

USE OF TITANIUM KNOT PLACEMENT DEVICE (TK-5) TO SECURE DORSAL VEIN COMPLEX DURING LAPAROSCOPIC RADICAL PROSTATECTOMY AND CYSTOPROSTATECTOMY

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ABSTRACT

Introduction. We evaluated the feasibility and describe the surgical technique of using the Ti-Knot device TK-5 to secure the dorsal vein complex (DVC) during 20 consecutive cases of laparoscopic radical prostatectomy and cystoprostatectomy.

Technical Considerations. Bloodless DVC ligation and transection was successfully achieved in 19 (95.03%) of 20 cases. In only 1 case, venous bleeding occurred after DVC transection. However, in this case, the two stitches used to ligate the DVC were tightly tied, and the bleeding probably occurred because the stitches were passed too superficially on the DVC. In another case, a third stitch had to be placed and tied with the aid of the Ti-Knot device because the second 2-0 Vicryl stitch placed at the DVC broke. In only 1 case did we experience some degree of trouble with the knotting process because one of the ends of the Vicryl suture slipped back into the abdominal cavity. The time to tie each suture with the Ti-Knot device, defined after the moment the needle was passed underneath the DVC to the moment the titanium knot was crimped and the Vicryl suture trimmed, was less than 1 minute (median 50 seconds, range 45 to 56) in all cases, except the case described above. No cases of the Ti-Knot device misfiring or malfunction occurred in this series.

Conclusions. In our experience, the Ti-Knot titanium knot placement device proved to be safe and efficient during laparoscopic ligation and control of the DVC. UROLOGY 67: 190–194, 2006. © 2006 Elsevier Inc.

During retropubic radical prostatectomy, absolute control of venous bleeding from the dorsal vein complex (DVC) is mandatory so that the remainder of the procedure can be performed in a bloodless field.¹ To achieve this ideal hemostasis, the DVC is usually suture ligated before its transection with the aid of a right-angle clamp that is blindly passed underneath the DVC to control it with a tie.² Despite careful technique, the average blood loss during open radical retropubic prosta-

tectomy is 1000 mL, and hemorrhage from venous structures remains the most common intraoperative problem of this intricate procedure.¹

Conversely, during the laparoscopic counterpart, precise placement of the DVC stitch is performed under clear and enhanced laparoscopic visualization. In addition, the tamponading effect of the 15 mm Hg pressure carbon dioxide pneumoperitoneum significantly decreases venous bleeding, which has been consistently reported to range from 322.5 to 488 mL in experienced hands.^{2,3} Nevertheless, the laparoscopic approach adds another layer of complexity to the task of tying a secure knot during DVC ligation because of such issues as diminished mechanical feedback, difficult manipulation of the suture, a smaller range of motion, and the absence of normal binocular vision.⁴ Therefore, laparoscopic DVC ligation may pose a challenge, especially for the novice laparoscopist, and venous bleeding may occur when the DVC stitch is loosened.

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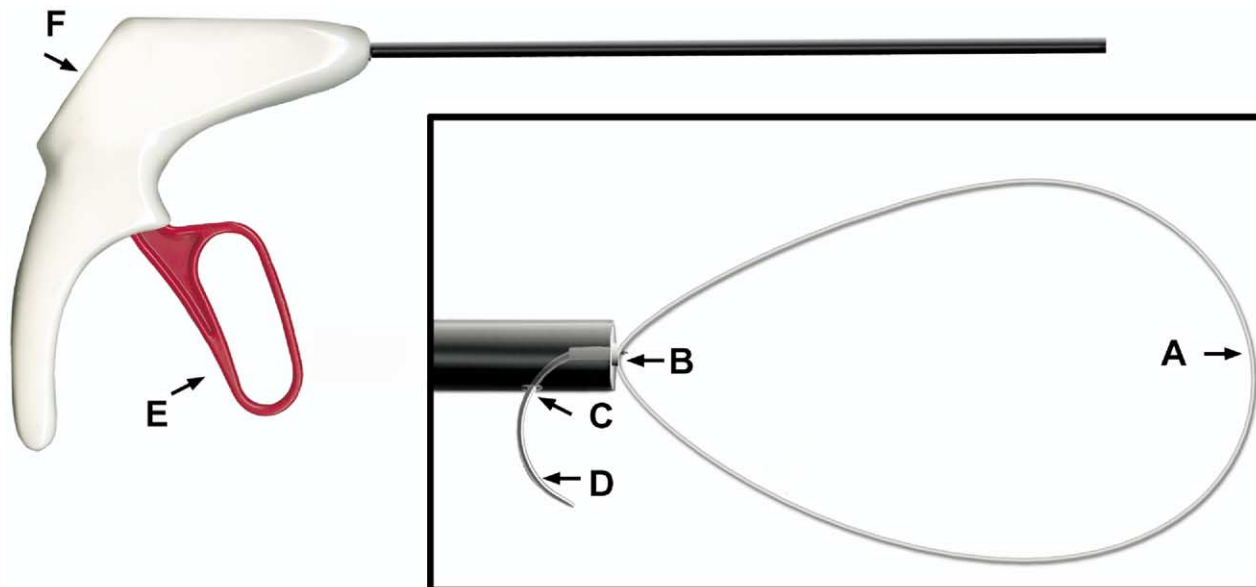


