

# YS knot: A new technique for a tension-controlled slip knot using a trocar

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The Yoon Soon (YS) knot is a laparoscopic extracorporeal slip knot that is easy to learn and apply. Our new technique, which uses the trocar as a knot pusher, is simpler, faster, and has more tension than conventional knot methods. The YS knot will help surgeons save operative time and perform tension-controlled knot-tying during laparoscopic surgery.

**Keywords:** Knot; Knot pusher; Laparoscopy; Surgical instruments; Tension

## Introduction

The recent advances in laparoscopic techniques have made it possible to extend the operative field beyond the limits considered unreachable in the past. However, suturing and knot-tying via laparoscopy has been an obstacle because of the high technical requirements and limited space during laparoscopic surgery. The extracorporeal slip knot was a solution to this obstacle, with the convenience of creating a knot and the ease of controlling the tension between the approximated tissue and the knot. We designed a novel technique for an extracorporeal slip knot via laparoscopy with the use of a disposable trocar, the merits of which are cost-effectiveness, and the ease with which the technique could be learned and applied. We have named this knot technique the Yoon Soon (YS) knot after the first name of the knot creator.

This report shows the feasibility and safety of the YS knot that has been applied to suturing and hemostasis for gynecologic surgeries with massive bleeding.

## Materials and methods

From January 2006, the YS knot was designed to perform uterine repair after myomectomy and vaginal cuff closure after simple or radical hysterectomy via laparoscopy in the Department of Gynecology at Kyungpook National University Hospital in Daegu, Korea (Fig. 1). The rebleeding caused by knot slippage or knot rupture was checked by the closed drains, which were placed at

cul-de-sac or each side of the pelvic lymph node dissection and brought out separately through the lower anterior abdominal wall of all the patients. The rupture of YS knot in vaginal cuff was checked by a vaginal speculum when performing vaginal dressing postoperatively.

The YS knot is a modification of the Gea knot, which can be performed significantly faster than the Roeder knot regarded as the origin of the laparoscopic sliding knot [1,2]. The YS knot consists of double hitches, one wind, and one locking hitch. The YS knot does not use novel equipment, rather the YS knot requires an 11-mm disposable trocar as a knot pusher. The YS knot is created with a synthetic, absorbable monofilament suture, the features of which are good knot sliding, high tensile strength, and satisfactory knot security due to the smooth and rigid characteristics of the surface.

After being introduced into the abdominal cavity through the trocar, the needle is stitched through the two edges of the tissue and

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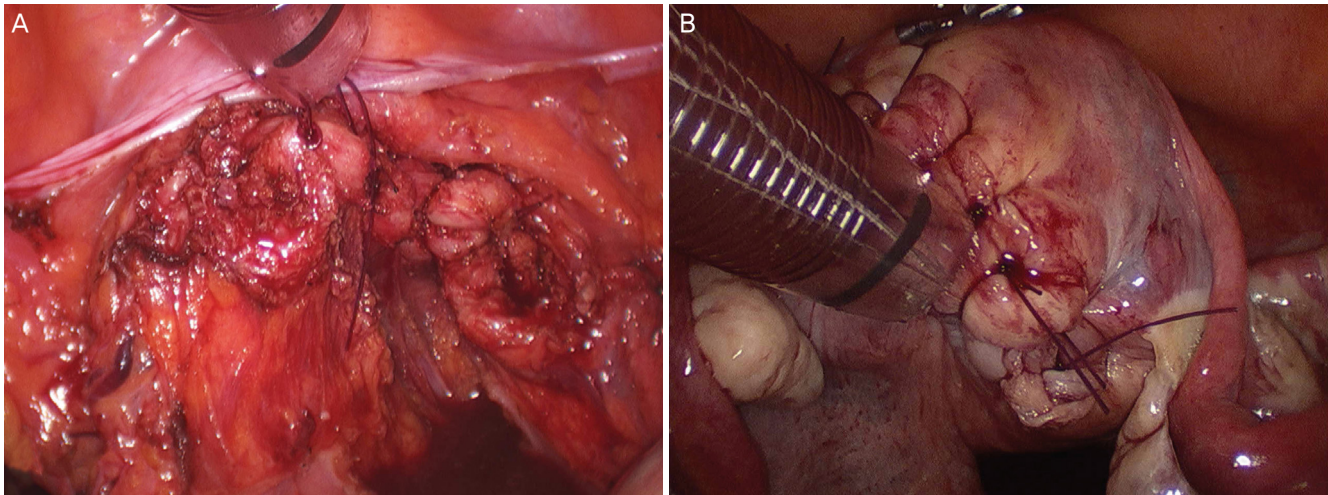
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**Fig. 1.** The YS (Yoon Soon) knot has mainly been used for vaginal cuff closure after simple or radical hysterectomy (A) and uterine repair after myomectomy (B).

