Bidirectional barbed suture for bladder neck reconstruction, posterior reconstruction and vesicourethral anastomosis during robot-assisted radical prostatectomy

R. Valero a, b, *, O. Schatloff a, S. Chauhan a, Y. HwiKo a, c, A. Sivaraman a, R.F. Coelho a, d, K.J. Palmer a, b, H. Davila b, V.R. Patel a

a Instituto de Robótica Global, Hospital Celebration Health de Florida, Celebration, FL, USA
b Servicio de Urología, Hospital Universitario de Caracas, Universidad Central de Venezuela, Caracas, Venezuela
c Departamento de Urología, Facultad de Medicina de la Universidad de Corea, Seúl, Republic of Korea
d Servicio de Urología, Hospital das Clínicas de la Facultade de Medicina de la Universidad de São Paulo, Hospital Israelita Albert Einstein, São Paulo, Brazil

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KEYWORDS
Barbed suture; Robot assisted radical prostatectomy; Knotless tissue-closure device; Urethrovessical anastomosis

Abstract
Background: The urethrovessical anastomosis is a particular challenging step of robot assisted radical prostatectomy (RARP). Failure to achieve a watertight anastomosis is associated with postoperative urinary leak and its consequences, which include paralytic ileus, prolonged catheterization, urinary peritonitis and possibly re-intervention. The bidirectional barbed suture is a new technology that may lead to improve the quality of the urethrovessical anastomosis.

Objective: To present our surgical technique of urethrovessical anastomosis, bladder neck reconstruction and posterior reconstruction, using a bidirectional barbed suture.

Material and methods: The bladder neck reconstruction, posterior reconstruction and vesicourethral anastomosis were performed using a 2-0 synthetic absorbable bidirectional monofilament barbed suture.

Results: All cases were finished successfully without major complication or conversion to laparoscopic or open surgery.

Conclusion: The authors successfully modified their RARP technique to take advantage of the properties of the bidirectional barbed suture. Comparative studies that evaluate objective outcomes such as leakage rates and operative time are needed to definitely establish the benefits of this device in comparison to the traditional absorbable monofilament.

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* Corresponding author.
E-mail address: raivalero@gmail.com (R. Valero).

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Sutura barbada bidireccional para la reconstrucción del cuello vesical, la reconstrucción posterior y la anastomosis vesicouretral durante la prostatectomía radical asistida por robot

Resumen

Antecedentes: La anastomosis uretrovesical es un paso exigente de la prostatectomía radical asistida por robot (PRAR). La imposibilidad de lograr una anastomosis hermética se asocia con la pérdida urinaria postoperatoria y sus consecuencias, que incluyen el ileo paralítico, la cateterización prolongada, la peritonitis urinaria y posiblemente la reintervención. La sutura barbada bidireccional es una tecnología nueva que puede llegar a mejorar la calidad de la anastomosis uretrovesical.

Objetivo: Presentar nuestra técnica quirúrgica de la anastomosis uretrovesical, la reconstrucción del cuello vesical y la reconstrucción posterior utilizando una sutura barbada bidireccional.

Materiales y métodos: La reconstrucción del cuello vesical, la reconstrucción posterior y la anastomosis vesicouretral se realizaron con una sutura barbada monofilamento bidireccional absorbible sintético 2-0.

Resultados: Todos los casos se completaron con éxito, sin complicaciones graves o conversiones a cirugía laparoscópica o abierta.

Conclusión: Los autores cambiamos con éxito la técnica PRAR para aprovechar las propiedades de la sutura barbada bidireccional. Estudios comparativos que evalúen los resultados objetivos, como el índice de pérdida y el tiempo de la operación, son necesarios para establecer definitivamente los beneficios de este dispositivo en comparación con el monofilamento absorbible tradicional.