FIGURE 1. TK-5 Quick load Unit and TK-5 device: A, wire snare; B, titanium knot; C, suture hole; D, curved handle; E, red lever; F, TK-5 device.

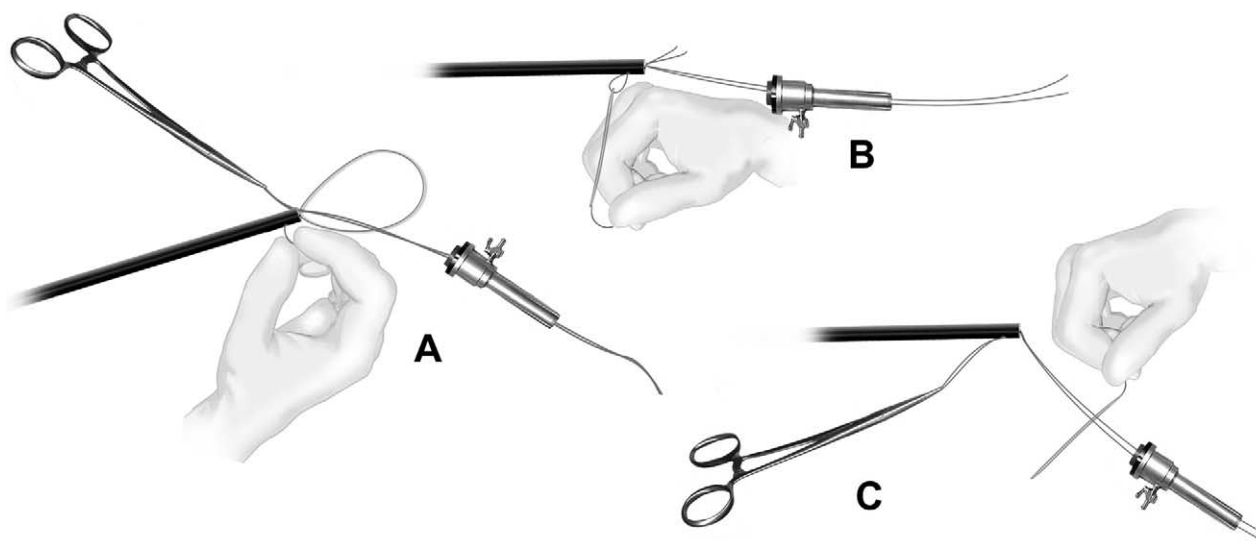


FIGURE 2. How to engage 2-0 Vicryl suture to TK-5 device.

In an attempt to overcome the difficulty of knot tying during DVC control, we have evaluated the feasibility and results of using the Ti-Knot device (TK-5, LSI Solutions, Victor, NY) to fasten and secure the DVC expeditiously and safely during laparoscopic radical prostatectomy (LRP) and laparoscopic radical cystoprostatectomy (LRC).

