

# Choosing sutures in small animal surgery

## Abstract

The range of available sutures has increased over the last 3 decades. This has assisted veterinary surgeons to select sutures that are appropriate for each wound; taking into account that typical healing rate of the tissue concerned might be influenced by local conditions and systemic factors. Generally sutures are classified according to suture material properties and surgical needle characteristics. When choosing sutures veterinary surgeons should always consider which is the appropriate suture material, surgical needle and suture size for a given tissue and be familiar with suture characteristics and tissue requirements. In this mini review sutures that are most commonly used in veterinary practices are described and recommendations for suture selection in different tissue types are discussed. Surgeon's preferences should also be taken into account.

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**Abbreviations:** USP, united states pharmacopoeia; Ph. Eur, pharmacopoeia european; MRSA, methicillin resistant *Staphylococcus Aureus*

## Introduction

Sutures role in wound repair process is to provide hemostasis and support for healing tissue.<sup>1-6</sup> Different tissues have differing requirements for suture support because they heal at different rates. Some tissues need support for only a few days (e.g. muscle, subcutaneous tissue, skin), whereas others require weeks (fascia) or even months (tendon) to heal. Patient variations further affect suture choice. Infection, obesity, malnutrition, neoplasia, steroids and disorders of collagen may delay wound healing. An ideal suture material would be one that will lose its tensile strength at about the same rate as the tissue gains strength and it will be finally absorbed by the tissue so that no foreign material remains in the wound. Endosurgery and minimally invasive surgical techniques in general, put additional demands on suture performance.<sup>4</sup> Good knot security must be maintained, tissue drag should be minimal and the surface lubricant must ensure ease of manipulation. Furthermore biocompatibility with minimal inflammatory response is mandatory. Surgeon's preferences also need to be taken under consideration.<sup>2-6</sup> Some years ago, a typical general veterinary practice would have stocked only catgut, silk, nylon and perhaps stainless steel, but we now routinely use a wide range of synthetic absorbable and non-absorbable sutures.<sup>2</sup> Aim of the review is to help veterinary surgeons to choose the appropriate suture for a given procedure and tissue to be sutured.

## Discussion

The ideal suture is easy to handle, reacts minimally in tissue, inhibits bacterial growth, holds securely when knotted, resists shrinking in tissue, is non-capillary, non-allergenic, non-carcinogenic and absorbs with minimal reaction after the tissue has healed. Unfortunately the so-called ideal suture does not exist although nowadays some of the sutures available in the veterinary market are very close to ideal.<sup>7,8</sup> Therefore surgeons must choose sutures that most closely approximate the ideal.<sup>4</sup> Each suture material is classified according to a variety of properties: flexibility, capillarity, relative knot security, tissue reaction and strength loss over time, ability to be absorbed and time to complete absorption.<sup>3,4,6</sup>

Surgical needles should also be considered. Selection criteria include tissue characteristics (penetrability, density, elasticity and thickness), the site of the wound (deep or narrow) and the characteristics of the needle. Most surgical needles are made from surgical-grade stainless steel, because it is corrosion free and does not harbor bacteria. The three basic components of a needle are the attachment end (swaged or eyed end), the body and the point.<sup>4,6</sup> Eyed needles are cheap and reusable but are less efficient, require threading and they cause more tissue trauma. Swaged needles form a continuous unit with the thread of suture, they cause less tissue trauma, are reliably sharp and easier to use but are more expensive and can only be used once. The body of the needle may be straight or curved as 5/8, 1/2, 3/8 or 1/4 of a circle.<sup>3,4,6</sup> Three eighths (3/8) and one-half (1/2) of a circle are the most commonly used surgical needles in veterinary surgery.<sup>4</sup>

Suture materials may be classified according to their behavior in tissue (absorbable or non-absorbable), their structure (monofilament, multifilament) or their origin (synthetic, organic or metallic). Sutures of biologic origin such as surgical gut (not widely used recently due to availability of strong monofilament synthetic absorbable suture materials) are gradually digested by tissue enzymes and phagocytized, whereas sutures manufactured from synthetic polymers (mostly used nowadays) are broken down by hydrolysis. Non-absorbable sutures are ultimately encapsulated or walled off by fibroblasts.<sup>4</sup>

