteristics make this material considered the 'standard of performance' by many surgeons.[1,4,7] Used in vascular surgery (PDA) or for skin sutures. May cause ulceration when used in hollow viscera (e.g., gastrointestinal tract) or predispose to calculi formation in the urinary or biliary tract. [1,7] Potentiates wound infection x 103-104.[7]

Polybutester (Novafil®): Synthetic monofilament suture is made from a copolymer of polyglycol terephthalate and polytriethylene terephthalate. Suture exhibits superior elasticity as compared to other materials but returns to its original length once the load is removed.[1,4,7] Elastic properties, good tensile strength and knotting characteristics make it suitable for surface closure, repair of tissues such as tendons or when prolonged wound healing is expected.[1,7]

Polyester fiber (Mersilene®/Surgidac®, Dacron®, [uncoated] and Ethibond®/Ticron®, Ethiflex® [coated]): Multifilament braided material comes coated with polybutilate (Ethibond), Teflon (Ethiflex), or silicone (Ticron) to reduce friction and improve pliability. Lasts indefinitely in the body.[4,7] Can be used in slow healing tissues, vessel anastomosis and during placement of prosthetic materials.[1,4,7] Avoid in infected wounds where bacteria entrapped between fibers can cause persistent incisional drainage.[1,7]

Nylon/Polyamide (Ethilon®, Monosof®, Nurolon®, Dermalon®, Bralon®, Surgilon®): Monofilament (e.g., Ethilon®, Monosof®) and braided [e.g., Nurolon®, Surgilon®] polyamide polymer suture. Braided forms coated with silicone. Stronger than silk and elicits minimal acute inflammatory reaction. Maintains

elasticity post implantation, even when moist.[1,4,7] Inert and non-capillary. Supramid®, a twisted multifilament suture, is available in large diameters only.[1]

Polymerized caprolactam (Supramid®, Vetafil®): Synthetic multifilament material. Similar to nylon, composed of a ploymide polymer but has a smooth sheath of polyethylene/proteinaceous material. Elasticity properties permit use in areas subject to movement or tension. Not sterile, so few indications other than skin closure. Causes subcutaneous swelling and sinuses. [7]

Polypropylene (Prolene®, Surgipro®, Surgilene®): Synthetic monofilament suture consists of a stereoisomer of polypropylene. Remains biologically inert. May be used as a pull- out suture (e.g., subcuticular or skin closure) since it does not adhere to tissues. Often used in vascular surgery due to being the least thrombogenic. Also good for use during hernia and tendon repair and in contaminated or infected wounds. [1,4,7]

Stainless steel (Flexon®): Comprised of monofilament or twisted multifilament iron- chromium-nickel-molybdenum alloy, but also manufactured without toxic elements. Demonstrates excellent knot holding capabilities, high tensile strength with little loss over time and biologically inert. Used in orthopedic, neurosurgical and thoracic (e.g., sternum closure) applications as well as for abdominal wall closure or in contaminated or infected wounds. [1,4,7] Visible radiographically but may interfere with magnetic resonance imaging (MRI) and requires special cutting scissors. [7]

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