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TRICK OF THE TRADE

Utilisation of a modified Roeder's knot in the era of minimal invasive surgery

T. S. Suhardja[1,2] · K. Buxey[1] · W. M. K. Teoh[1,2] · T. C. Nguyen[1] · H. Chouhan[1]

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Introduction

The era of minimally invasive colorectal surgery has spurred the development of novel vessel-sealing and suture devices. This is in part due to the increased technical demand of performing minimally invasive surgery. Novel technology benefits the surgeon and at times reduces operating time, but does increase the cost of the operation. We describe the application of the extracorporeal Roeder knot in advanced laparoscopic and transanal procedures, which is a highly cost effective tool to add to the minimally invasive colorectal surgeon's armamentarium.

The original Roeder's knot was first described by Hans Albert Röder in 1931 [1], and it has a 1:3:1 formula—i.e. one half hitch, three winds, and one locking hitch. Its use in laparoscopic surgery was pioneered by Semm in 1981 when the knot was tied extracorporeally to ligate a vessel before transecting it [2]. This has also allowed approximation of tissue laparoscopically, used in earlier procedures such as laparoscopic tubal ligation or laparoscopic appendicectomy [2, 3].

Modifications to the original Roeder's knot have been described due to the tendency of the original knot to slide back. These include the Melzer–Buess modification that is now commonly used in the proprietary Endoloop Ligature (Ethicon, Summerville, NJ, USA) [4] and the Sharp-modified Roeder's knot that was originally recommended for laparoscopic colposuspension [5]. In our colorectal unit we perform a modification of the classic Roeder's knot and utilise this in laparoscopic colorectal resection to provide a more secure ligation around a skeletonised vascular pedicle vessel of a thick mesentery. We find that especially in patients with inflammatory bowel disease, the thick mesentery makes ligation with a vessel-sealing device less secure. We also use this same modified Roeder's knot for the closure of mucosal defects after transanal endoscopic microsurgery (TEMS).

Technique

In laparoscopic vascular pedicle ligations, we skeletonise the pedicle and with the aid of a grasping instrument, pass an 0 polydioxanone thread through one of the working ports, encircle the vessel, and bring the suture out the same port it was passed through initially to allow for extracorporeal knot tying (Fig. 1).

Our modified Roeder's knot starts with an index loop of the standing strand around the anchoring hand (Fig. 1a, b). This is followed with two half hitches of the working strand around the standing strand (Fig. 1c, d). The end of the working strand is then passed four turns around both suture strands (Fig. 1e). Two further half hitches around the standing part in the loop is performed before passing the free end of the working strand through the index loop to secure the knot (Fig. 1f–i). The knot is then gathered together (Fig. 1j). The free end is cut to about 1 cm long. The knot is then held firmly with a laparoscopic grasper, before being advanced through the port towards the vessel, while maintaining traction on the standing strand (Fig. 1k, l). Once secured close to the vessel, further tension can be adjusted by pulling the free end of the strand using a laparoscopic needle holder against the standing strand (Fig. 1m). The stranding strand then can be cut to a centimetre. Subsequently, the more distal section of the vessel is safely ligated with a vessel-sealing device.

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✉ T. S. Suhardja
thomas_suhardja@yahoo.com

[1] Colorectal Surgery Unit, Monash Health, Dandenong Hospital, 135 David Street, Dandenong, VIC 3175, Australia

[2] Department of Surgery, School of Clinical Sciences at Monash Health, Monash University, Clayton, VIC 3168, Australia

