

# Intracorporeal Knot-Tying and Suturing Techniques in Laparoscopic Surgery: Technical Details

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## ABSTRACT

**Background:** Intracorporeal suturing and knot-tying in laparoscopic surgery require great manual dexterity; these techniques must absolutely be mastered by every surgeon who is interested in pursuing the minimally invasive approach.

**Method:** The initial and final knot of a laparoscopic continuous suture can be accomplished in several ways and with easy technical solutions that are fully illustrated in the present study.

**Conclusion:** We think it is better to perform a continuous suture than an interrupted one. It is advisable, moreover, to use traditional suture materials (not specially created for laparoscopy) that cost less than the more sophisticated ones.

**Key Words:** Laparoscopy, Laparoscopic suture, Suturing techniques, Intracorporeal knots, Continuous suture, Preformed loops.

## INTRODUCTION

Although minimally invasive surgery reproduces the same technical phases of traditional surgery, there are still some specific differences due to the limits inherent to its method. One of the most difficult acts in laparoscopic surgery is the knot-tying and suturing technique. The knots performed laparoscopically must be as safe as the traditionally performed ones. Fundamental elements are the easiness and rapidity of execution, the tightness of the knot and its possibility of reproduction. It is important to remember that the safety of the knot depends not only on the knot itself, but also on the type of material used. For instance, any material that swells at the contact with water after having being introduced into the body theoretically increases its capacity of tying and tightening.

Therefore, knots made from catgut, dacron, polyglactin and lactomer can be considered safe, whereas ones made from PDS, silk or polyamide are less reliable.<sup>1</sup>

The tightness of an extracorporeal knot made from a 2/0 thread is the double of a 3/0 thread.

## MATERIALS AND METHODS

The initial knot of a continuous suture can be accomplished in several ways: 1) performing an intracorporeal knot with a needle holder and an assistant needle holder (in this particular case the number of knots to be performed depends on the material employed, as postulates traditional surgery); 2) creating a slipknot or a preformed loop on the distal end of the suture (having pierced the tissues with a needle, this one is pulled through the preformed loop, which, after having been tied, functions as a lock); 3) it is possible, when using an interlaced thread, to create a loop simply piercing the distal end of the suture with the needle; and 4) using special threads furnished with reabsorbable clips. The ideal length of a suture for the intracorporeal performance of a separate stitch is 10 cm, a length that makes the knot-tying maneuvers easier. In the performance of a continuous suture, the thread should be 15 cm long, thus allowing the surgeon a way to accomplish the final knot.<sup>2</sup> Even before it was commercially available, we

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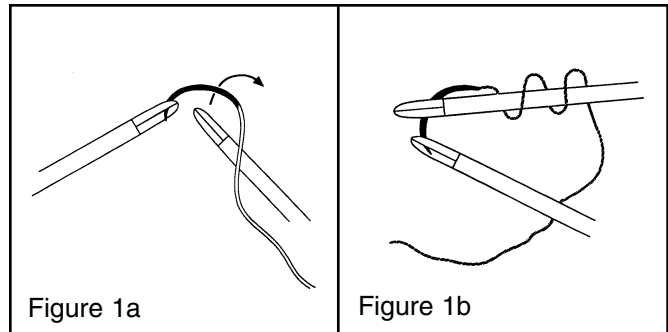
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started to use, with great satisfaction, a synthetic monofilament reabsorbable suture material, the Biosyn (Autosuture, USSC), with a 2/0 and 3/0 gauge and curved needle. We employed it for the performance of continuous anastomosis and sutures both in traditional and laparoscopic surgery, where its qualities are still more patent. This material associates the advantages of an intertwined suture (better tightness of the knot, high tension strength, quick absorption, lack of memory) with the peculiar features of a monofilament (greater smoothness, lack of capillarity, higher inertial force and minor trauma of the tissues).

