Understanding and Selecting Surgical Suture and Needle

Szczepan Baran, VMD, MS, Elizabeth Johnson, VMD, and Marcel Perret-Gentil, DVM, MS

An overview of types, principles, and procedures.

When planning on performing surgery in a research setting, it is essential to consider aspects of the procedure that can act as confounding factors. Two elements that often do not receive enough consideration, especially in rodent surgery, include the type of needle and the suture being used for individual procedures. Selecting an inappropriate needle can lead to preventable trauma. In addition, sutures are foreign biomaterial, which could impact the wound healing process, thereby potentially acting as a confounding factor. Surgical needle and suture selection is dependent on their characteristics, the type of procedure for which they are intended, the anatomic site of the procedure, and the surgeon's preference and experience. This article reviews the types of needles and sutures available, as well as the principles that impact needle and suture selection, while providing recommendations for commonly performed surgical procedures within the laboratory animal science field.

Needles

Needle Ends

The ideal surgical needle is made of high quality stainless steel, as slim as possible without compromising strength, stable in the grasp of a needle holder, able to carry suture material through tissue with minimal trauma, sharp enough to penetrate tissue with minimal resistance, rigid enough to resist bending but not break, sterile, and corrosion-resistant.

There are two basic needle end types, "eyed" and "eyeless" (Figure 1). Those that have the hole at the suture side of the needle and that need to be threaded with suture are "eyed." Conversely, those that have the suture crimped within the needle are "eyeless" or "swaged." For the purpose of surgical research, there are more benefits to utilizing the eyeless needle over the eyed needle. Some of those benefits include the fact that the eyeless needle is composed of a single use needle and suture. This avoids the loss of sharpness that occurs with reusable needles. There is only a single strand of suture that is pulled through the tissues, and the gap that is created by the needle is fully plugged by the suture. This reduces potential leakage through the suture line. There is no re-threading of an eyeless needle, and its use is more time efficient.

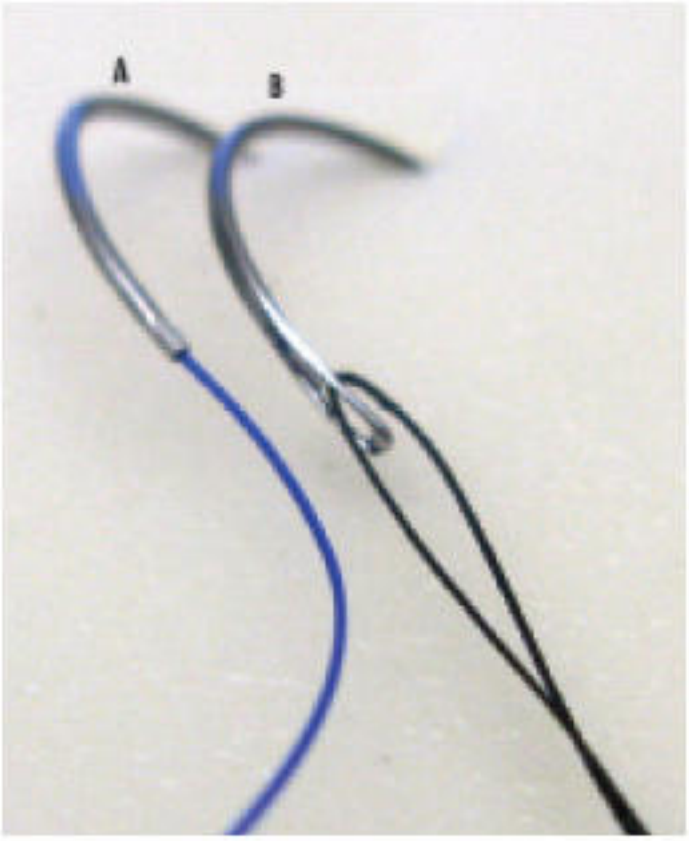

Figure 1: Example of Eyeless (Swaged) Needle (A) and Eyed Needle (B).

Needle Curvature

Straight Needles: This needle should be used when tissue is easily accessible, and is designed to be used by hand (without the aid of instruments). The straight needles are most useful for skin closure or microsurgical procedures like nerve and vessel repair.

Half-curved (ski): This needle is used to suture using laparoscopic technique. It is rarely used in rodent surgery.

1/4 Circle: This needle has a shallow curvature and is used on easily accessible convex surfaces. Typically used for ophthalmic and microsurgical procedures.

3/8 Circle: This is the most commonly used needle. The curvature makes it easy to manipulate in large and superficial wounds, however it is impossible to use in deep cavities due to the large arc of manipulation needed.

1/2 Circle: This needle is to be used in confined locations, but requires more pronation and supination of wrists.

5/8 Circle: This needle is ideal for deep, confined holes, and can be used by rotating the wrist with little to no lateral movement.

Needle Body and Point

There are needles with round bodies, and these needles can either have sharp or blunt points. These round-bodied needles pierce and spread the tissues with minimal cutting. They are used in easily penetrated tissues like the peritoneum and abdominal viscera. This type of needle is also used in internal anastomosis to prevent leakage. Blunt, round body needles are used to dissect through friable tissues like liver and kidney.

There are needles with triangular shaped bodies, and these are referred to as “cutting” needles. Each of the three edges is a cutting edge, and they are used to penetrate tough tissues and are ideal for suturing skin. “Conventional” cutting needles have the cutting edge on the concave surface and are useful for skin and sternum. “Reverse” cutting needles have their cutting surfaces on the convex surface and are ideal for tough tissue like skin, tendon sheath, or oral mucosa, and are especially useful when performing subcuticular skin closures. Reverse cutting needles have more strength than conventional cutting needles, and there is a reduced risk of cutting through tissue. These types of needles are typically used in ophthalmic and cosmetic surgery, where minimal trauma is paramount.