MATERIAL AND METHODS

From August 2004 to April 2005, we used the Ti-Knot device to secure the DVC in 20 consecutive laparoscopic cases including 15 LRPs and 5 LRCs. Of the 20 cases, 18 (13 LRPs and 5 LRCs) were performed by one of us (S.C.A.) with some prior experience with LRP and 2 (2 LRPs) were performed by another of us (M.R.) with no prior experience with LRP. All LRP and LRC cases were performed using the transperitoneal

approach, as described in detail elsewhere.^{2,3,5,6} We briefly describe the LRP technique, highlighting the relevant surgical steps related to DVC control that are similar during LRP and LRC.

After circumferential mobilization of the bladder, control of the superficial dorsal vein, and exposure of the puboprostatic ligaments and the endopelvic fascia on either side, the prostate is retracted tautly, and the endopelvic fascia is bilaterally incised distally up to the lateral-most puboprostatic ligament, which is not divided. Subsequently, the Foley catheter is replaced by an 18F metallic urethral sound, and, to avoid inadvertent transgression of the urethra by the needle and suture, the assistant pushes down the metallic sound, displacing the urethra posteriorly. A 70-cm-long, 2-0 Vicryl stitch with a CT-1 needle is placed in a backhand manner from the right to the left side, distal to the prostatic apex, between the DVC and the urethra. The needle is then grasped on the left side of the prostatic apex and retrieved outside the abdominal cavity through the right-hand working port. Extracorporeally, the