Monofilament sutures are made of a single strand of material. They have less tissue drag than multifilament sutures and do not have interstices that may harbor bacteria. They should also be handled with care because nicking or damaging them with needle holders or forceps weakens them and predisposes them to breakage. Multifilament sutures generally consist of several strands of suture that are twisted or braided together. Generally they are more pliable and flexible than monofilament sutures. They may be coated to reduce tissue drag and enhance handling characteristics.<sup>3,4</sup> Synthetic absorbable sutures lose most of their tensile strength within 60 days and eventually disappear from the tissues because they have been hydrolyzed. The time to loss of strength and for complete absorption varies among suture materials.<sup>4,6</sup> In the recent years most commonly synthetic absorbable sutures used in veterinary practices are:

## Polyglytone 6211

This synthetic monofilament suture material has excellent

handling characteristics, good knot security and minimal tissue reactivity. Like all synthetic absorbable suture materials, it is broken down by hydrolysis. It loses 50% of its tensile strength by 10days after implantation and is fully absorbed by 56days.<sup>3</sup>

### Poliglecaprone 25

This synthetic monofilament suture material has good handling characteristics, good knot security and minimal tissue reactivity. It's initial strength is high thus a smaller size than usual may be used.<sup>3,9</sup> In common with all synthetic absorbable suture materials, it is broken down by hydrolysis. It loses 50% of tensile strength by 7days, 80% by 14days and is fully absorbed by 90-120days.<sup>3</sup> This rapid absorption makes it a good choice for rapidly healing tissue, such as oral and pharyngeal mucosa, subcutaneous tissue and urinary bladder and a poor choice for tissues that regain tensile strength slowly like fascia or tendons.<sup>5,10</sup> It can also be an excellent choice for buried continuous intradermal suture pattern.<sup>9,11</sup>

### Polyglactin 910, Polyglycolic Acid and Lactomer 9-1

These synthetic braided multifilament materials are very soft, pliable and easy to handle (the soft knotted ends can easily be buried).<sup>5</sup> They have good knot security and cause mild tissue reaction. They are also absorbed by hydrolysis. They tend to lose approximately 35% of their strength by 14days, 60-70% by 21days and are fully absorbed by 56-90days.<sup>3,4,6</sup> They may be broken down more quickly when exposed to alkaline environment, so use in bladder closure is not recommended.<sup>3,5,10</sup> Their main use in veterinary surgery is for vessel ligation and subcutaneous closure.<sup>3,5,6,10</sup> A new suture line, the Plus Sutures was recently introduced to the veterinary market. These are new sutures that were designed to reduce bacterial colonization on the suture material. They are coated with triclosan, an antibacterial agent. Triclosan-coated sutures have shown broad antimicrobial efficacy against bacteria, including methicillin-resistant *Staphylococcus Aureus* (MRSA).<sup>5</sup>

### Polydioxanone, Polyglyconate, Glycomer 631

These synthetic monofilament suture materials have good handling characteristics, good knot security and minimal tissue reactivity. They vary mostly by their duration of tensile strength. Polydioxanone loses 14% by 14days, 30% by 42days and is completely absorbed by 180 days. Polyglyconate loses 30% by 14days, 45% by 21days and is also fully absorbed by 180days. Glycomer 631 is absorbed more quickly, with 60% loss of tensile strength by 21 days and full absorption by 90-100days.<sup>3,6</sup> Polydioxanone and polyglyconate are excellent choices for slowing healing tissues such as fascia (including linea alba).<sup>4,5,6,10</sup>

Non-absorbable sutures are marketed as braided multifilaments or monofilaments. They are typically strong and induce minimal tissue reaction. Non-absorbable sutures, which consist of an inner core and an outer sheath (e.g. Supramid) should not be buried in tissue because they may predispose to infection and fistulation. The outer sheath is frequently broken thus allowing bacteria to reside under it.<sup>4</sup> Nowadays most commonly non-absorbable sutures used in veterinary practices are:

#### Silk

This is the first non-absorbable suture used in surgery.<sup>12</sup> It is a natural braided multifilament suture with excellent handling properties; poor knot security and marked tissue reactivity, thus offering veterinary surgeons the option to choose it when chronic

progressive vascular occlusion is desired.<sup>6</sup> It should never be used to repair the gastrointestinal tract or urinary bladder and should also be avoided in contaminated sites.<sup>3,4</sup> Although silk is considered a non-absorbable suture it is broken down by phagocytosis, losing all significant tensile strength by 6months after implantation and is eventually absorbed over 2years.<sup>3,5</sup>