withdrawn through the trocar. The thread end without the needle (wrapping strand, white strand in Fig. 2) is held with the dominant hand, while holding the thread end with the needle (axon strand, brown strand in Fig. 2) with the non-dominant hand. The axon strand is located anteriorly. The overhand throw of the wrapping strand is made over the axon strand with the dominant hand twice (two hitches, Fig. 2A). The overhand throw of the wrapping strand is made over both strands with a mosquito or Kelly forceps once (one wind, Fig. 2B). A locking hitch is made by passing the end of the wrapping strand through the last loop with a mosquito or Kelly forceps once (one locking hitch, Fig. 2C).

The knot which is created is slipped into the trocar by a mosquito or Kelly forceps as deeply as possible. The trocar tip grasps the knot, while the trocar is withdrawn. We use the trocar tip instead of a knot pusher. The trocar tip advances the knot over the axon strand and locates the knot in close proximity to the stitched tissue (Fig. 2D). No tension is transmitted to the stitched tissue during these steps of the procedure. The knot is tightly fixed by retraction of the axon strand while holding the trocar tip up at the knot (Fig. 2E). The tension of the knot can be controlled by the extent of pulling the axon strand with tactile impression transmitted via the axon strand. Additional hitches are not required if the YS knot is tightened with precision.

The YS knot has been applied to uterine repair after myomectomy (302 cases) or adenomyomectomy (23 cases) or subtotal hysterectomy (25 cases), and vaginal cuff closure after simple (501 cases) or radical hysterectomy (87 cases) via laparoscopy from January 2006 to December 2009. A knot rupture or rebleeding has not occurred at the YS knot-tying sites in vaginal cuff and uterine repairs, with the exception of one case involving vaginal

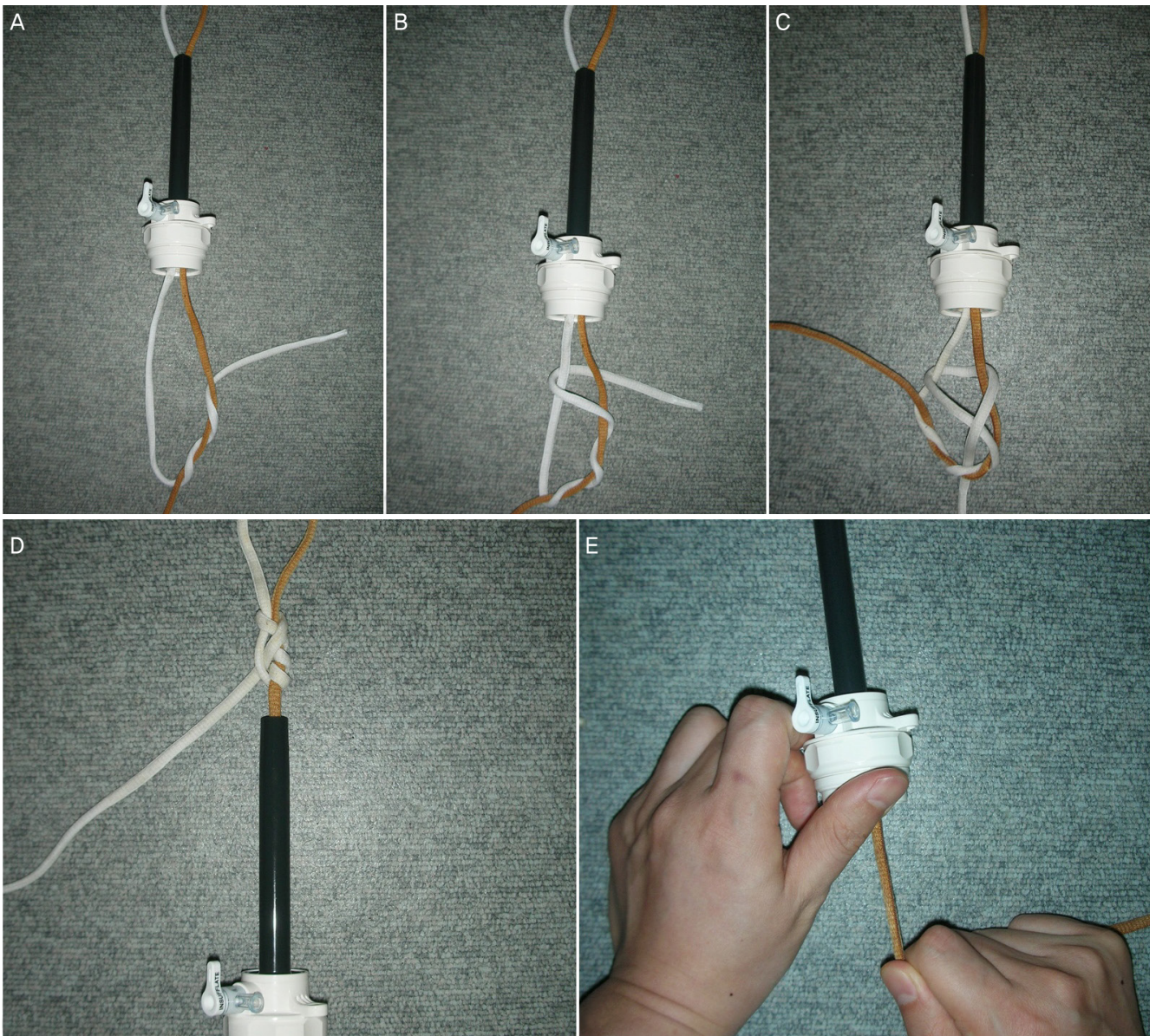
evisceration due to vaginal cuff dehiscence which developed 7 months after a radical hysterectomy [3].

