UNIVERSITÉ LAVAL

Direction des services vétérinaires **Standard Operating Procedure**

Re: Suture material and techniques	Number: C-10
Scope: A directive from the Direction des services vétérinaires to users and staff of Université Laval animal facilities (campus and affiliated research centres).	
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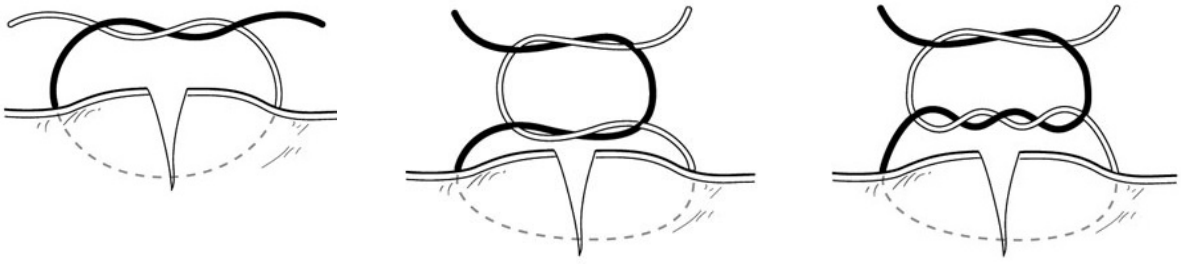
Purpose: Describe the various types of suture material available and provide details. Describe wound closure techniques.	Version 1

General considerations

- The choice of suture material plays a critical role in the wound healing process.
- The suture material (needle and suture) must be single-use and must not be utilized on more than one animal.
- Change the suture when the needle becomes blunt and difficult to pass through tissue or when the suture looks damaged (loss of tensile strength) or is no longer sterile.
- Handle the needle with a self-locking instrument, such as a needle holder.
- The suture material is a foreign body. Use as little suture material as possible to close a wound or tie a ligature securely.
- Suture strength decreases with its diameter.
- The higher the suture number, the smaller the diameter (e.g., a 6-0 suture is smaller and weaker than a 4-0 suture).
- Increasing the number of sutures is better than increasing the suture's size.
- The choice of suture will depend on tissue type, the strength and duration required during healing, and the degree of tissue contamination.
- The knot is the suture's weak point. Poorly tied knots are the leading cause of wound dehiscence
- Surgeon's knots are not recommended because they increase the amount of suture material in the wound. They should only be used sparingly.
- Use of continuous sutures for abdominal wall muscle and skin tissue is strictly forbidden.

Definitions

- Absorbable: material that is broken down by the body. Used when only temporary support is needed (see Table 1).
- Knot: a solid structure composed of a number of throws.
- Ligature: a procedure used to occlude a vessel or duct.
- Monofilament: a single-strand suture. Monofilament sutures have a very smooth surfaces and glide easily through tissues but can be challenging to handle and tie.
- Multifilament: a suture composed of two or more strands braided together. Multifilament sutures do not glide as easily through tissues and can cause tissue trauma when not coated to make them smoother. However, their knots are more secure than those of monofilament sutures.
- Non-absorbable: material not broken down by the body. A material that can permanently be left in the animal to secure an implant or reinforce weak tissue (see Table 2).
- Square knot: a knot consisting of two throws with the second in the opposite direction of the first. The two ends of the same strand must exit the knot parallel to each other on the same side.



Simple throw Square knot Surgeon's knot

- Surgeon's knot: a knot derived from the square knot with an extra twist in the first throw that increases friction and strength
- Suture:1) a procedure used to join the edges of a wound; 2) a loop of thread, or similar material, used in this procedure, a stitch.
- Throws: the interlacing of threads that collectively forms a knot

Procedures

Selecting the suture material

- Avoid multifilaments when closing a contaminated wound as they are more likely to cause infection.
- Use the smallest suture diameter commensurate with the natural strength of the tissue to be sutured and appropriate for the species (see Table 3 and Table 4).
- Select the needle type suitable for the tissue to be repaired. A cutting needle, e.g., reverse cutting, can traumatize friable tissue (e.g., muscle) and delay healing. A taper point needle is not recommended for skin (see Table 5).
- Use a tissue adhesive (Vetbond™, Dermabond®) for skin sutures where knot security is in question or if there are gaps between existing knots and adding an extra stitch isn't possible.

