

Extracorporeal instrument knotting technique for minimal access thoracic surgery

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Abstract: Knot-tying technique is essential for surgery. We described here a novel instrument knotting technique that is simple, safe and useful in minithoracotomy. This technique was used on 14 consecutive patients that underwent selective minithoracotomy during the past half year. Both knot security and loop security could be easily achieved with this technique. No unraveling or dislodgement of the knot was noted. This method is simple, convenient and reliable to achieve secure flat square knots in limited, deep operating spaces. Its clinical advantages render it as a promising knot-tying technique that can be routinely used in a variety of thoracic surgery.

Keywords: Minimal invasive surgery; lung; thoracoscopy/video-assisted thoracoscopic surgery (VATS); thoracotomy

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Introduction

In minithoracotomy procedure, the limited incision and the rigid chest wall results in deep and remote surgical sites which makes it impossible to tie knots conveniently by hand (1). Here we described a new knotting technique for minithoracotomy using common right-angled or curved haemostatic forceps without a specialized knot-pusher.

Operative techniques

Common right-angled or curved haemostatic forceps was used in this technique. The forceps was hold in right hand and the two ends of the suture were held extracorporeally by left hand, with one end being held between the thumb and index finger and the other between the ring and little finger (*Figure 1A*). A half-hitch was made similarly to the conventional instrument knot-tying method, with the strand of the little finger side twisting around the tip of the forceps in clockwise direction to form a single loop and the other end of the suture being grasped and pulled through the loop by the forceps (*Figure 1B*). Then the holding sites of the two suture ends by left hand were exchanged with the strand

gripped by forceps to be held between the ring and the little finger, and the other between the thumb and index finger (*Figure 1C,D*). The knot was thrown onto the desired site using the tip of the forceps with the stand sliding through the grooves of the inner surface of the forceps jaws (*Figure 1E*). During the throwing, the other strand of the suture was held under tension by the index finger of left hand. Finally, the loop was tightened with two sides of the suture that were being pulled by the forceps and the left index finger with equal tension in opposite direction (*Figure 1F*). While tightening the loop, the forceps may grasp the suture gently as required to impose a proper tension upon the suture. The first knot was thus completed.

The second half-hitch was made with the strand twisting in counter-clockwise direction around the tip of the forceps to achieve a flat square knot. Additional knots can be easily placed as required with the strand twisting around the forceps in opposite direction of each other for a series of throws.

The knot can be easily transformed into a surgeon's knot by the strand twisting around the forceps in two circles during the first half-hitch to obviate loosening of the knot loop.