### Polypropylene

This synthetic monofilament suture is awkward to handle and tie but the knot security is excellent. It causes minimal tissue reaction, it is not weakened from tissue enzymes, retains its strength in tissues and is the least likely of the suture materials to potentiate infection in contaminated wounds.<sup>3,4,5,6</sup> Polypropylene has a lower initial tensile strength than nylon but it retains longer.<sup>5,10</sup> It is highly flexible and non-thrombogenic and therefore it is an excellent choice for cardiovascular repairs.<sup>3,4,5,6,10</sup> It is also a good choice for suturing fascia, ligament and tendons.<sup>5,10</sup>

### Nylon

This synthetic suture material is a polyamide. It is available in a multifilament form but is most commonly used as a monofilament suture material. Nylon is also awkward to handle and has poor knot security. It causes minimal tissue reaction, though buried cut ends may cause irritation.<sup>3,5,6</sup> Monofilament nylon degrades slowly, losing 30% of its tensile strength within 2years of implantation, whereas the multifilament form loses 75% within 6months.<sup>3,5</sup> It is a good choice for skin closure.<sup>5,10</sup>

### Polymerized caprolactam

This synthetic twisted multifilament suture material also belongs to the polyamides. It is inexpensive with excellent handling properties and tensile strength. It is coated with a proteinaceous sheath to decrease tissue drag. Any damage to the sheath leads to a marked tissue reaction and therefore this material is not recommended for implantation beneath the skin.<sup>3,5,10</sup>

### Stainless steel

This is the most commonly used metallic suture and it is usually used in the monofilament form. It is very strong, with excellent knot security but its handling qualities are poor. It is an inert material with minimal tissue reaction, but cut ends beneath the skin may cause irritation and trauma to the tissue.<sup>3,4,6,10</sup>

## Conclusions

Choosing the appropriate suture is based on suture characteristics, tissue requirements and surgeon's preferences. When selecting sutures the general objective is to choose a suture that can hold together the tissues that have been separated until healing has occurred. It is therefore important to select:<sup>2,10</sup>

- i. The proper suture material for each tissue. This is based on the expected healing rate of that tissue, whilst also taking into account any effects that the suture material may have on the healing process.<sup>3-7,10,13</sup>
- ii. The proper suture size. Sutures are sized according the USP (United States Pharmacopoeia) or metric scale (Table 1). The most commonly used standard for suture size is the USP scale, which denotes dimensions from fine to coarse (with diameters in inches) according to a numeric scale, with 12-0 being the smallest

and 7 the largest.<sup>4,10</sup> Stainless steel is sized according to Brown and Sharpe wire gauge.<sup>4,6,7</sup> Selection of suture size is guided by the strength of the tissue being repaired. As a rule of thumb the smallest diameter suture that will adequately hold the tissue to be sutured should be used.<sup>4,10</sup> Using excessively large suture sizes should be avoided, since this can lead to increased trauma to the tissues, changes to tissue architecture and an increase in foreign material implanted within the wound.<sup>3,10</sup> When suturing using simple continuous appositional suture patterns self-locking anchor knots produce small and absolutely safe knots.<sup>10</sup>

iii. The proper surgical needle. Straight needles are used in superficial wounds, as are 3/8 and 1/4 circle needles. Deeper structures may be more easily sutured with a 5/8 or 1/2 circle needle.<sup>3,10</sup> The point of the needle is selected according to the type of tissue to be sutured. Cutting needles are used for tough tissue such as skin. The reverse cutting needle is used more commonly than the standard cutting needle because its design is associated with less tissue cut-out.<sup>3</sup> Taper-cut needles have a rounded body with a cutting point and are best used for dense tissue such as tendon.<sup>3,4</sup> Taper-point needles have a rounded body with sharp point and are best used for more delicate tissues such as intestines and fascia. Blunt-point needles have a rounded body with blunt point and are best used for friable structures such as liver or spleen.<sup>3,4,6</sup>

**Table 1** Suture sizes

USP	Metric (Ph. Eur.)	Brown & Sharpe wire gauge
7/0	0.5	41
6/0	0.7	38-40
5/0	1	35
4/0	1.5	32-34
3/0	2	30
2/0	3	28
0	3.5	26
1	4	25
2	5	24

Ph. Eur, pharmacopoeia european; USP, united states pharmacopoeia

Surgeon's preferences may play a role but is not a very important criterion, since the general guidelines for choice of suture materials have to be followed. They may be influenced by a number of factors. The area of surgeon's expertise plays primary role but on the other hand no single suture material is used by every surgeon who practices within the specialty. Wound closure experience during clinical training, professional experience in the operating room, knowledge of the healing characteristics of tissues and organs, knowledge of the physical and biological characteristics of various suture materials and patient factors (age, weight, overall health status and the presence of infection) may also influence suture choice.<sup>10</sup>