The intracorporeal knot-tying technique reproduces the phases of a technique already known to traditional surgery. The fastest and easiest method, in our opinion, consists in holding the needle with its concavity bent downwards (**Figure 1a**) or, better still, toward the operating surgeon (**Figure 1b**). In this way, the curved and rigid structure of the needle allows the needle holder to act on it and makes it possible to perform quickly and simply the execution of the spyles around the needle holder. The end of the suture should not be longer than 2 cm and should be positioned, before performing the knot on the needle holder, under direct vision and in such a way that makes it easy to be grasped.<sup>3-5</sup>

To tie the knot, the needle holder drops the needle and grasps the thread close to the suture in order to close it well. A different method of performing an intracorporeal knot consists in grasping with the needle holder the suture thread 1/2 cm distal to the needle (**Figure 2a**); at this moment, one has just to rotate the instrument in order to wind the thread round the needle holder (**Figure 2b**). Then forceps are used to grasp the needle

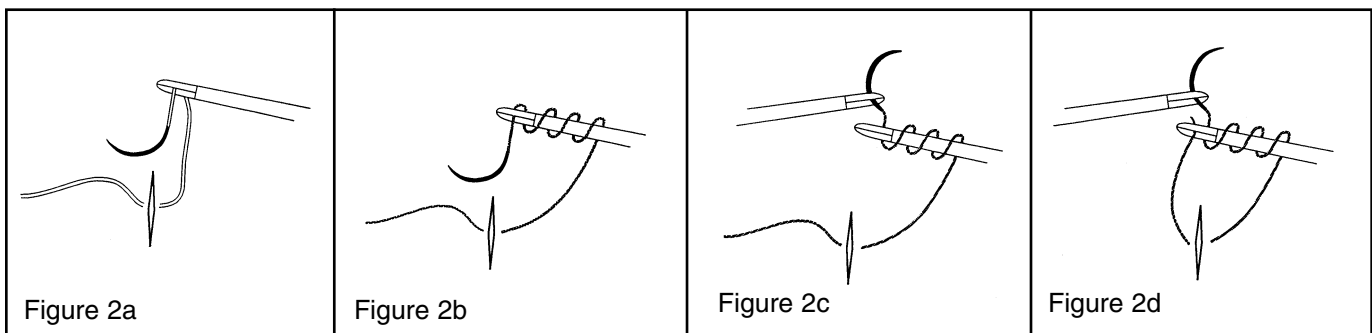


**Figure 1.** Intracorporeal knotting technique.

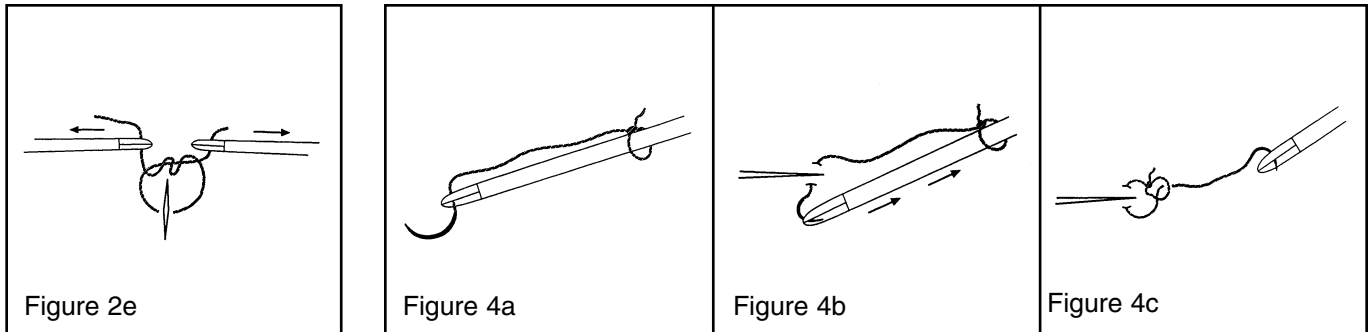
while the needle holder catches the distal end of the suture (**Figure 2c, 2d**). The knot is accomplished by pulling on both the ends (**Figure 2e**). To avoid causing any damage to the abdominal organs, it is important that the two instruments remain under the optic of the laparoscope, while the surgeon ties the knot.<sup>6</sup> The next throw is accomplished in the same way.

It is possible to perform a preformed loop in several ways:

1) Having accomplished a complete loop with the distal end of the suture around the final part of the suture thread, the distal end a is introduced into the loop c; then a and the loop b are simultaneously pulled, in order to tie the knot on the suture thread and to measure the length of the distal end that can be used as a suspension or retraction point (**Figure 3a-3d**). Now one just has to introduce the suture into the abdominal cavity. Since with this type of loop the knot slides on the suture