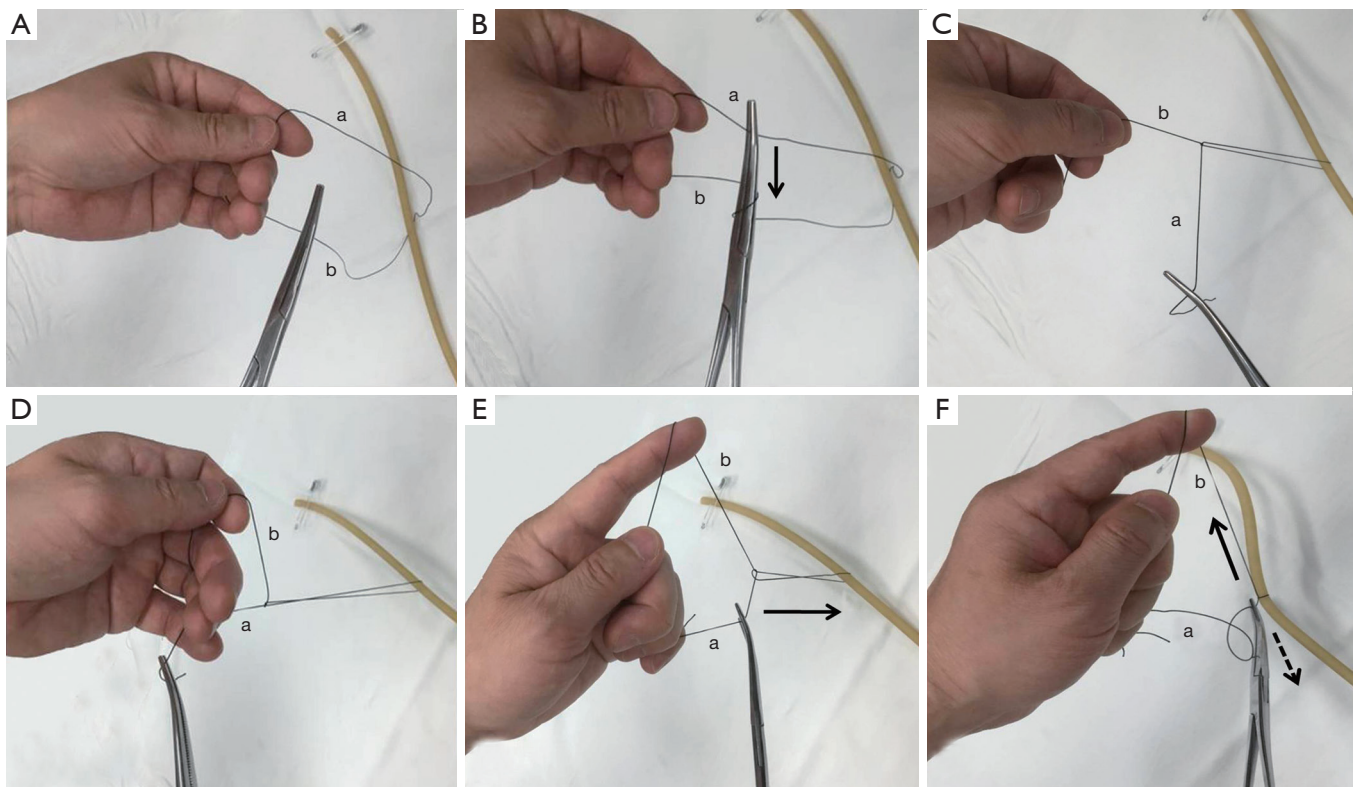


Figure 1 Extracorporeal instrument knot-tying procedure. (A) The two ends (strand “a” and “b”) of the suture were hold with left hand and the forceps in the right hand; (B) the strand “b” was twisted around the forceps in clockwise direction to form a single loop and the strand “a” was grasped and pulled through the loop of the strand “b” with the forceps (the arrow); (C,D) the holding sites of the two suture ends by left hand were exchanged with each other; (E) the knot was thrown (the arrow) using the forceps with the strand “a” sliding through the grooves of the inner surface of the forceps; (F) the loop was tightened by the forceps and the left index finger with equal tension in opposite direction (the solid and dashed arrow). With step (E) and (F), the knot can also be pushed down along strand “b” using the forceps and the loop thus can be tightened by the forceps and the left little finger.

If it is not convenient for the forceps to throw the knot down along the strand of the little finger side in some cases, the knot can also be thrown intracorporeally along the other strand and the loop thus is tightened by the forceps and the left little finger.

This novel technique was used in 14 consecutive patients who underwent elective minithoracotomy with or without video-assisted during the past half year. They include two esophagectomies, ten anatomic pulmonary resections and two other procedures. Nearly 100 ligations were achieved utilizing this skill. In addition to the most commonly used non-absorbable silk sutures, the absorbable braided sutures and monofilament sutures were also used with little trouble. We commonly tied a surgeon’s knot with the monofilament suture and several extra throws were added to optimize both knot security and loop security because of its lower friction

coefficient and higher degree of memory. No unraveling or dislodgement of the knot was noted.

The Ethics Committee at First Hospital of Tsinghua University approved the clinical application of this technique. The informed consent from all patients was signed individually before surgery.

Comment

Knot-tying is an essential technique to achieve reliable vessel ligation, proper tissue approximation and improve the final surgical outcomes. Surgeons should strive to tie the most secure knot, and the knot method should be simple, convenient and time-saving with minimum bulk to reduce tissue reaction.

In minithoracotomy with or without video-assisted, it is

almost impossible to tie knots properly and securely by hand because of the limited access and the depth of the operated field. Tying knots intracorporeally, just as in laparoscopic surgery, needs more patience and time (2). In comparison, it is comfortable for the surgeon to tie a knot extracorporeally and then push the knot to the desired site intracorporeally.

For most of the various extracorporeal knot-tying technique described previously, special instrument such as knot-pusher or sliding knots with large bulk was involved (1,3). We have attempted to tie knots extracorporeally and throw the knots down to the deep site using a right-angled or curved haemostatic forceps just as Bo *et al.* described (4), however, it is not easy for a right-handed surgeon to tie a single hand knot with his left hand. Meanwhile, it is not uncommon that the first half-hitch loosens due to the improper tension of the suture while tying the second one.

With the present technique described here, a modification of routine instrument knot-tying method is used to tie the knots extracorporeally. It is easy for the surgeons to master. The learning curve is short; in fact, the junior thoracic surgeons in our center found no difficulties in following the steps of this new technique after introducing the method to them. It seldom results in the first half-hitch loosening while tying the second one because of the string free of tension during knot-tying. A surgeon's knot can be achieved easily by twisting the string one more circle around the tip of the forceps to insure the security of the knot. The knot is pushed with the forceps down to the desired site, and then the suture is grasped by the forceps to tighten the knot, that is different from the specialized knot-pusher and makes the knot much more secure. With this technique, both the knot security and loop security can be guaranteed. Furthermore, the right-angled or curved haemostatic forceps is a very useful instrument in minithoracotomy surgery. This makes the present technique time-saving, efficient and convenient.

In addition to silk sutures, absorbable braided sutures such as Vicryl (Ethicon, Somerville, NJ, USA) can also be used with this novel technique without any difficulties. As for the monofilament sutures, the knot can also be achieved with ease using this novel technique after practice. Considering that scratch marker of the sutures may be caused by improperly clamping, which may decrease its smoothness and tensile strength, we prefer to recommend the trainee to use this technique after plenty of practice or use a specialized knot-pusher to throw the knot if possible (5).

An automatic knot-tying and cutting device named Cor-Knot (LSI Solutions, Victor, New York, USA) has been introduced into minimally invasive mitral valve surgery in

recent years (6). It was reported that the knots secured with the Cor-Knot device were stronger, more consistent and faster than with manual tied knots. Maybe, the automatic knot-tying device is the future of minimal invasive surgery, but the technique of manual tied knots for deep surgical sites as described here will continue to play an important role for a long time.

In conclusion, the present novel technique is simple, convenient, and reliable to tie flat square knots in limited, remote and deep operating spaces. Its clinical advantages render it as a promising knot-tying technique that can be routinely used in a variety of thoracic surgery including minithoracotomy, video-assisted thoracic surgery and traditional thoracotomy.

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Footnote

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

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