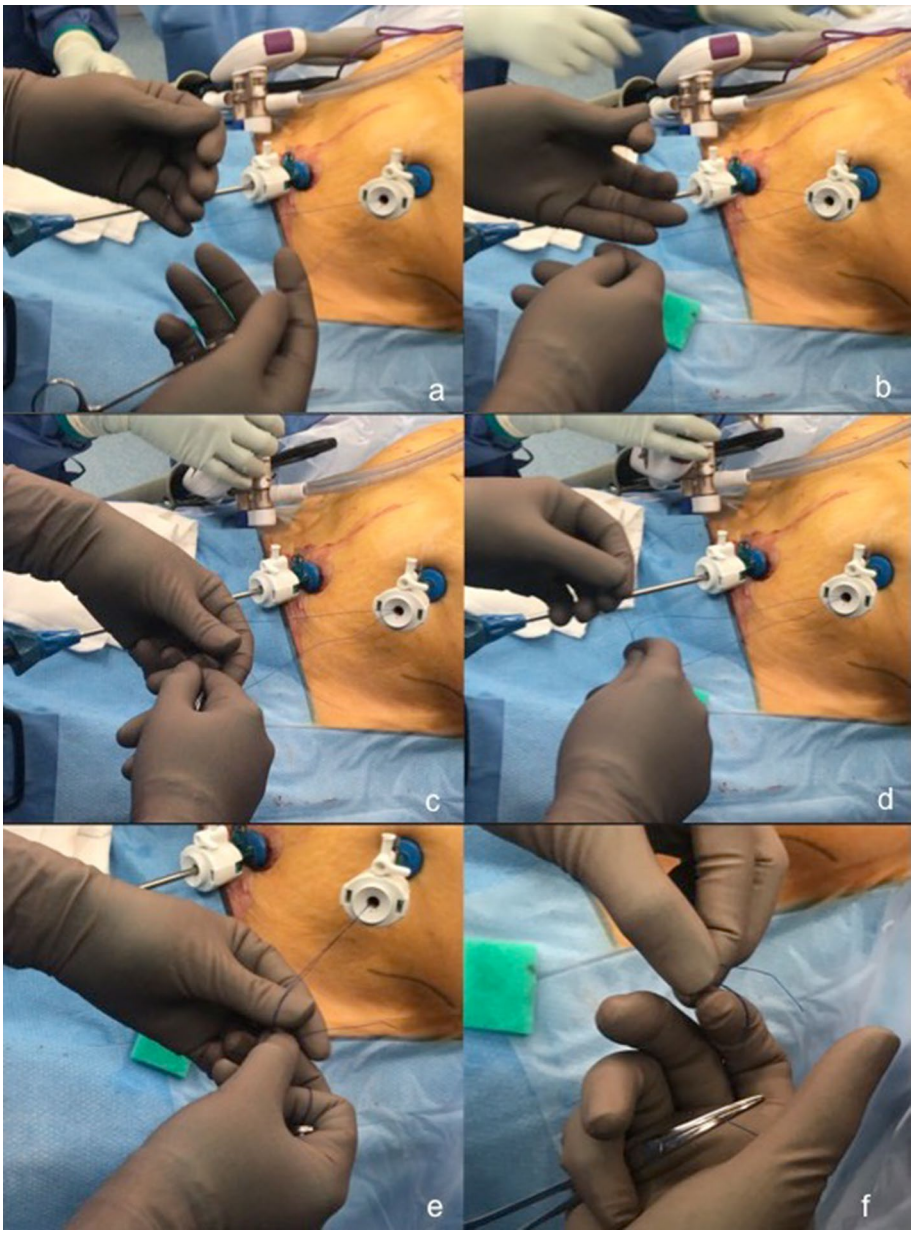


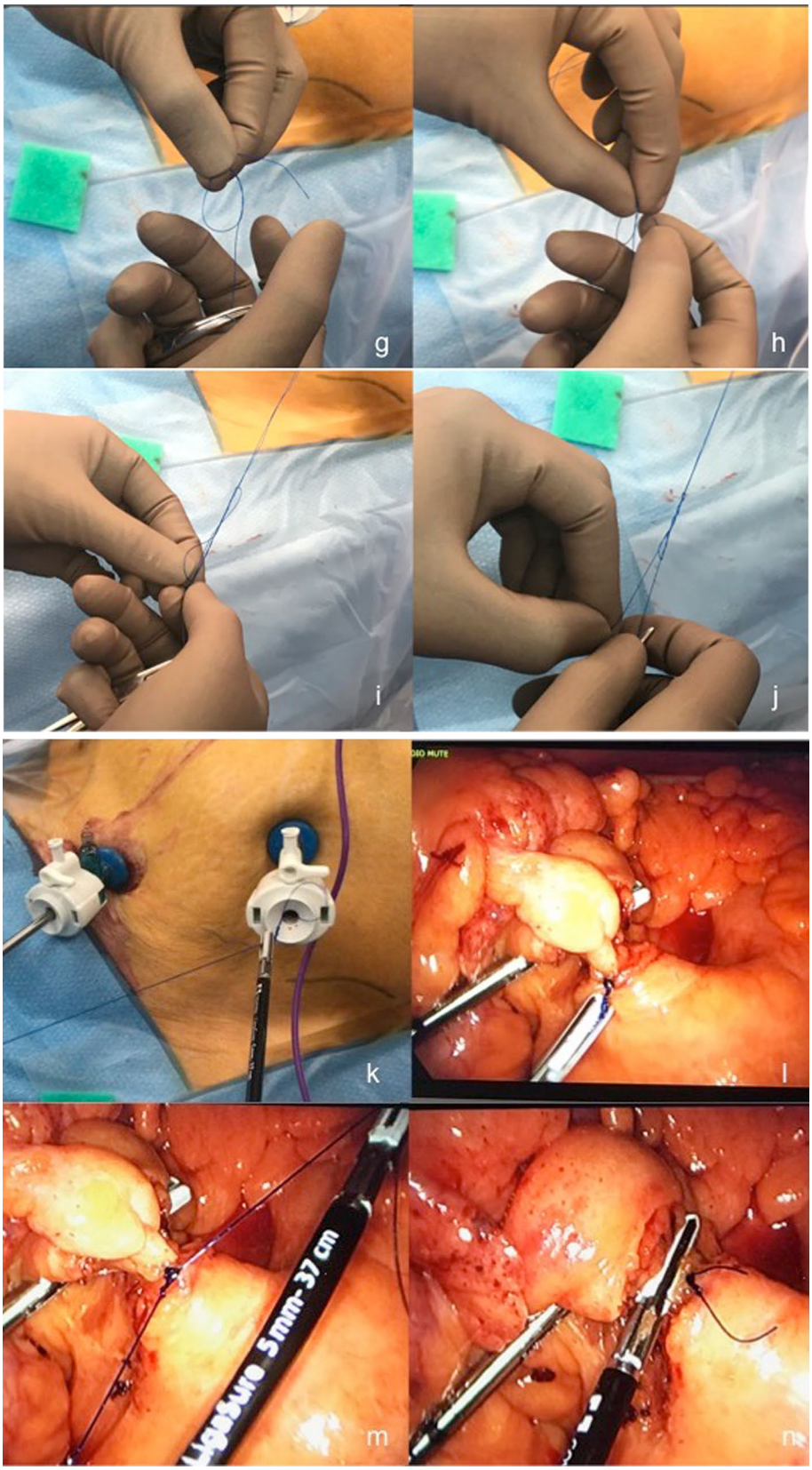
Fig. 1 **a**, **b** Our modified Roeder's knot starts with an index loop of the standing strand around the anchoring hand. **c**, **d** This is followed with two half hitches of the working strand around the standing strand. **e** The end of the working strand is then passed four turns around both suture strands. **f–i** Two further half hitches around the standing part in the loop is performed before passing the free end of the working strand through the index loop to secure the knot. **j** The knot is then gathered together. The free end is cut to about 1 cm long. **k**, **l** The knot is then held firmly with a laparoscopic grasper, before being advanced through the port towards the vessel, while maintaining traction on the standing strand. **m** Once secured close to the vessel, further tension can be adjusted by pulling the free end of the strand using a laparoscopic needle holder against the standing strand