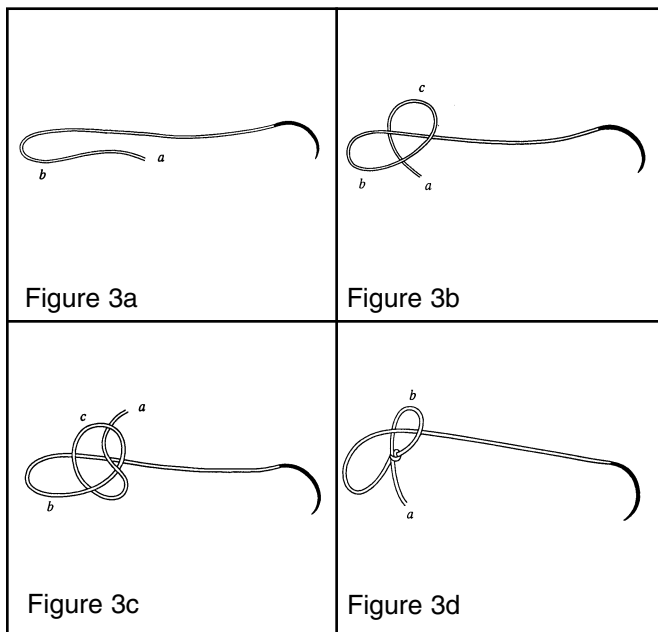
**Figure 2.** Intracorporeal knotting technique.



**Figure 4.** Extracorporeal preformed loops for continuous suturing.

thread, it is better to adopt another safety measure in order to avoid the loop's getting loose or tightening during its passage through the trocar, especially if the latter is furnished with a universal valve. To do so, it is advisable to insert the suture by introducing the rod of the needle holder into the loop and keeping the thread between the morsels of the needle holder at approximately 2 or 3 mm from the needle (**Figure 4a**). In this way the needle, being close to the assistant needle holder, can be easily grasped by the needle holder. Having pierced the two limbs that have to be sutured with the

needle, this one is grasped by the needle-holder, which is gradually withdrawn (**Figure 4b**), in such a way that allows the loop to slide on the rod of the needle-holder and to be tied creating the initial knot of the suture (**Figure 4c**). It is also possible to tie the knot by pushing the loop itself with the graspers or by applying countertraction on the distal end of suture a.

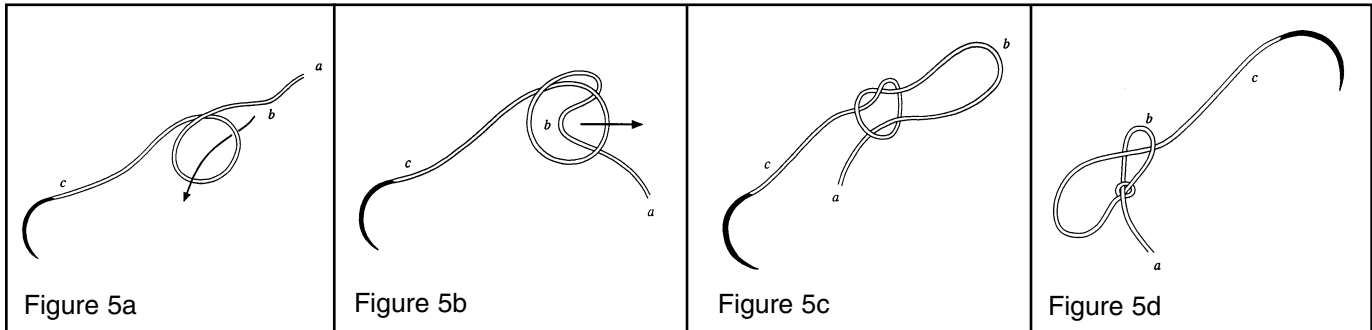


**Figure 3.** Intracorporeal knotting technique.

2) Having performed a complete loop, be it simple or double, on the distal end of the thread (**Figure 5a**), the site b is introduced inside the loop in order to generate a new loop inside the already existing one (**Figure 5b**), and then the ends of the thread a and c are retracted, keeping in countertraction the end b, which will form the height of the hole (**Figure 5c**). It is also possible to create a similar loop performing a simple or double knot near the distal tract of the suture; then the distal end of the suture a is then introduced in the preformed knot b, which is tied on it (**Figure 5d**).

In this way, the knot is not going to get loose or tied during its passage through the trocar, since the knot is fixed on the suture thread and is tied only when one pulls the distal end of the suture. It is also possible, as in the first case described above, to insert the needle holder inside the loop in order to spare a phase in performing the initial knot of the suture: the introduction of the needle into the loop, after having pierced the two limbs that have to be sutured.

