Choice of Suture materials in Laparoscopic and Robotic Surgery

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Introduction

Suturing and knot tying in laparoscopic and da Vinci robotic surgery constitute advanced minimally invasive surgery skills. Developing proficiency in the standard methods with needle drivers is often an arduous process because of loss of tactile feedback. In laparoscopic surgery limited tactile feedback is present but in robotic surgery tactile feedback is replaced by haptic feedback. Recent advances in laparoscopic and robotic instrumentations have allowed surgeon and gynecologists for easier methods of suturing and tying. The evolution of laparoscopic and da Vinci robotic surgery has expanded to more advanced and complex general surgery, urological and gynecological procedures. For patients to get benefit from minimal access surgery surgeons must first develop and expertise those laparoscopic surgery skills necessary for these advanced operations. Suturing and knot tying are among these advanced minimally invasive surgery skills required for many complex procedures. Developing proficiency in the standard methods of minimal access surgical suturing and knot tying with needle drivers may often be an arduous process.

Characteristics of suture material

The choice of suture is determined by a balance of the various characteristics of suture materials most appropriate for the specific wound closure situation.

Absorbable vs Non-absorbable	The major subdivision of sutures is important to understand. Sutures that lose the majority of their tensile strength within 60 days are considered absorbable suture. The absorbable sutures are degraded by tissue enzymes or hydrolysis. ▪ The absorbable sutures in laparoscopic surgery are generally used as deep sutures; they do not need to be removed post-operatively, like myomectomy or intestinal anastomosis. ▪ The non-absorbable sutures in laparoscopic surgery are used for reconstructive surgery and where it is not require manual removal of suture post-operatively, because it is not possible in minimal access surgery.
Tensile Strength	Depends on size (thickness) the Laparoscopic Surgeons prefer to use the smallest size that will provide adequate strength. It is important to have less foreign body load on the tissue. The strength increases as the first digit decreases. ▪ 3-0 is a thick strong suture used for fine surgery in laparoscopic

	surgery ▪ 6-0 is a thin comparatively weak suture used for ultrafine surgery like tubal recanalization surgery.
Plasticity and Elasticity	In laparoscopic surgery the ability to retain length and strength after stretch and the ability to regain its original length after stretch, respectively. Laparoscopic instruments are always insulting the tissue because of tactile feedback. The laparoscopic surgeon should try to respect suture as much as possible. This is important: ▪ To accommodate post-operative oedema without cutting into the tissue ▪ To maintain epidermal approximation once the oedema has resolved.
Ease of handling and Knot security	It is important for laparoscopic surgeons to keep in mind the coefficient friction of suture. Ease of handling and knot security is determined by a number of related characteristics. ▪ A suture with a low coefficient of friction generally slides through tissue well but the knot will unravel more easily. ▪ A suture with a high memory will spring back to its original position and it is difficult to use this type of suture in laparoscopic surgery. While non absorble suture like Prolene sutures tend to be strong, they may be difficult to handle and have decreased knot security. ▪ A suture with high pliability can be easily bent, and will therefore handle well in laparoscopic surgery with good knot security.
Multifilament vs Monofilament	▪ In Laparoscopic Surgery the multifilament braided sutures handle more easily and tie well, but can potentially harbour organisms between fibres leading to increased infection risk. Although in laparoscopic surgery chance of infection is less compare to open surgery because interior milieu is maintained but if possible the multifilament should be avoided in contaminated wounds. They also tend to have higher capillarity so can absorb and transfer fluid more easily increasing potential for bacteria to enter from the skin surface. ▪ Monofilament sutures have a lower infection risk and a lower coefficient of friction, but with a lower ease of handling and knot security.
Tissue reactivity	Refers to the degree of inflammatory response to the suture.

	▪ Higher for natural products such and silk and gut ▪ Lower for synthetic fibres such as nylon.