## Discussion

The Roeder knot cannot be applied to tissue approximation where a continuous tension is needed, because it has unstable knot security [1,4,5]. A Gea knot is a good alternative to a Roeder knot because the Gea knot can be performed significantly faster and is more resistant against rupture and slippage than the Roeder knot [1].

Despite the modification of the Gea knot, the YS knot is superior to the Gea knot for the following reasons. The YS knot consists of one locking hitch instead of the two locking hitches of the Gea knot. Although a simpler knot configuration has a potential loss in knot and loop security [5], good knot sliding and fast knot formation trumps such shortcomings. The YS knot is less expensive than the Gea knot because the YS knot does not require a knot pusher. Consecutive knot formation with the YS knot is faster than the Gea knot because the YS knot does not require insertion and withdrawal of the knot pusher. The time of knot elaboration is calculated from extracorporeal formation until the knot was set down on the tissue to be intracorporeally approximated. The mean time of the YS knot is 15 seconds, while the mean time of the Gea knot is 19 seconds [1]. The tension of the knot can be controlled by the extent of pulling the axon strand with tactile impression transmitted via the axon strand. These merits of the YS knot are beneficial in





**Fig. 2.** Steps of the YS (Yoon Soon) knot. (A) The brown strand is the axon strand. The overhand throw of the wrapping strand is made over the axon strand with the dominant hand twice (two hitches). (B) The overhand throw of the wrapping strand is made over both strands with a mosquito or Kelly forceps once (one wind). (C) A locking hitch is made by passing the end of the wrapping strand through the last loop with a mosquito or Kelly forceps once (one locking hitch). (D) The trocar tip advances the knot over the axon strand and locates the knot in close proximity to the stitched tissue. (E) The knot is tightly fixed by retraction of the axon strand while holding the trocar tip up at the knot.

achieving hemostasis in touch tissues with massive bleeding.

One case experienced delayed dehiscence of vaginal cuff dehiscence after a radical hysterectomy. However, this complication may have arisen from thermal injury of the vaginal cuff mucosa during vaginal cuff hemostasis using electrocoagulation and less vascularity after radical hysterectomy rather than the YS knot itself [3]. Thus, knot security of the YS knot can be assured clinically.

Because most Korean women are neither obese nor tall, there have been few concerns whether or not the length of the trocar was sufficiently long to reach the knot which needs to be secured. However, if the trocar tip does not reach the YS knot-tying site in obese or tall patients, a decreased pneumoperitoneum after CO<sub>2</sub> gas is vented via the trocar is a possible solution to decrease the length between the trocar tip and the YS knot-tying site.

The YS knot with a multifilament suture has unstable knot security and rough knot sliding, which results in premature tightening of the sliding knot and delayed knot-tying. A laparoscopic grasper advances the non-sliding knot over the axon strand and locates it in close proximity to the stitched tissue.

In conclusion, the YS knot is not only easy to learn and apply, but also feasible and safe in suturing and hemostasis of thick tissue with massive bleeding which requires rapid bleeding control and tension-controlled knot-tying. The use of the YS knot can be extended to general surgeries.

## Conflict of interest

No potential conflict of interest relevant to this article was reported.

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