Laparoscopic suture training curricula and techniques

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Abstract: With the development and ubiquitous use of minimally invasive surgery, the advanced laparoscopic skills such as suture is essential for performing gastrointestinal procedures. However, the steep learning curve and lack of standardized training make most residents underprepared for laparoscopic suture. Moreover, the current simulation-based training is inadequate for trainees to master these advanced skills. Thus, there is a need for laparoscopic suture training modeled with cognitive knowledge, approachable techniques and standardized steps. Here, we present a suture training curriculum with video demonstration. In this study, we developed a suture training curriculum, which are divided into two categories depending on its difficulty and application. Basic techniques are designed for novice to master the basic suture skills, and it also shortens the learning curve of advanced suture techniques. Advanced techniques focused on the application of suture in specific circumstances. Also, it could prepare residents for more complex procedures. In order to increase the efficacy of suture training, we recommend a learning method similar to Peyton's four-step approach, personalized video feedback and spaced learning in our curricula. This article demonstrates the various laparoscopic techniques and their applications from simple to complex, with a view to help residents in training. Also, the training curricula and recommendations will further help residents to improve efficiently. Thus, we recommend to incorporate the curricula into suture training courses and surgical programs.

Keywords: Laparoscopic suture; training techniques; laparoscopic knot

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Introduction

Due to the rapid development of laparoscopic surgery, master of laparoscopic suture techniques is essential for all the surgeons performing complex laparoscopic procedures. However, even in the developed country such as Canada, where over 87% residents had access to a skill lab that taught MIS techniques, there still exists a wide disparity between training lab and bedside, only 8% stated they would be comfortable performing advanced procedures at the end of their training (1), let alone the situations in developing countries such as China. Furthermore, despite having passed the Fundamentals of Laparoscopic Surgery (FLS) course, more than 50% surgery graduates beginning subspecialty training were considered to be unable to independently perform laparoscopic suture in the clinical environment (2). In order to increase the number of individuals who are competent to perform advanced laparoscopic suture, the authors, as a resident of an academic hospital in China, design a structured training curriculum and demonstrate its key techniques in this study.

Training and techniques description (*Figure 1*)

Instruments requirement

(I) Training box;
(II) Suture model;
(III) Tissue holder;
(IV) Laparoscopic needle holder;
(V) Laparoscopic Maryland forceps;
(VI) Laparoscopic scissors;
(VII) Gloves;
(VIII) Camera: iPad;
(IX) Suture needles.

Figure 1 Laparoscopic suture training and technique—a resident's experience (3).
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Techniques

Basic technique

Three-step needle maneuver

This maneuver could make the novices to master the needle handling technique quickly, and the novices could hold a needle at any position through this maneuver.

This technique is divided into three simple steps. First, grasp the suture 1 cm from the needle using the right-hand needle holder. The distance between needle holder and the needle could prevent needle wobbling. Then, grasp the needle at a point about one-third from the tip using the left-hand grasper, and the needle righting could be achieved by using the needle holder to gently tug on the suture so that the needle is correct positioned on the grasper. Last, when the needle is correctly positioned, hold the needle using the needle driver. Now the needle is ready for driving. In order to master the advanced skills later and improve our feedback for needle adjustment, "needle dancing" technique could be practiced as the video demonstrated.

Pre-knot training

Pre-knot could practice eye-hands coordination and get prepared for further intracorporeal knot. Besides, the pre-knot training could efficiently minimize the learning curve for other advanced knot techniques.

In order to facilitate throwing knot, place the curved sides of right-hand needle holder and left-hand grasper face to each other. First, suture is grasped with the needle side of the suture 6 cm from the tissue using the left-hand grasper, and lower the grasper near the tissue so that the suture could form a loop automatically. Then, make the double-coiled clockwise or counter-clockwise throw practice. The term clockwise or counter-clockwise refers to the tip of the needle holder related to the tip of the grasper. During the knot-throw course, the needle holder could approach the tail of the suture to improve the knot efficiency.

Surgical knot

Surgical knot is the most common and useful knot used in laparoscopic surgery. A qualified surgical knot achieves two aims: (I) it will ligate a blood vessel securely or appose tissue tightly; (II) it will resist untying, breaking, and slipping because the extra coil around the sutures in the first throw increases friction and reduces slippage.

First, like the pre-knot practice, make the double-coiled clock wise throw and grasp the suture tail using the right-hand needle holder. Then, the right-hand needle holder is now pulled caudally while the left-hand grasper is now pushed cephalad, after tighten the suture, the suture tail is placed cephalad for further throws. Finally, additional throws are added to secure the surgical knot.

Continuous "cis and trans" suture training

This training is a composite of forward/reverse needle adjustment and multiple needle driving/suture. It could be considered as the preparation of gastrointestinal anastomosis.

First, use three-step needle maneuver to hold the needle and drive it through the tissue forwardly. Second, grasp the needle tip and pull it out of the tissue using grasper, tug the suture using needle holder to place it in a reverse position, then grasp the needle and drive it through the tissue reversely. Repeated practice like this could improve the fluency of continuous suture.

Advanced technique

Slip knot

Slip knot is useful in situations where it is difficult to tighten knot under tension. Particularly, they are also very useful when tying monofilament suture, which has reduced friction compared with braided suture.