Absorbable Sutures

Surgical Gut	▪ Plain gut loses its strength in 7-10 days and is completely digested by 60 days. It is seldom used now due to poor strength and high tissue reactivity (due to proteolytic enzyme degradation rather than hydrolysis). ▪ Chromic gut has been manufactured with chromium salts to reduce enzyme digestion and therefore maintains strength for 10-14 days making it useful for mucosal closures. ▪ Fast-absorbing gut is produced by pre-heating and can be used for attaching skin grafts, or in areas of low tension where the wound is well supported by deep sutures, and suture removal would be difficult. It maintains strength for 3-5 days.
Polyglactin 910 (Vicryl®, Polysorb®)	▪ A synthetic braided co-polymer which maintains 75% strength at 2 weeks, and 50% at 3 weeks. Absorption is usually complete by 3 months. It handles well, has minimal tissue reactivity, and does not tear tissue. It may occasionally persist as a small nodule or extrude (‘spitting’).
Poliglecaprone 25 (Monocryl®)	▪ Monofilament maintaining 50-60% strength at 7 days with complete absorption by 3 months. It offers better handling and knot security than most other monofilament sutures, with even less tissue reaction than Vicryl® and is therefore useful where minimal tissue reaction is essential.
Polydioxanone (PDS II®)	▪ Monofilament polymer with prolonged tensile strength (70% at 2 weeks, 50% at 4 weeks) and may persist for more than 6 months. Good for high-tension areas or contaminated wounds, but being a monofilament it has poor handling and knot security. Its minimal tissue reaction makes it good for repair of cartilage where inflammation would lead to significant discomfort.
Polytrimethylene carbonate (Maxon®)	▪ A monofilament that combines the prolonged strength of PDS® and the good handling and knotting of Vicryl®. 80% strength at 2 weeks, 60% at 4 weeks, and complete absorption by 6 months. Minimal tissue reaction.

Glycomer 631 (Biosyn®)	▪ A monofilament similar to Monocryl® in characteristics but with prolonged strength akin to Maxon®.

Non-absorbable Sutures

Nylon (Ethilon®, Dermalon®, Surgilon®, Nurolon®, Nylene®)	▪ Inexpensive monofilament with good tensile strength, and minimal tissue reactivity. Disadvantages are its handling and knot security, but it remains one of the most popular non-absorbable sutures in dermatological surgery. Surgilon® and Nurolon® handle better but are more expensive.
Polybutester (Novafil®)	▪ A monofilament with good handling and excellent elasticity. It responds well to tissue oedema, and is also suited to subcuticular running sutures.
Polypropylene (Prolene®, Surgilene®, Surgipro®)	▪ A monofilament polymer with a very low coefficient of friction making it the suture of choice for running subcuticular stitches. It has good plasticity but limited elasticity, poor knot security, and it is relatively expensive. Favoured by some for facial repairs.
Silk (Dysilk®)	▪ Braided natural protein with unsurpassed handling, knot security, and pliability (making it ideal for mucosal surfaces and intertriginous areas) but limited by its low tensile strength, and high coefficient of friction, capillarity, and tissue reactivity.
Polyester (Dacron®, Mersilene®, Ethibond®)	▪ Braided multifilament suture with high strength, good handling, and low tissue reactivity. Ethibond is coated and has a low coefficient of friction. Pliability makes these excellent for mucosal surfaces without the reactivity of silk.
GORE-TEX® Suture	▪ GORE-TEX® Suture, is a unique, microporous, nonabsorbable monofilament made of expanded polytetrafluoroethylene (ePTFE), the same proven material used in other GORE Medical Products. This unique material offers the benefits of both monofilament and multifilament sutures with the excellent material properties of PTFE including:

Needles

The three major parts of a surgical needle are the tip (or point), the body, and the shank.

- The most common body configuration in dermatological surgery is curved, with a radius of between 1/4 and 5/8 of a circle.
- The tip is usually triangular with either conventional cutting (sharp edge on the inside arc) or reverse cutting (sharp edge on the outside arc). The more the tip is honed, the sharper and more expensive the needle.
- A reverse cutting needle provides less chance of the tissue tearing during suturing. A round needle with tapered tip is the least likely to cause tissue tearing, and is primarily used for suturing fascia, muscle, and aponeuroses in minimal access surgery.
- The body may be flattened to facilitate needle-holder grasp, and limit twisting during placement.

Alternative of port wound closure

Staples provide a quick alternative for large scalp and trunk wounds.

Surgical glue may be appropriate where there is little or no wound tension.

Wound closure tapes (e.g. Steristrips□) are often helpful to support the wound following subcuticular closure, use of surgical glue, or after removal of epidermal sutures.