  Note: Systematic use of tissue adhesive to close all wounds is not recommended. Use of tissue adhesive is not recommended for fish.

Table 1: Absorbable sutures

Material	Suture brand	Type	Absorption	Use	Other features
Glycolide and lactide	Velosorb™ Fast	Multifilament	Loss of 100% tensile strength in 14 days Absorption in 40–50 days	Intradermal, subcutaneous, muscular, and mucosal sutures, where no more than 7 days of support is required	**Not** to be used for nervous, cardiovascular, ophthalmic tissue or ligatures.
Polyglytone 6211	Caprosyn™	Monofilament	Loss of 50% tensile strength in 7 days Absorption in 56 days	Intradermal sutures, intestinal surgeries, bladder, and other soft tissues sutures	**Not** to be used for nervous, cardiovascular, or ophthalmic tissue
Poliglecaprone 25	Monocryl®	Monofilament	Loss of 50% tensile strength in 7 days Absorption in 3 months	Intradermal sutures, intestinal surgeries, and other soft tissue sutures	**Not** to be used for nervous, cardiovascular, or ophthalmic tissue

Material	Suture brand	Type	Absorption	Use	Other features
Polyglactin 910	Vicryl® [1]	Multifilament	Loss of 50% tensile strength in 14 days Absorption in 56–70 days	Intradermal, subcutaneous, muscular, and mucosal sutures	**Not** to be used for nervous or cardiovascular tissue
Lactomer 9-1	Polysorb™	Multifilament	Loss of 20% tensile strength in 14 days Absorption in 56–70 days	Intradermal, subcutaneous, and other soft tissue sutures	**Not** to be used for nervous or cardiovascular tissue
Polyglycolic acid	Dexon™ II [2]	Multifilament	Loss of 35% tensile strength in 14 days Absorption in 60–90 days	Skin sutures, abdominal, and thoracic surgeries	**Not** to be used for nervous or cardiovascular tissue
Glycomer 631	Biosyn™	Monofilament	Loss of 25% tensile strength in 14 days Absorption in 3 months	Abdominal and other soft tissue sutures	Very strong material
Polyglyconate	Maxon™	Monofilament	Loss of 25% tensile strength in 14 days Absorption in 6 months	Muscle and fascia sutures and gastrointestinal surgeries	Not recommended for nervous, cardiovascular, or ophthalmic tissue
Polydioxanone	PDS®	Monofilament	Loss of 30% tensile strength in 14 days Absorption > 6 months	Muscle and fascia sutures and gastrointestinal surgeries	Not recommended for nervous or cardiovascular tissue

[1] A rapidly absorbed version is also available. Vicryl Rapide® loses 50% of tensile strength in 5 days and is completely absorbed in 42 days.

[2] A non-coated version (Dexon™ S) is also available.

Table 2: Non-absorbable sutures

Material	Brand	Type	Use	Other features
Stainless steel	Surgical Steel	Mono or multifilament	Sternotomy, skin sutures (staples)	Strongest material, inert, hard to handle
Polyamide (nylon)	Monosof™, Ethilon®	Monofilament[1]	Skin, cornea, fascia sutures	1 additional throw is needed since it has less knot security
Polybutester	Novafil™	Monofilament	Skin sutures, ophthalmic and vascular surgeries	More robust material and easier to handle than polypropylene
Polypropylene	Prolene®	Monofilament	Skin sutures. vascular surgeries, other permanent applications	Least thrombogenic material Surgeon's knot is often required, but 1 less throw needed
Silk	Sofsilk™	Multifilament	Vascular surgeries (**don't** use for skin)	Loss of 30% tensile strength in 14 days Absorption > 2 years Moderate tissue reaction, more likely to cause infection, moderate knot security

[1] Polyamide is also available as a multifilament but its use is less recommended.