First, make one counter clockwise throw and place the suture tail cephalad without tightening it. Second, make a clockwise throw and then pull the needle side suture upward. Now, the square knot is transformed to slip knot automatically. Continue pulling the needle side suture upward until the knot is tightened. Finally, pull the two

sutures evenly to transform the slip knot to square knot, extra knots are added to strengthen it.

Multi-angle suture

However, it could not fulfill all the situations in practice when merely mastering the forward and reverse suture technique. Therefore, the multi-angle suture is developed to improve the needle handling skills for residents in training.

In this training, the resident will suture a column from four different angles: 90°, 180°, 270°, 360°. As previously shown, the 90°, 180° and 270° angles could be achieved by tugging the suture to adjust needle. Actually, based on the "needle dancing" technique we have acquired, any angle between 45° and 315° could be achieved by this technique. The most difficult angle is 360°, a two-step needle righting technique as the video shown is applied to complete the suture.

Single hand needle maneuver

In some situations, only one hand could be spared to complete the suture. For example, in the event of hemorrhaging, the application of direct pressure by one hand to control bleeding is often the first maneuver. Then the other hand is used to suture the bleeding spot to achieve hemostasis. Therefore, the technique of single hand needle maneuver is very helpful.

The mechanism of single hand needle maneuver as follows, the needle lay flat on the "soft tissue", which would facilitate to handle the needle. The needle holder is used to press the needle to make it "stand up" automatically. The needle "stand up" practice would improve proficiency. In practice, open jaws of the needle holder and use the upper jaw to press the needle until it "stand up", then close the jaws to grasp the needle. Now the needle is ready to be drive.

Single hand knot

Like the single hand needle maneuver, single hand knot might be used in some particular situations.

During the whole procedure, keep long tail thread out through the trocar for further retraction. Take the long tail thread as reference, rotate alone the long tail thread using the needle to make a slip knot. Then retract the needle cephalad and long tail thread caudally respectively to approximate the tissue. Finally, additional throws are added to secure the knot.

"Finger" anastomosis training

The "finger" anastomosis is the last suture training, also it is the most technique demanding training. This training highly simulated the procedure of gastrointestinal anastomosis. It could not only train the skill of suture and knot, but also improve the capability of exposure and hands coordination.

The anastomosis is achieved by 15–18 interrupted suture. Every stitch is secured by 4–5 throws of knots. After a batch of practice, it will take less than 1 minute to complete one stitch and its knots. Therefore, this training will dramatically shorten the learning curve of laparoscopic anastomosis.

Discussion

Surgical training has traditionally been one of apprenticeship, where the surgical trainee learns to perform surgery under the supervision of a trained surgeon. With the advent and development of laparoscopic technique, an increasing number of surgeries are being done laparoscopically. However, laparoscopic training is different from open surgery because the increased requirement for hand-eye coordination, indirect visualization, manual dexterity and so on, therefore, surgical trainees always faced a long and steep learning curve (4), which further made them lacking of procedure exposure. In order to solve these problems, video-box training, as a cost-effective training, was applied a few years ago. This box model training has demonstrated to improve technical skills compared to no training in trainees with no previous laparoscopic experience in a Cochrane database study (4). Nowadays, more and more complex laparoscopic procedures, such as liver, biliary and pancreatic surgery, could be performed laparoscopically. Master advanced laparoscopic suturing skills has become the prerequisite for residents to access to these advanced laparoscopic surgeries. Current training curricula focus on basic laparoscopic skill learning such as the FLS. Therefore, there are still a lot of training gaps for acquiring laparoscopic suture techniques (5). Specialized and well-designed suture training curricula are needed.

In this study, we developed a suture training curriculum, which are divided into two categories depending on its difficulty and application. Basic techniques, including three-step needle maneuver, pre-knot training, surgical knot and continuous "cis and trans" suture, is designed for novice to master the basic suture skills, and it also shortens the learning curve of advanced suture techniques (6). Advanced techniques, including slip knot, multi-angle suture, single hand needle maneuver, single hand knot and "finger" anastomosis, more

focused on the application of suture in specific circumstances. Also, it could prepare residents for more complex procedures. In order to increase the efficacy of suture training, we recommend a learning method similar to Peyton's four-step approach in our curricula (7). This method consists of four major aspects: (I) demonstration: trainee observes a specific procedure with normal pace to form a general impression quickly; (II) deconstruction: trainee repeatedly observe every detailed action in a specific procedure to master how it works; (III) comprehension: with the help of the description and comments, trainee could understand why it works; (IV) performance: trainee has to practice it repeatedly to achieve proficiency. In addition, there are also some other recommendations for laparoscopic training. A latest research (8) from Mayo clinic demonstrated that personalized video feedback could efficiently improves laparoscopic knot-tying performance and perceived workload, which recommend novice to record and analyze the manipulations during their learning curve. Another study (9) indicated that the spaced learning, based on the repeated temporal patterns of highly condensed laparoscopic training for creating long-term memories, is very suitable for complex motor skill acquisition like laparoscopic suture and knot tying.

In summary, this article demonstrates the various laparoscopic techniques and their applications from simple to complex, with a view to help residents in training. Also, the training curricula and recommendations will further help residents to improve efficiently. It is very likely that the learned skills are transferrable into a clinical setting and will translate into improved laparoscopic performance in the operating room. Thus, we recommend to incorporate the curricula into suture training courses and surgical programs.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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