In TEMS, we use the same modified Roeder's knot for the closure of the mucosal defect after both partial and full thickness transanal excisions (Fig. 2a). Our institution uses the Transanal Endoscopic Operation device (Karl Storz GmbH, Tüttlingen, Germany). Interrupted 3–0 polydioxanone sutures are placed individually to appose the mucosal defect, and each knot is tied extracorporeally. After placement of the needle through both sides of the mucosal defect, the needle is exteriorised through the port. The modified Roeder's knot is performed extracorporeally. In this case, a needle holder can be utilised to hold the knot firmly as it is being advanced through the port, towards the mucosa. Care should be taken not to pull on the free end prior to the knot reaching the designated spot, as this has the effect of tightening the knot prematurely. Should further tension be required after the knot has reached the mucosa, the needle holder can be used to pull on the free end to tighten the knot further. Laparoscopic scissors are then used to cut the standing strand to a centimetre. This procedure is repeated for every interrupted suture required (Fig. 2b).

Discussion

Extracorporeal knot tying used in the manner described provides a secure, reliable knot that can be made without a dedicated knot-pusher. The use of standard monofilament suture decreases the cost of the procedure. The addition of a

Fig. 1 (continued)



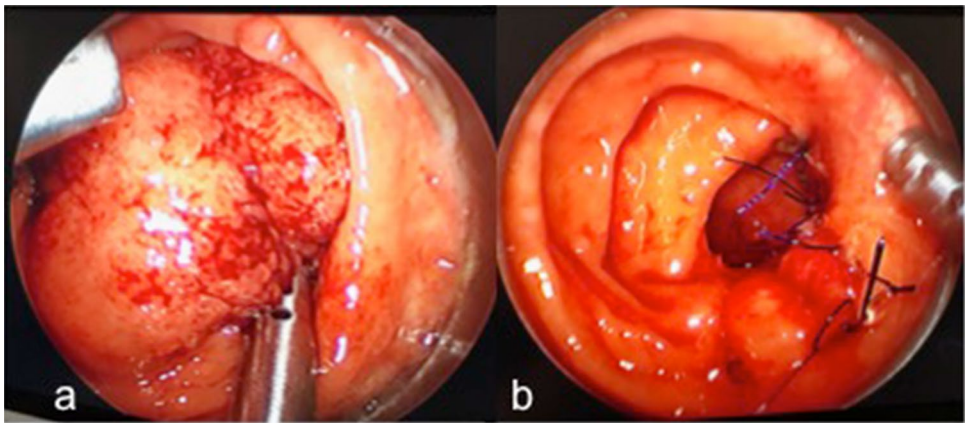


Fig. 2 **a** Our modified Roeder's knot used for the closure of mucosal defect after both partial or full thickness transanal excisions. **b** This allows the accurate placement of interrupted knots performed for closure of transanal excision mucosal defect

more proximal ligature with the modified Roeder's knot provides a more secure ligation of a thick mesentery, especially in the setting of inflammatory bowel disease. The increasing use of transanal surgery for local excision of rectal pathologies warrants the development of a reliable, safe, and cheap method of closing the resultant tissue defects to prevent local infectious complications and allow for optimal hemostasis.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This study does not contain any studies with human or animals performed by any of the authors.

Informed consent For this study, formal consent form is not required.

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