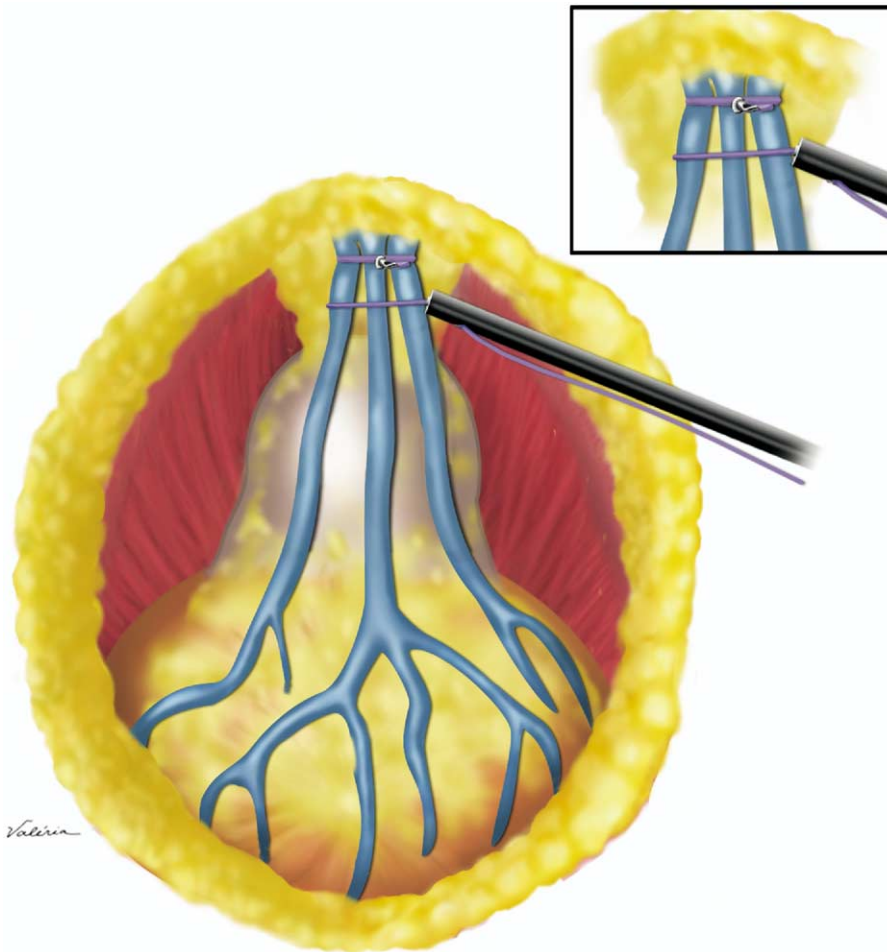


FIGURE 3. *Second knot applied to DVC to secure it reliably.*

needle is detached from the suture and both ends are passed through the wire snare of the TK-5 Quick load Unit, which is already engaged to the Ti-Knot device (Fig. 1). The curved handle of the TK-5 Quick load Unit is rotated out of the suture hole at the tip of the Ti-Knot device. Subsequently, the wire snare and the 2-0 Vicryl suture are completely pulled out of the tip of the Ti-Knot device (Fig. 2). The ends of the suture are grasped with a Kelly clamp to pull the slack from the suture. The Ti-Knot device is then advanced over the taut suture back into the abdominal cavity through the right-hand working port. Intracorporeally, the surgeon further advances the Ti-Knot device with one hand to the vicinity of the DVC, thus apposing its tip against the tissue that will be ligated. Subsequently, the surgeon applied tension on the Vicryl suture by pulling the Kelly clamp cephalad with the other hand, thus snugging down the DVC. The red lever of the Ti-Knot device is squeezed, thus simultaneously crimping the titanium knot and trimming the Vicryl suture. The excess suture is pulled away, the red lever is pushed forward to release the titanium knot, and the instrument is removed from the trocar and reloaded. The entire process is repeated again because we routinely place two stitches across the DVC in an attempt to achieve safe ligation (Fig. 3). Next, the anterior and posterior bladder neck are divided, the vas deferens and seminal vesicles are dissected, and the neurovascular bundles are released. At this point, a laparoscopic Allis clamp is used to grasp the transected base of the prostate with significant cephalad traction, placing the urethra and DVC on stretch. Subsequently, J-hook electrocautery is used to divide the DVC meticulously along the curvature of the apex of the prostate.

RESULTS

Bloodless DVC ligation and transection was successfully achieved in 19 (95.0%) of 20 cases. Only in 1 patient (patient 9 in this series) did venous bleeding occur after DVC transection. However, in that case, the two stitches used to ligate the DVC were tightly tied. Therefore, we believe that the bleeding resulted because both stitches were passed too superficially on the DVC, and hence did not completely control all the venous structures in the Santorini plexus. Nonetheless, the degree of hemorrhage coming from the DVC was not significant, and it was readily controlled by placing another stitch (2-0 Vicryl, CT-1 needle) around the transected dorsal vein, which was tied conventionally with laparoscopic needle holders. In another case (patient 1 in this series), a third stitch had to be placed and tied with the aid of the Ti-Knot device because the second 2-0 Vicryl stitch placed at the DVC broke before full crimping. This perhaps occurred because we applied excessive tension to the suture during this first case. In only 1 case did we experience some degree of trouble with the knotting process. In that case, after the needle was

retrieved outside the abdominal cavity and detached from the Vicryl suture, one of the suture ends slipped back into the trocar, thus precluding its passage through the snare. To overcome this, the end of the suture that remained outside the abdomen was gradually pulled until the other end came out of the trocar's shaft into the abdominal cavity. Next, a laparoscopic clamp was inserted through the right-hand working port, the end of the suture was grasped and retrieved outside the body through this same port, and the Ti-Knot was applied. The time to tie each suture with the Ti-Knot device, defined after the moment that the needle was passed underneath the DVC to the moment the titanium knot was crimped and the Vicryl suture trimmed, was less than 1 minute in all cases (median 50 seconds, range 45 to 56) except in the case described above. No cases of the Ti-Knot device misfiring or malfunction occurred in this series.

COMMENT

Suturing and knot tying are basic skills for surgeons. However, performing these tasks laparoscopically can be a tedious, time-consuming endeavor associated with much frustration. This difficulty is largely related to the restricted working space, limited degree of freedom, and hand-eye coordination problems resulting from disconnection between the visual and motor axes of the operator.⁷ Supporting this, Crosthwaite and colleagues⁸ reported that intracorporeal knot tying task efficiency of experienced surgeons decreased about 50% when the exercise was performed under an endoscopic view compared with direct vision. Also, Pattaras and colleagues⁹ reported times of more than 5 minutes to securely tie a laparoscopic knot of five half-hitches, which would not be tolerated in open surgery. Furthermore, laparoscopically formed knots may be weaker than those tied by hand and can have a slippage rate of up to 44%.^{10,11}