Table 3: Natural tissue strength

Tissue	Healing time[1]	Strength
Ligaments, tendons, fascia, skin[2]	Several months	Strong tissues
Stomach, intestine, bladder	14 to 21 days	Intermediate tissues
Fat, liver, kidney, spleen	7 to 10 days	Weak tissues

[1] A number of physiological or pathological conditions, including advanced age, obesity, dehydration, immunosuppression, and chronic endocrine disease; can prolong healing time.

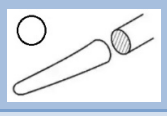
[2] Skin will have regained 5% to 10% of its initial strength by the time stitches are removed.

Table 4: Suture recommendations by tissue and by species

Species	Tissue	Suture options
Cat	Muscle Subcutaneous Skin	Polyglactin, Polyglycolic acid, Glycomer 4-0 Poliglecaprone, Polyglactin, Polyglytone 4-0 Polyamide (Nylon) or Polypropylene 4-0
Dog (20 kg)	Blood vessels Intestine Linea alba Muscle Subcutaneous Intradermal	Polypropylene, Polyamide (Nylon) 10-0/8-0 Polydioxanone, Polyglyconate, Poliglecaprone 4-0/3-0 Polydioxanone, Polyglyconate, Poliglecaprone 2-0/0 Polyglactin, Polyglycolic acid, Lactomer 3-0/2-0 Poliglecaprone, Polyglactin, Lactomer 4-0/3-0 Absorbable monofilament 4-0/3-0
Ferret	Blood vessels Intestine Linea alba Subcutaneous Intradermal	Polypropylene 8-0/6-0 Absorbable monofilament 5-0/4-0 Absorbable 4-0/3-0 Absorbable monofilament 5-0/4-0 Absorbable monofilament 5-0/4-0
Rabbit	Intestine Linea alba Subcutaneous Intradermal Skin	Absorbable monofilament 6-0 Absorbable monofilament 4-0/3-0 Absorbable monofilament 4-0 Absorbable monofilament 4-0 Polyamide (Nylon), Polypropylene 4-0/3-0
Pig (25 kg)	Intestine Sternotomy Thoracotomy Muscle Subcutaneous Intradermal	Absorbable monofilament 3-0 Stainless steel or non-absorbable multifilament 0/2 Polydioxanone or non-absorbable 0/1 Absorbable 2-0 Absorbable monofilament 3-0/2-0 Poliglecaprone 3-0/2-0
Primates	Subcutaneous Intradermal Skin (cross-mattress)	Poliglecaprone 5-0/4-0 Poliglecaprone 5-0/4-0 Polyamide (Nylon), Polypropylene 5-0/4-0/3-0
Guinea Pig	Intradermal Skin implant	Polydioxanone 5-0/4-0 Polyamide (Nylon) 5-0/4-0
Rats	Gastrointestinal tract Muscle Intradermal Skin	Poliglecaprone, Glycomer 7-0/6-0 Absorbable monofilament 5-0/4-0 Poliglecaprone, Polyglycolic acid, Glycomer 6-0/5-0 Staples or non-absorbable monofilament 5-0

Species	Tissue	Suture options
Mouse	Gastrointestinal tract Muscle Intradermal Skin	Poliglecaprone, Glycomer 7-0/6-0 Absorbable monofilament 6-0/5-0 Poliglecaprone, Polyglycolic acid, Glycomer 7-0 Staples or non-absorbable monofilament 6-0/5-0
Amphibians	Muscle Skin	Polydioxanone 5-0 Polyamide (Nylon), Polydioxanone 5-0/6-0
Fish	Muscle Skin	Synthetic absorbable monofilament, Polyglyconate Synthetic absorbable monofilament, Polyglyconate

Table 5: Needle types frequently used

Type	Features	Use
Blunt	Round shape, blunt point 	Liver, spleen, kidney
Taper point (*round point*)	Round shape, sharpened point 	Muscle, gastrointestinal tract, subcutaneous, fascia, blood vessels
Reverse cutting	Triangular shape, 3 cutting edges 	Skin, dermis, fascia, ligaments

Cutting needles have a cutting edge on the inside of the curve. They are rarely used because there is a greater risk of tearing tissue than with reverse cutting needles, which have a sharp edge on the outside of the curve.