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Introduction

Robot assisted radical prostatectomy (RARP) was first performed in Germany,¹ and has rapidly become popular among surgeons and patients.² Urethrovesical anastomosis is a challenging step in RARP. Failure to achieve a watertight anastomosis is directly related to urinary leakage and its consequences, such as paralytic ileus and urinary peritonitis. In addition, there is evidence obtained during open radical prostatectomies that suggests an association between urine leaks and stricture of the vesicourethral anastomosis.³,⁴ Several techniques of urethrovesical anastomosis have been tested in an attempt to reduce postoperative urine leak and its sequelae. These include the use of interrupted sutures, two independent running sutures,⁵ and pre-tied running sutures (the van Velthoven method).⁶ Despite these variations, rates of urine leak have been reported to range between 4.5% and 7.5% at high volume centers.⁷,⁸

The suture material plays an important role in the quality of the anastomosis. The ideal suture must have the adequate strength for the procedure as well as minimal tissue reactivity during the healing process. In this context, bidirectional barbed sutures offer unique benefits such as better control of the closure with the ability to distribute tension more evenly along the suture line. These sutures keep tissues near and eliminate the need to tie knots, which makes them especially suitable for complex reconstructive procedures. The purpose of this article is to describe our technique and experience using a bidirectional barbed suture.

Material and methods

The authors have used bidirectional barbed suture for a period of 6 months in more than 500 cases for all reconstructive steps during RARP, including bladder neck reconstruction, posterior reconstruction of the rhabdosphincter and urethrovesical anastomosis.

Suture

The bidirectional barbed suture (Quill™ knotless Tissue-Closure Device, previously Quill™ SRS; Angiotech, Reading, PA) is designed with tissue retainers (e.g. barbs), helically arrayed around a monofilament suture in opposing directions on either side of a transitional retainer-free segment (Fig. 1).⁹ ¹⁰ It is double-armed with surgical needles attached to each end. One end is advanced into the tissue, often at the midpoint of a wound, until the opposing barbs are engaged. Then, the barbs penetrate the surrounding tissue and lock the device in place, self-anchoring at approximately 1 mm of the tissue.

The bidirectional barbed suture is available in short-term absorbable (a polyglycolide-poly-e-caprolactone copolymer, PGA-PCL, Monoderm™), long-term absorbable (polydioxanone, PDO), and non-absorbable formulations (polypropylene, nylon).¹¹,¹² Of the absorbable formulations, the PGA-PCL device supports the wound for two to three weeks, and absorption is essentially complete between 90 and 120 days post-implantation. Based on in vivo testing, the PGA-PCL device retains 62% of its original tensile strength at 7 days post-implantation, and 27% at 14 days post-implantation.¹³ Since the production of retainers on the suture material decreases the internal core diameter of the device, it is recommended that surgeons "upsize" by one size from their current conventional suture size. For laparoscopic and robotic procedures, the PGA-PCL device is available in various barbed configuration and lengths (from 7 cm × 7 cm to 16 cm × 16 cm) and in USP diameter sizes.
ranging from 3-0 to 0, with taper point needles of different sizes (18–36 mm) and lengths (3/8 circle to 1/2 circle). The device used was an undyed monofilament with a configuration of 16 cm × 16 cm with a dark spot marking the middle of the length (Fig. 1). The needles at each device end were both HR18 taper point 1/2 circle 18 mm, specially designed for laparoscopic and robotic procedures.

Surgical technique

All cases underwent RARP using our six-port transperitoneal technique. The peritoneum is dissected to enter the pre-vesical space of Retzius. The endopelvic fascia is opened bilaterally and the elevator muscle is separated until the dorsal venous complex (DVC) is visualized and ligated. Periurethral suspension is then performed as previously described, and followed by bladder neck dissection and atheral mobilization of the seminal vesicles. Nerve-sparing (NS) is performed atherally with an early retrograde release of the neurovascular bundle. The specimen is then removed and placed in a bag.

Subsequently, a 3-step reconstructive sequence consisting of bladder neck reconstruction, posterior reconstruction of the rhabdophincter, and urethrovesical anastomosis is performed, using one independent suture for each sequence. A bladder neck reconstruction is carried out after removing one of the needles from the suture. A figure-of-eight or a running suture is placed laterally at 9 and 3 o’clock, according to the size of the defect. The suture is then cut without tying the free ends (Fig. 2a and b).