In addition to the characteristics listed above, these different types of needles come in varying lengths and varying weights: “super heavy” needles are used for extremely tough tissues.

Suture

Just like needles, there are varying types of sutures, and their uses depend on the type of tissue being repaired and the duration of time needed for the suture to stay in place, as well as ease of use. There are absorbable and non-absorbable sutures, monofilament or multifilament, and there are varying materials that comprise sutures. The ideal suture is the smallest possible that provides high uniform tensile strength, the ability to hold the wound securely during the healing phase and then rapidly absorb, a consistent uniform diameter, sterility, pliability, knot security, least amount of tissue reactivity, and predictability.

Drag and pliability are concerns that should be addressed when choosing a suture material. Some sutures are coated with materials that reduce tissue drag and also facilitate movement of the suture during suture removal.

All suture material will cause tissue reaction, as it is a foreign substance. The tissue reaction will persist until the suture is absorbed or encapsulated. The smaller the suture diameter, the less the tissue reaction due to less foreign material being left behind. However, the smaller the diameter, the weaker the tensile strength will be. As a general rule, the smallest suture material that properly holds tissues should be used.

Types of non-absorbable suture are silk, stainless steel, polyester, polypropylene, nylon, and cotton. These, like absorbable sutures come in differing gauges, depending on the level of tension needed to close the defect. The smaller the gauge that is used, the less the tissue reaction will be and the faster the wound will heal.

There are four main classifications of suture material: Physical, Handling, Biocompatibility, and Biodegradation.

The physical characteristics include size (diameter), number of filaments, tensile strength, elastic modulus, bending stiffness, stress relaxation, capillarity, swelling, and coefficient of friction. Handling characteristics include pliability, packaging memory, knot tie-down, knot slippage, and tissue drag. Biocompatibility deals with the degree of inflammatory reaction and the propensity for wound infection, thrombi formation, carcinogenicity, and allergic reactions. Biodegradation includes the tensile breaking strength and mass loss as well as the biocompatibility of degradation properties.

The absorbability of a suture is determined by the material it is made from and the number of strands that comprise that suture. Natural suture is broken down by enzymatic attack while synthetic sutures are broken down through hydrolysis; the process by which water gradually penetrates the suture filaments, causing breakdown of the suture’s polymer chain. Suture strands can either be monofilament, braided, or twisted.

Monofilament sutures are comprised of one strand, create less drag when passing through tissues, and resist harboring infections. However, monofilament sutures crush and crimp easily, creating weak spots that lessen the tensile strength. Multi-filament suture consists of several strands braided or twisted together, which provide increased tensile strength and pliability but increase drag on the tissues.

Multi-filamentous suture can be coated with different materials that facilitate handling by lessening the drag while passing through tissues and making knots easier to slide into place. Conversely, this also results in poor knot security. Coatings come in absorbable and non-absorbable types.

There are some drawbacks to utilizing suture (versus surgical clips, the discussion of which is beyond the scope of this article) such as the time consuming nature of proper knot tying, the absolute need for knot security, the risk of suture breaking during surgery, loss of control due to needle slippage or rotation, post-surgical slippage of the knotted suture, and early degradation of absorbable suture.

Breaking strength rate is a term that is used to describe the length of time when 50% of the breaking strength of the suture remains.

Non-absorbable sutures retain the majority of their breaking strength for more than 60 days and are comprised of three classes:

- Class 1: silk monofilament and sheathed, nylon and polypropylene
- Class 2: cotton and linen
- Class 3: metallic

Class 1 and 3 are the most popular as class two is prone to infection and contamination.

Non-absorbable sutures are encapsulated or walled off by the body's fibroblasts.

Suture Size

There are two classifications of suture size; those that follow USP (United States Pharmacopeia) or those that follow the European system. The European system uses the diameter of the suture in millimeters. The USP method uses a complex relationship between diameter, tensile strength, and knot security.

The inherent tensile strength of a particular suture depends on many factors, such as the material it is made of, the diameter, the condition the suture is in (wet, dry, knotted, whether it is hydrophobic or hydrophilic), the condition the suture is stored in, and whether or not it can be re-autoclaved.

Sutures lose some of their strength when knots are applied. The strength of a knotted suture usually decreases by 50% due to the stresses from bending and twisting that are introduced into the suture.

There are seemingly limitless combinations of sutures and needles. However, experienced surgeons typically find a few sutures that they prefer to work with and use them exclusively unless the procedure specifically calls for a different suture or needle type. It could be recommended to "go by the book" when first experimenting with new suture and needle types, and over time decide which suture type handles best for applicable procedures. This way, the surgeon does not have to keep hundreds of different types of suture on hand for various procedures.

Szczepan Baran, VMD, MS *is the President for the Veterinary Bioscience Institute. Wake Forest Innovation Quarter, 200 East 1st Street, Winston-Salem, NC 27101. He can be reached at* szczepanb@vetbiotech. com *[1];* www.vetbiotech.com *[2].*

Elizabeth Johnson, VMD *is the CEO for the Veterinary Bioscience Institute, Wake Forest Innovation Quarter, 200 East 1st Street, Winston-Salem, NC 27101. She can be reached at* info@vetbiotech.com *[3].*

Marcel Perret-Gentil, DVM, MS *is the University Veterinarian and Director of the Laboratory Animal Resources Center at The University of Texas at San Antonio, One UTSA Circle, San Antonio, TX; 78249; 210-458-6692,* marcel.perret@utsa.edu *[4].*

Links:
[1] mailto:szczepanb@vetbiotech. com
[2] http://www.vetbiotech.com
[3] mailto:info@vetbiotech.com
[4] mailto:marcel.perret@utsa.edu