3) Performing 3 or 4 windings between the distal and the medial end of the suture, the result is a loop b (**Figure 6a, 6b**) through which is pulled the suture distal end a (**Figure 6b**). This generates a new loop d, through which the distal end of the suture a is pushed



**Figure 5.** A simple way to introduce in the abdominal cavity the preformed loops for continuous suturing.

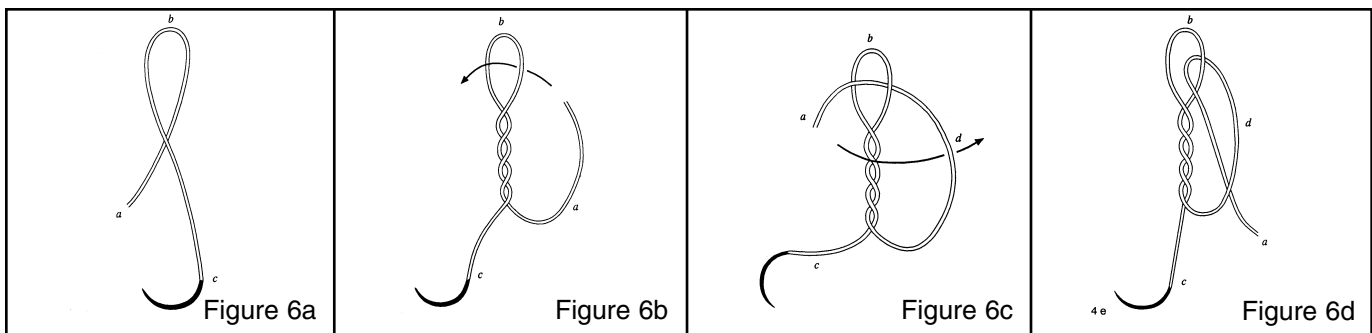
**(Figure 6c).** While in the first loop the distal end of the suture is pushed underneath, in the second one it must be pulled through the front, and vice versa.

Pulling the distal end of suture a, the knot is tied generating a slipknot. Then, after the tissues have been pierced, the needle is pulled through the slipknot, which is tied by pulling the distal end of the suture or pushing on the knot itself **(Figure 6d-6f)**.

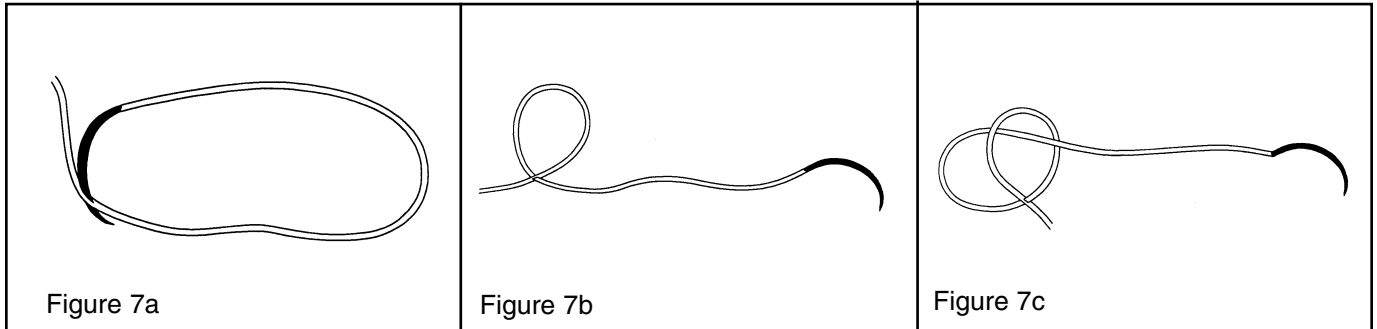
4) An easier method to accomplish a preformed loop, as quick and as safe as the other methods, is the following: When using a braided thread, a preformed loop can be created simply by piercing the distal end of the suture with the needle, exactly at its middle and at the required distance **(Figures 7a, 7b)**. Then the needle is pulled through this newly formed loop, in order to allow the tightening of the knot **(Figure 7c)**. It is, therefore, also possible to measure the length of the final part of the suture, which can also be used as a retraction or a suspension point. To avoid this loop getting loose during its passage through the trocar, it is advisable, in this case,

also, to introduce the suture inserting the rod of the needle holder into the loop, as has been previously illustrated.