Choice of suture material in laparoscopic and robotic surgery

Laparoscopic or Robotic Surgery	First Choice	Second Choice
Laparoscopic or Robotic Cholecystectomy Cystic Pedicle	(Monocryl®) or PDS (1-0) – Extracorporeal ROEDER, MELTZER OR PRETZEL Knot	Vicryl (1-0) – Extracorporeal. ROEDER, MELTZER OR PRETZEL Knot
Laparoscopic or Robotic Appendectomy	(Monocryl®) or PDS (2-0) – Extracorporeal ROEDER, MELTZER OR PRETZEL Knot or MISHRA'S Knot.	Vicryl (2-0) – Extracorporeal ROEDER, MELTZER OR PRETZEL Knot or MISHRA'S Knot.
Laparoscopic or Robotic Myomectomy Intramural layer	(Monocryl®) or PDS (1-0) – Extracorporeal MELTZER OR SQUARE Knot.	ViCryl (1-0) – Extracorporeal MELTZER OR SQUARE Knot.
Laparoscopic or Robotic Myomectomy Sub Serous layer	Vicryl (2-0) – Intracorporeal Dundee Jamming Knot Continuous suturing and Aberdeen Termination.	(Monocryl®) or PDS (2-0) – Intracorporeal Dundee Jamming Knot Continuous suturing and Aberdeen Termination.
Laparoscopic or Robotic Tubal Recanalization	Vicryl (6-0) – Intracorporeal Surgeon's Knot.	Proline (6-0) – Intracorporeal Surgeon's Knot.
Laparoscopic or Robotic Ureteric Recanalization	Vicryl (4-0) – Intracorporeal Surgeon's Knot.	(Monocryl®) or PDS (4-0) – Intracorporeal Surgeon's Knot.
Laparoscopic or Robotic Vaginal Vault Closure	(Monocryl®) or PDS (2-0) – Extracorporeal Square Knot or Weston Knot.	Vicryl (2-0) – Extracorporeal Square Knot or Weston Knot.
Laparoscopic or Robotic	Vicryl (3-0) – Intracorporeal	(Monocryl®) or PDS (3-0) –

Duodenal Perforation	Surgeon's knot or Tumble Square Knot	Intracorporeal Surgeon's Knot or Tumble Square Knot
Laparoscopic or Robotic Peritoneal Repair of Hernia	Vicryl (3-0) – Intracorporeal Dundee Jamming Knot Continuous suturing and Aberdeen Termination.	(Monocryl®) or PDS (3-0) – Intracorporeal Dundee Jamming Knot Continuous suturing and Aberdeen Termination.
Laparoscopic or Robotic Bladder Perforation Repair including repair of Vesicovaginal Fistula	Vicryl (2-0) – Intracorporeal Surgeons Knot or Dundee Jamming Knot Continuous suturing and Aberdeen Termination.	(Monocryl®) or PDS (2-0) – Intracorporeal Surgeons Knot Dundee Jamming Knot Continuous suturing and Aberdeen Termination.
Laparoscopic or Robotic Intestinal Anastomosis	Vicryl (3-0) – Intracorporeal Surgeons Knot	(Monocryl®) or PDS (3-0) – Intracorporeal Surgeons Knot
Laparoscopic or Robotic Anastomosis of vascular grafts for vascular access	GORE-TEX Suture (3-0) – Intracorporeal Surgeons Knot	Vicryl (3-0) – Intracorporeal Surgeons Knot
Laparoscopic or Robotic Sacrocolpopexy To fix the mesh to sacral promontry	GORE-TEX Suture (1-0) – Extracorporeal Square Knot or Tayside knot	Silk Suture (1-0) – Extracorporeal Square Knot or Tayside Knot
Laparoscopic or Robotic Crural Approximation in Fundoplication	GORE-TEX Suture (1-0) – Extracorporeal square knot. Intracorporeal Tumble Square Knot, Surgeons Knot or Weston knot.	Silk Suture (1-0) – Extracorporeal Intracorporeal Tumble Square Knot, Surgeons Knot or Weston knot.
Laparoscopic or Robotic Burch Suspension	GORE-TEX Suture (1-0) – Extracorporeal Square Knot or Weston Knot or Tumble Square Knot	Silk Suture (1-0) – Extracorporeal Square Knot or Weston Knot or Tumble Square Knot

Summary

On an average in laparoscopic or robotic surgery, surgeon has to select one number thicker thread than open surgery because laparoscopic instruments more injury to suture material than open surgical instrument.

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