In an attempt to facilitate laparoscopic suture and knot tying, needle drivers and knot tying devices have been created. In this study, we evaluated the feasibility of using the TK-5 titanium knot placement device to secure the DVC during LRP and LRC. This device applies a reliable and strong titanium knot to fasten the DVC stitch together mechanically, which was illustrated in our study by the 95.0% successful ligation rate of the DVC, resulting in virtually no bleeding in 19 of 20 cases on its transection. Moreover, this device allows for an expeditious knot tying process, with 97.5% of the knots (40 of 41) tied in less than 1 minute in our study. Notwithstanding that the DVC can be reliably secured with knots applied with conventional laparoscopic needle drivers, this would certainly require meticulous technique and practice.

In particular, because the first half knot on the DVC stitch usually needs to be double or triple looped, thus increasing the contact surface and friction of the treads and allowing the holding force of the initial half knot to be just enough to maintain the DVC structures tightly together while the subsequent half knots are tied. The latter involves rolling the suture material two to three times around the needle driver, requiring a degree of expertise and concentration.⁴ In contrast, the TK-5 titanium knot placement device facilitates exquisite finger-tip tension of the suture, allowing adequate apposition of the vascular structures. This was illustrated in the study of Joseph and colleagues¹² that demonstrated that the Ti-Knot device is capable of occluding the renal arteries to pressures that exceed 800 mm Hg with no leak, equivalent to standard hand ties under supraphysiologic conditions.¹²

Three caveats are worth highlighting. First, before actually firing the titanium knot, it is crucial to relax the urethral metallic sound fully, avoiding any posterior displacement of the urethra, which could result in a loose stitch. Second, if bleeding occurred during DVC transection, the tamponade effect of the carbon dioxide pneumoperitoneum usually minimizes the degree of hemorrhage, allowing placement of another stitch around the transected dorsal vein. Third, after the DVC structures (closure site) are pulled together, only mild to moderate tension is needed to maintain appropriate tissue apposition during knot crimping. Thus, the suture tension should be minimized during squeezing of the red lever to avoid the suture breaking, similar to what we observed during our initial case.

Concerns related to the use of nonabsorbable materials, such as placement of the titanium knot close to the urethra, might not be an issue. This is because the actual suture used to secure the DVC is made of absorbable material and the titanium knot is positioned away from the inner surface of the urethra, which is separated from the titanium knot by the bulk of the squeezed DVC. Moreover, in the rare event that the titanium knot actually migrates into the urethra, it is very likely that it would be removed endoscopically or would be easily eliminated by the urinary stream. Furthermore, because of its corrosive resistant nature, low toxicity, and excellent tissue and fluid biocompatibility, titanium has been safely used in a variety of urologic ablative and reconstructive procedures, including bladder cuff resection during laparoscopic nephroureterectomy, laparoscopic pelvioplasty, and open and laparoscopic neobladder construction.¹³⁻¹⁶ The endoscopic gastrointestinal anastomosis stapler, which delivers multiple titanium staples, has already been used for ligation, division, and sta-

pling of the DVC during open retropubic radical prostatectomy, as described by Gould and Borer in 1996.¹⁷ Moreover, in 3 of 5 patients who underwent LRC, cystoscopy was performed in the second postoperative month (to remove the double-J stents) without any signs of TK-5 knot protrusion into the urethra.

Finally, although we believe that the TK-5 knot actually helps with the DVC knot-tying task, precise placement of the DVC stitch is paramount to achieve safe ligation of the venous complex. Moreover, one (especially the novice laparoscopist) should not underestimate the value of practicing to secure the DVC safely using free-hand suturing and knot tying techniques exclusively. The additional costs related to the use of this disposable device were not evaluated in this study, but could certainly preclude the widespread use of it.

CONCLUSIONS

In our experience, the TK-5 titanium knot placement device proved to be safe and efficient during laparoscopic ligation and control of the DVC. DVC knotting was an easy and rapid task using the TK-5 knot-tying device. We believe that less experienced surgeons and surgeons in training would benefit the most from the use of this device.

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