5) Finally, medical companies have created several suture materials. Among those, in our opinion, one in particular is of simple and quick use: it is a thread furnished with reabsorbable terminal clips, both made from PDS **(Figure 8a)**. This product (MIC 54, Ethicon), 7 cm long, regularly used successfully by us to perform a continuous suture following ideal choledochotomy, has a terminal clip pre-anchored to the suture thread and a second one loose in its box.<sup>7</sup> The clip anchored to the suture thread functions as initial knot, while the second one is attached to the thread with special forceps when the suture is completed, performing in this way the function of a final knot **(Figure 8b)**. It is also possible to use only clips made from PDS, which are sold in special boxes; one is anchored distally to the thread one wishes to use and long as one desires, whereas the other clip is attached to the thread after the suture has been completed.



**Figure 6.** Extracorporeal preformed loops for continuous suturing.



**Figure 7.** Extracorporeal preformed loops for continuous suturing.

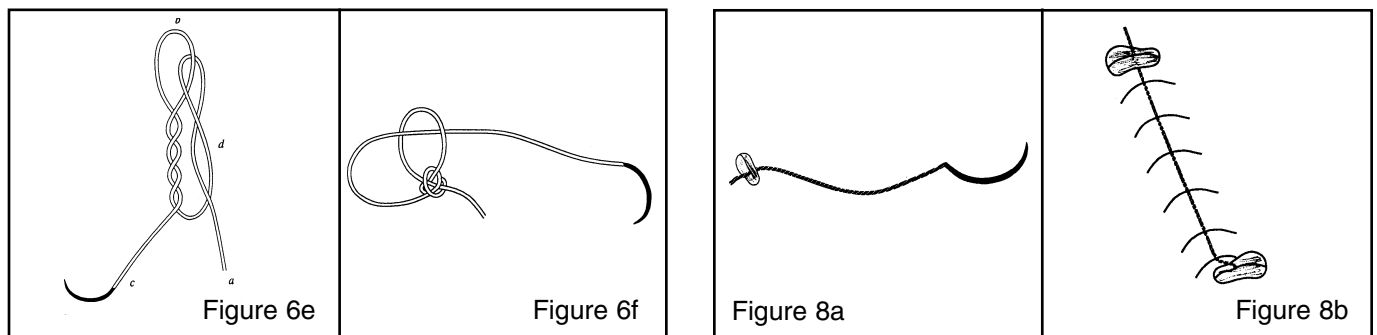
The final knot of a continuous suture can be accomplished in the traditional way of open surgery (two surgical knots in the same direction and a final one in the opposite direction), tying the final loop of the continuous suture with the end of the suture with the needle, or it is possible to recur to the “Aberdeen knot,”<sup>8</sup> in which a final knot is accomplished by creating a new loop in the already existing one. The final loop of the suture is kept loosely; then, grasping the needle with the assistant needle holder, the needle holder is inserted into the loop, and the suture thread is grasped at its middle and retracted without the grasper dropping the needle. This process generates a new loop in the already existing one, which is tied guiding the needle holder through the loop and applying countertraction between the needle holder and the assistant needle holder.

This procedure is repeated twice. Finally, the end of the suture is guided with the needle through the last generated loop, and, using retraction, the final tightening of the knot is performed. If, at the end of the suture, the thread were too short to accomplish one of the described

procedures, it would be possible to use clips (better if they are made from absorbable material), or, after performing a knot with a second thread near the final part of the suture, it would be possible to tie together the terminal end of the first suture and one of the two ends of the thread that had just been tied.

**CONCLUSION**

To perform a laparoscopic suture and to tie a knot, the surgeon must possess great manual dexterity, since the possibility of moving the instruments is reduced by the trocar sites in the abdominal wall. Performing a suture or a knot in laparoscopy without the necessary experience and practice increases the operative times. Adequate experience is reached by practicing for a long time on the simulator, before performing any operation in which these techniques are necessary. Every laparoscopic surgeon must absolutely learn these techniques. A firm hand enables the surgeon to face laparoscopically certain intraoperative situations without recurring to a laparotomy. We firmly believe that the knowledge of



**Figure 8.** Continuous suturing with the aid of PDS clips.

suturing techniques in laparoscopic surgery must be open to every surgeon who wants to follow this minimally invasive approach. Special threads, metal clips, or clips made from reabsorbable material cannot substitute traditional sutures or ligations in every situation. Moreover, the high cost of the materials specifically created for laparoscopy by the medical companies speaks in favor of these “simple” sutures performed with “ordinary” threads, the cost of which is definitely lower. Nevertheless, there is in every situation always a specific relationship between functionality and costs: it is the surgeon who, on the basis of his or her skill and good sense, has to choose the most appropriate solution.

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