General recommendations for small animal veterinary surgeons regarding suture selection in different tissues are (Table 2):

**Skin**

Synthetic monofilament suture material 2-0 to 4-0 on a cutting or reverse cutting needle is recommended (e.g. nylon, polypropylene).<sup>3,10</sup>

Some surgeons prefer polymerized caprolactam due to its superior handling qualities, but significant skin irritation is often seen.<sup>3,5</sup>

**Table 2** General recommendations for suture selection in different tissues

Tissue	Suture material	USP	Surgical needle
Skin	Polyamide		
	Polypropylene	2-0 to 4-0	Cutting or Reverse cutting
	Poliglecaprone 25		
Subcutaneous tissue	Polyglytone 6211		
	Poliglecaprone 25		
	Polyglactin 910	2-0 to 4-0	Taper
	Polyglycolic acid		
	Lactomer 9-1		
Linea alba & fascia	Polydioxanone		
	Polyglyconate	1 to 3-0	Taper or Reverse cutting
	Polypropylene		
Muscles	Polyglactin 910		
	Polyglycolic acid	2-0 to 3-0	Taper
	Lactomer 9-1		
	Glycomer 631		
	Polydioxanone		
Tendons	Polyglyconate	1 to 3-0	Taper-cut
	Polypropylene		
	Poliglecaprone 25		
Hollow viscous organs	Glycomer 631		
	Polydioxanone	2-0 to 5-0	Taper
	Polyglyconate		
Parenchymal organs	Glycomer 631		
	Polydioxanone	2-0 to 5-0	Blunt
	Polyglyconate		
	Polyglactin 910		
Blood vessels (ligation)	Polyglycolic acid		
	Lactomer 9-1	0 to 4-0	Taper
	Polydioxanone		
	Polyglyconate		
Oral and Pharyngeal Cavity	Glycomer 631		
	Poliglecaprone 25		
	Polydioxanone	3-0 to 4-0	Taper
	Polyglyconate		

**Subcutaneous tissue**

Most skin sutures are removed by 14days, although skin regains only 20% of its strength by 21days postoperatively. The subdermal or immediate subcutaneous sutures therefore need to provide support beyond this time. Synthetic absorbable monofilament or multifilament suture material 2-0 to 4-0 on a taper needle is recommended.<sup>3,5,10</sup>

## Linea alba and fascia

Fascia heals relatively slow and its tensile strength is only 20% at 20 days postoperatively. A suture material that can provide long-term support is required. The majority of surgeons recommend a synthetic absorbable suture material that loses its tensile strength relatively slow (e.g. polydioxanone, polyglyconate) but non-absorbable material (e.g. polypropylene) may be indicated when delayed healing is anticipated.<sup>3-6</sup> Recommended suture size should be 1 to 3-0 on a taper or reverse cutting surgical needle.<sup>4,10</sup>

## Hollow viscous organs

Synthetic absorbable monofilament suture material 2-0 to 5-0 on a taper needle is recommended for closure of organs such as the intestine and bladder. Non-absorbable monofilament suture material may be used to repair the gastrointestinal tract when delayed healing is anticipated.<sup>2,3,10</sup>

## Parenchymal organs

Since multifilament suture material may tear through tissue and may potentiate infection, synthetic absorbable monofilament suture material 2-0 to 5-0 on a blunt needle is recommended for repair of organs such as the liver and kidney.<sup>2,3,10</sup>

## Blood vessels

Absorbable monofilament or multifilament suture material 0 to 4-0 is recommended for ligation of the majority of blood vessels. Large blood vessels may be ligated with a non-absorbable suture material such as silk or polypropylene. Repair of large blood vessels should be performed with fine-gauge polypropylene.<sup>2,3,10</sup> Anastomosis of blood vessels often is performed with 10/0 polypropylene or nylon.

## Oral and pharyngeal cavity

Current recommendation for wound closure in this confined body area (e.g. tooth extraction sites, maxillectomy, mandibulectomy, palate surgery, and tonsillectomy) is synthetic absorbable monofilament suture material 3-0 to 4-0 on a taper needle. Many surgeons also use non-absorbable monofilaments (polypropylene or nylon) whilst others utilize polyglactin 910 because of its softness and presumed decreased postoperative irritation.<sup>14</sup>

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## Conflict of interest

The author if this article has no financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

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