Posterior reconstruction of the rhabdophincter (Fig. 3a–c) is subsequently performed using a complete unmodified double-needle suture. In this way, the surgeon is able to skip the step of pre-tying the two branches of a conventional suture, as required for the traditional van Velthoven method. The free edge of the remaining Denonvillier’s fascia is identified after the prostatectomy and approximated to the posterior aspect of the rhabdosphincter and the posterior median raphe using one arm of the continuous suture, while this is half-length pulled-up until the dark spot is visualized. As a rule, four passes were taken from right to left. The suture was pulled up and the tissues were approximated distributing tension across the whole suture line. The suture end was then cut without tying and the needle was removed. The second layer of the reconstruction was then performed with the other arm of the suture, approximating the posterior lip of the bladder neck (full thickness) to the posterior urethra and to the already reconstructed median raphe. The suture was then pulled up, cut, and the needle was removed as before.

The anastomosis is finally performed in a similar fashion, again using the 2-0 PGA-PCL bidirectional barbed device (Fig. 4). The posterior aspect of the anastomosis is carried out by running one arm of the device in a clockwise direction, starting at the 5 o’clock position and ending at 10 o’clock position. The anterior aspect of the anastomosis is then performed with the second arm of the suture in a counter clockwise direction. Both suture ends were then tied together at the 10 o’clock position. A Jackson-Pratt drain was positioned in the pelvic gutter.

![Image](http://www.elsevier.es)
Figure 3  (a) The free edge of the remaining Denonvillier's fascia is approximated to the posterior aspect of the rhabdosphincter and median raphe. (b) One arm of the continuous suture is half-length pulled-up until the dark spot is visualized. (c) The second layer of the reconstruction was performed with approximation of the posterior lip of the bladder neck to the posterior urethra and median raphe.

Discussion

We report our current technique for RARP using a new technology, the bidirectional barbed suture. Greenberg et al. have associated barbed suture use with time saving, particularly in laparoscopic and robotic reconstructive procedures because of not tying knot needs.\textsuperscript{10} Compared with conventional sutures of similar internal core diameter, barbed sutures have proven to be equal or better wound breaking strength in both in vivo and in vitro testings.\textsuperscript{18,19} In addition, these devices distribute tension across the entire suture line, which has shown to help in the healing process and offer a greater watertight seal.\textsuperscript{20-22}

In 2007, Moran et al. reported the results of their study using the 3-0 polydioxanone bidirectional barbed suture versus a traditional van Velthoven (using 3-0 polyglactin 310 sutures) in an in vitro model of microfiber synthetic material, using a 12 bite technique.\textsuperscript{23} They compared 10 procedures of barbed suture versus conventional suture, and observed a reduction in operative time of 17.3 min and 19.2 min, respectively. The authors observed as well that cutting the suture resulted in a complete disruption of the monocryl suture line, while the barbed suture resulted in separation of the edges, but not in disruption of the anastomosis.

Bidirectional and unidirectional barbed devices have distinct features (Table 1). Recently, Williams et al.\textsuperscript{24} compared a unidirectional barbed polyglyconate suture to a conventional polyglactin suture for RARP anastomosis. They evaluated 45 patients using the barbed suture against 36 with the conventional polyglactin. The results showed shorter means of anastomosis times (9.7 min vs. 9.8 min), higher rates of extravasation on cystograms associated with ischemia for overtightening the suture, and greater costs per case. They concluded that the unidirectional device

<table>
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<th>Device</th>
<th>Main features</th>
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<tr>
<td>V-Loc\textsuperscript{TM}</td>
<td>Unidirectional barbs, Welded loop design</td>
</tr>
<tr>
<td>Quill\textsuperscript{TM}</td>
<td>Bidirectional barbs, Double needle, Barbs with helical distribution</td>
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was more expensive and required technical modification to avoid overtightening the suture, otherwise, it could cause complications.

Kaul et al.\textsuperscript{26} described their experience using the unidirectional barbed suture for a running urethrovesical anastomosis performed in two layers in 50 patients who underwent RARP. They found that the unidirectional device was safe, efficient, and prevented slippage, with a median time for vesicouethral anastomosis and posterior reconstruction of 11 min and 4 min, respectively. It also avoided the need for an assistant, knot tying, and constant reassessing of the anastomosis. