

A New Method of Laparoscopic Instrument Knot Tying

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The following is an introduction to a new intracorporeal knot-tying technique which brings the open, manual knotting method into the realm of laparoscopic surgery. This technique broadens the range of tissue approximation by suturing methods to include those that are performed at open surgery. Unique among all known knotting methods, it is performed with a multifunctional needle-holding instrument with a loop-forming spur member. The instrument includes important ergonomic features in its design and can be easily dismantled for inspection, cleaning, and sterilization by autoclave. In essence, the technique is a one-handed hand-tie action completed with two instruments where simple forward and rotation movement of the instrument mimics the role of the hooked index finger.

A needle holder, with a loop-forming spur member, has been developed to perform this technique.¹ The instrument allows completion of a half hitch, with the spur mimicking the movement of the hooked index finger, as in a one-handed hand tie at open surgery. Only forward and axial rotation movements of the instrument are needed to complete the half hitch. These two movements are readily appreciated on the video screen. This easy recognition overcomes some of the problems associated with adjustment to monocular and depth-of-vision viewing.

INSTRUMENTATION

The instrument (Fig. 1) is 47 cm long. The outer shaft is 9.5 mm in diam-

eter and narrows to a 5-mm diameter at the jaw end. The jaws (5 mm long) have a concave direction spur (6 mm high) which is attached to the mobile jaw (Fig. 2). The handle, with an enclosed lever to operate the jaws, has been ergonomically designed to allow rotation. There is a graduated ratchet lock in the handle. The instrument is multifunctional in its capacity to hold tissue to be sutured and to be used as a dissector, needle driver, and suture grasper. The bias position of the jaw and lever can be set according to operator preference. As already noted, the instrument can be dismantled for inspection, cleaning, and sterilization by autoclave techniques (Fig. 3).

For maximum efficiency, one uses paired left and right instruments where the loop-forming spur is directed clock-

wise and counterclockwise respectively. The direction of the spur promotes forward movement and therefore ease of knot tying.

METHOD

The suture is held in the jaws of the left instrument next to the needle which is in turn oriented in the direction in which it is to be passed through the tissue.

The loaded instrument is introduced through the left access port under vision. The needle is grasped in the jaws of the right instrument so that it is ready to pass through the tissue. The left instrument is released from the suture. After passage of the needle through the tissue, the short and long

ends of the suture are held by the right and left instruments respectively (Fig. 4). The right instrument is rotated over the thread held coaxially in the left. The loop-forming member of the right instrument is placed under the long thread (Fig. 5), rotated further counter-clockwise and advanced, carrying the short end beneath the long tail (Fig. 6).

The long tail is released and the left instrument transferred to grasp the tail of the short thread being held in the right instrument (Fig. 7). The right instrument is released from the short end and, with the jaws closed, is rotated out of the loop. The right instrument then clamps onto the long end of the suture. The instruments are separated to complete the half hitch (Fig. 8).

The knot is completed with the right instrument, already grasping the long

Figures 4-9. Simple square knot. Right over left, then left over right.

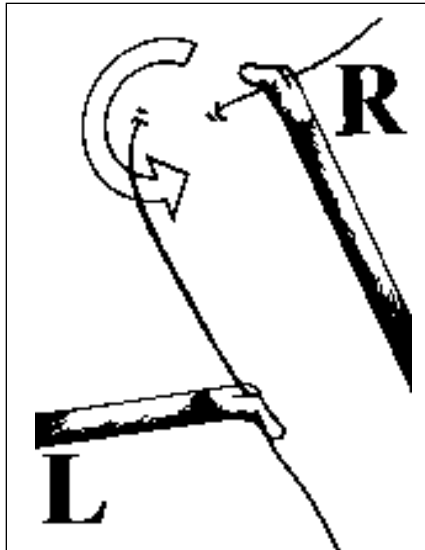


Figure 4.

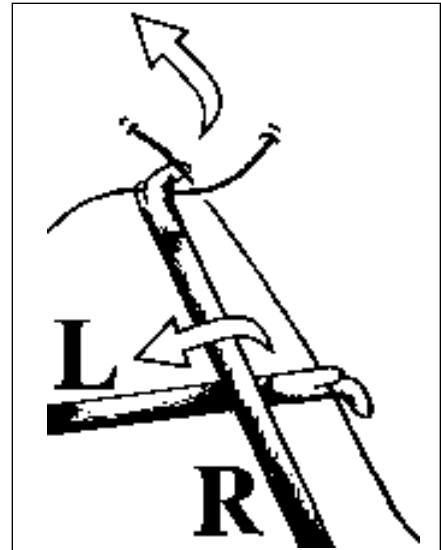


Figure 5.

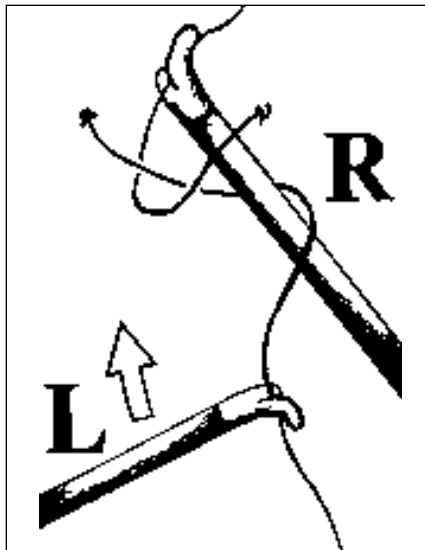


Figure 6.

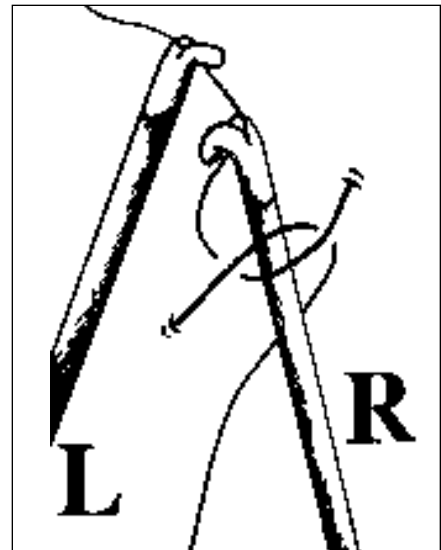


Figure 7.

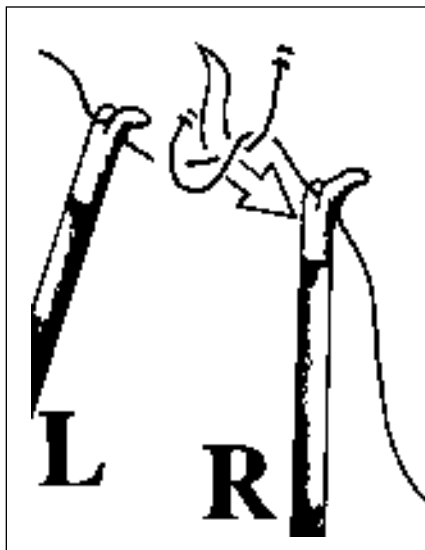


Figure 8.

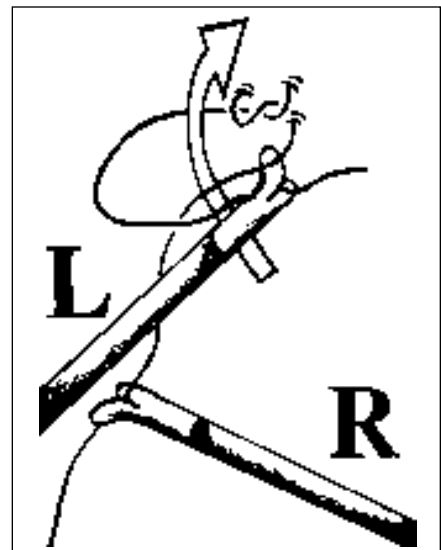


Figure 9.



Figure 1. Left: the multipurpose instrument.
 Figure 2. Center: magnified view of jaws and spur.
 Figure 3. Right: dismantled instrument.

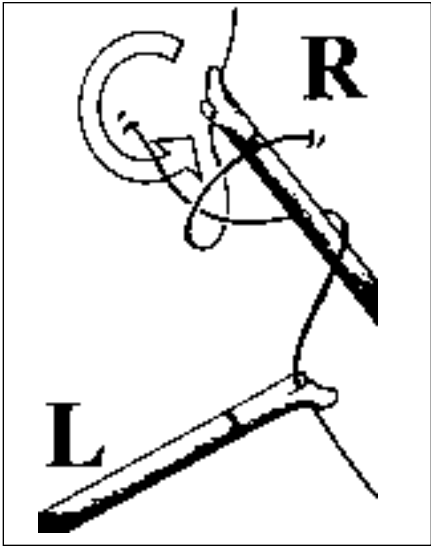


Figure 10. Surgeon's double knot (1st loop).

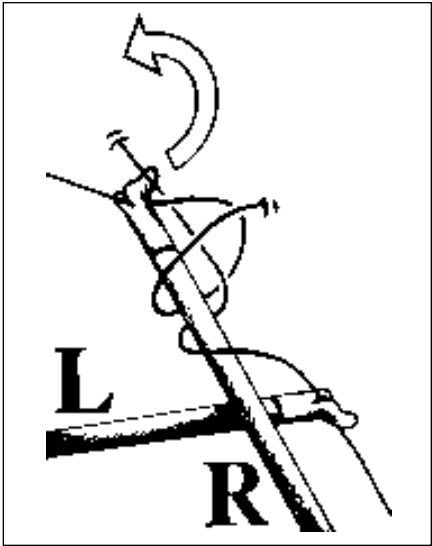


Figure 11. Surgeon's double knot (2nd loop begun).

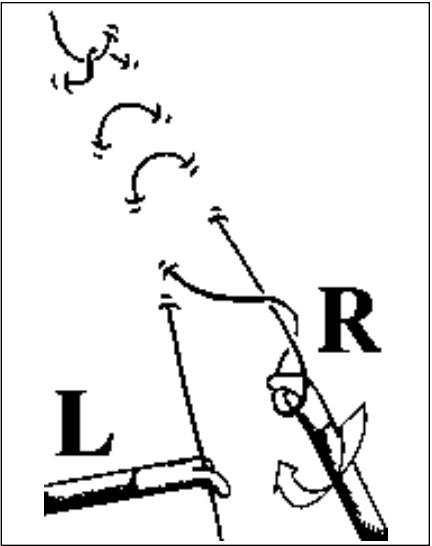


Figure 12. Continuous suture.

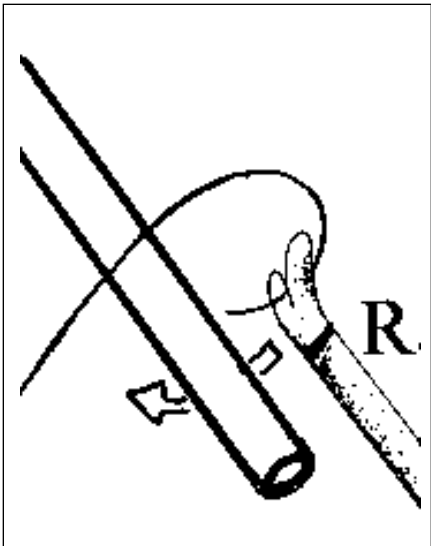


Figure 13. Passage of the needle behind the vessel.

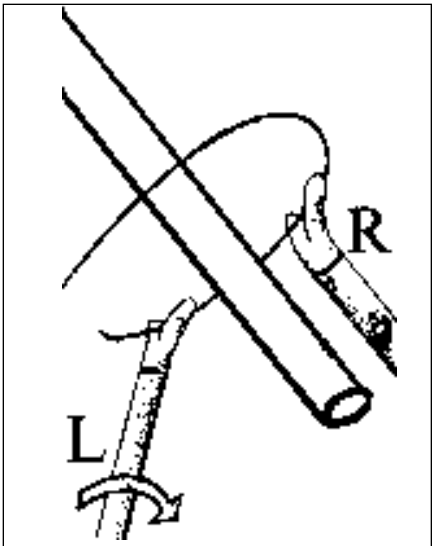


Figure 14. The needle (tip) is held in the left instrument and is released from the right.

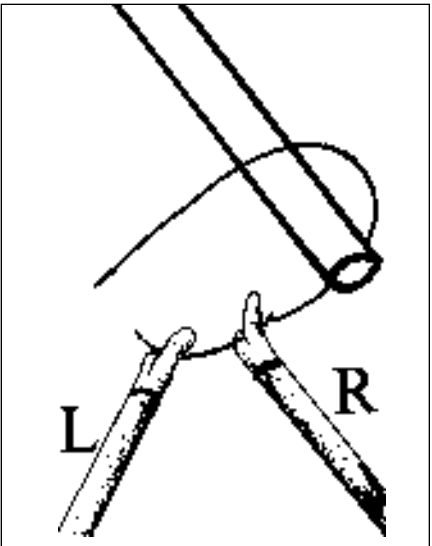


Figure 15. Transfer of the right instrument.

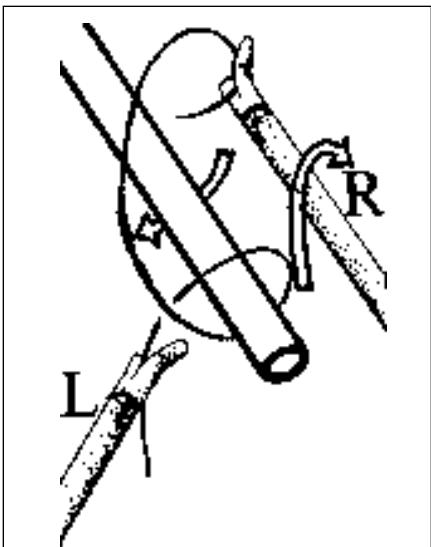


Figure 16. Clockwise rotation of the right over the thread and passage behind the vessel.

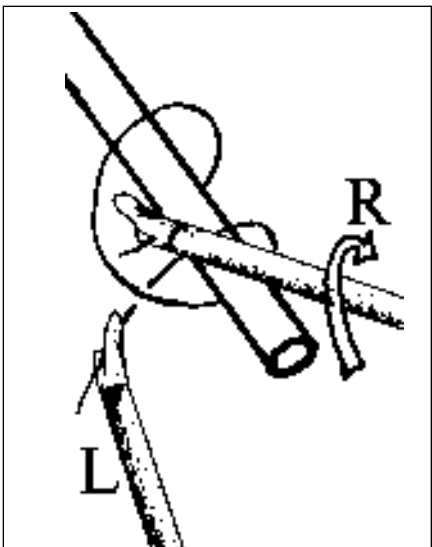


Figure 17. Transfer of the right instrument to the needle tip inside the second loop.

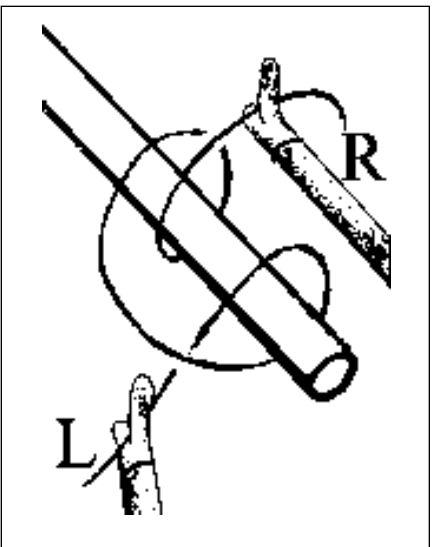


Figure 18. Clockwise rotation of the right instrument completes the clove hitch, which is tightened by instrument separation.

end of the suture which is held so that it is now coaxial with the left instrument. For the second throw, the left instrument, already holding the short thread, is rotated over the long thread, and the spur of the left instrument passes under the long thread (Fig. 9), rotated further clockwise and advanced.

The right instrument releases the long thread and is transferred to grasp the tail of the short thread (as in Figure 7 for the first throw). The short thread is released from the left instrument and with jaws closed is rotated out of the loop to then grasp the long thread (as in Figure 8). Separating the two instruments tightens the thread and completes the square knot. A third loop can be used to reinforce this knot.

Application of this new instrument and associated knot-tying techniques permits during laparoscopic surgery a full range of other knots which are performed at open surgery:

1. Surgeons' knot: a double-throw surgical half hitch is formed by a second rotation of the instrument around the long end (Figs. 10, 11). The surgical knot is completed by following the steps shown in Figures 7, 8, and 9.
2. Clove hitch plus square knot used for tying large vessels (Figs. 13-18).
3. Figure-of-8 suture.
4. Continuous suture completed with a simple square knot (Fig. 12). The last loop is held with the jaws and rotated to form a single thread; following the steps shown in Figures 4 through 9 leads to completion of the knot.

For surgeons experienced in intracorporeal laparoscopic knotting methods,² an alternative simple square knot can be performed. A combination of the standard instrument tie technique is used to establish the first loop, and subsequent throws can be completed by using this new method. A double-loop surgical half hitch can similarly be formed.

The spur allows loop formation as the instrument is rotated forward around the long end of the suture. The spur also helps to control and retain the loop(s). The jaws then grasp the short end of the suture; reverse rotation and withdrawal completes the half hitch. The short end is then rotated forward to complete the knot (Figs. 4-8).

This knotting method is very efficient in instrument movement, with only one instrument transfer required per hitch.

DISCUSSION

This method has been developed as a result of recognizing that the major difficulties in laparoscopic knot tying relate to the transfer of the standard instrument tie techniques from open surgery to the intracorporeal situation—in particular, the difficulties relating to, and limitations of, instrument movement. Studying the knotting movements in creating a half hitch for an instrument tie versus the one-handed hand tie provides the key to understanding this new instrument tie, which requires only two movements—forward

and axial rotation—needed to complete the half hitch. These two entirely different movements in forming a half hitch could be considered mirror images of each other.

In essence, the new method is a one-handed hand-tie action completed with instruments, or more accurately, a reverse, standard instrument tie.³ Workshop and laboratory trials have preceded satisfactory clinical usage of the instrument(s) and this simple technique. The method is readily appreciated at demonstration or on video viewing and is different from all other known intracorporeal knotting techniques. This new-generation instrument⁴ is multifunctional and can be used as a needle holder and tissue forceps, and the loop-forming spur member can be used as a dissector.

ACKNOWLEDGMENTS

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