The needle body comes in various shapes—¼ circle to $^{5}/_{8}$ circle. There are also straight needles. The most versatile needles are the $^{3}/_{8}$ and ½ circles.

Handling tissue

- Use fine-point forceps like Adson mouse-teeth to avoid tissue trauma.

  Note: In rodents, avoid repeatedly pinching the skin when suturing since microtraumas often lead to self-mutilation.
- Avoid leaving dead space.
- Avoid strangulating tissue or compromising blood flow.

Making a suture

- Select a needle holder size appropriate for the needle size.
- Hold the needle by its middle third, perpendicular to the needle holder. Holding the needle too close to the suture thread can damage the thread and compromise knot security. Holding the needle too close to the point can damage it and compromise its sharpness.
- Start the suture at the wound end furthest from you and suture towards yourself.
- Once the sutures are knotted, apply consistent and equal force to the two ends of the suture, directing them horizontally and perpendicularly to the wound.
- Make sure the knot is securely tied and flat.
- Leave some space to allow for tissue swelling, a normal postoperative response.
- Do not let the suture ends extend more than 3 mm. Remove the cut ends from the surgical site.
- Use the required number of throws appropriate to the suture type and pattern (see Table 6).

Table 6: Number of throws required

Suture type	Interrupted suture	Start of a continuous suture	End of a continuous suture
Multifilament	3	4	5
Monofilament	4	5	6

Some sutures require additional throws (e.g., nylon), but a polypropylene monofilament suture can be knotted with the same number of throws used for a multifilament suture.

Simple interrupted

- Insert the needle into the tissue at a 90° angle.
- Bring the needle out of the tissue on the other side of the incision, also at a 90° angle.

  Note: The needle must pass through the incision perpendicularly. The depth of the suture must be the same on both sides of the incision.
- Make square knots using the number of throws specified in Table 6.

  Note: If the first throw does not hold and comes loose before you can add an additional throw, undo it entirely and tie a surgeon's knot.
- Cut the suture, making sure not to cut the tissue or knots. Continue adding more knots to close the wound completely.

Note: It is recommended that sutures be equidistant from one another. The spacing between sutures should approximate the distance from the wound edge to the suture exit point.

Simple continuous

- Insert the needle into the tissue at a 90° angle, very close to the end of the wound.
- Bring the needle out of the tissue on the other side of the incision, also at a 90° angle.
- Make square knots using the number of throws specified in Table 6.

  Note: If the first throw does not hold and comes loose before you can add an additional throw, undo it entirely and tie a surgeon's knot.
- Do not cut the sutures.
- Reinsert the needle under the first stitch at a 90° angle and bring the needle out on the other side of the incision, still perpendicular to the wound.
- Keep some tension on the suture between each stitch so the incision is closed without overtightening.
- Proceed in this way until the end of the incision. Do not pull on the suture of the final stitch. The loop will serve as a short leader to tie the final knot. Respect the number of throws specified in Table 6.
- Cut the remaining suture at each end of the wound.

Continuous subcutaneous

- In the corner of the wound, insert the needle into the deep part of the wound. Bring the needle out under the dermis.
- Reinsert the needle into the other side of the wound, under the dermis, and bring it out in the deep part of the wound. This allows you to bury the knot.

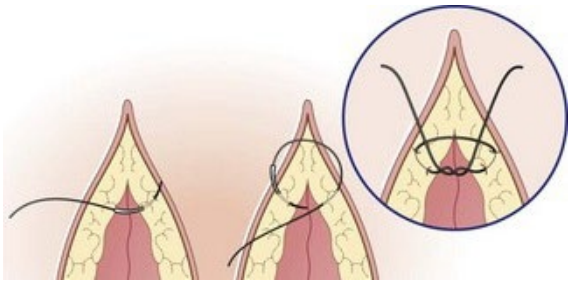
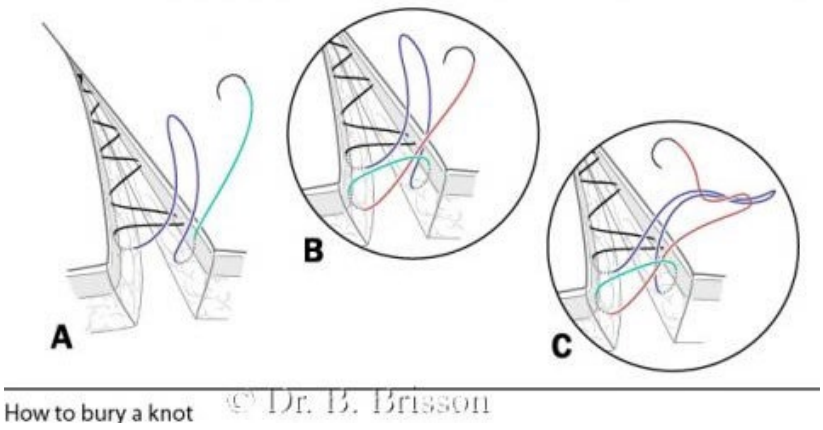


Image adapted from the Veterian Key website.

- Make square knots using the number of throws specified in Table 6.

  Note: If the first throw does not hold and comes loose before you can add an additional throw, undo it entirely and tie a surgeon's knot.
- Only cut the suture's short leader.

- Insert the needle into the subcutaneous tissue near the first knot, laying it on its side and exiting further on. Reinsert the needle in the same way on the other side of the incision opposite the first side exit point.
- Keep some tension on the suture between each stitch so the incision is closed without overtightening.
- Continue in this manner until you reach the end of the incision.
- Make the last stitch in the same way as the first, i.e., deep to superficial, then superficial to deep, leaving a loop of suture after the penultimate stitch. The loop will serve as a short leader to tie the knot. Respect the number of throws specified in Table 6.
- Cut the suture.



The image is taken from the Guelph University Veterinary School, Veterinary Surgery website.

Continuous intradermal

- Use the suture pattern described for the continuous subcutaneous suture, but introduce the needle into the dermis rather than under it.
- At the last knot, cut only the loop suture.
- To properly bury the knot under the skin, insert the needle at the end of the wound and bring it out through the skin about 0.5–1 cm from the end.
- Gently pull on the suture and cut it flush with the skin.

Applying tissue adhesive

- Remove the bottle cap and replace it with a 25 G needle, or withdraw a small volume of adhesive with a tuberculin syringe.
- Approximate the two wound edges with forceps or your fingers. Dry the wound as needed.
- Apply the adhesive one drop at a time over the wound, not into the wound.

  Note: Since tissue adhesive is irritating, apply only a small amount. Use a needle to reduce the amount applied.
- When applying adhesive to the head, be very careful not to get any in the animal's eyes.

Applying staples

- Chose staples designed for the species, e.g., Autoclip® or Reflex 7 for rodents.
- Approximate the two wound edges with forceps.
- Staple the tissue with an applicator compatible with the type of staples selected.

  Note: The centre of the staple should line up with the centre of the wound.
- Make sure the wound edges are properly apposed.
- Leave some space for tissue swelling a normal postoperative response.
- Place the staples 0.5 cm apart.

  Note: Staples are not recommended for use on a rodent's ventral surface due to the increased risk of wound contamination by litter. Do not use staples on inflamed, edematous, or necrotic tissue.

Removing sutures

- Remove all skin sutures 7 to 10 days after surgery.
- Put on clean gloves and clean the site with 0.5% chlorhexidine
- Grasp the knot with clean forceps.
- Using clean or sterile scissors, cut the suture on one side of the knot flush to the skin.
- Pull on the knot.

  Note: Suture material exposed to air should not be pulled through the skin.

Removing staples

- Remove all staples 7 to 10 days after surgery.
- Use staple-remover forceps to facilitate and accelerate the process.

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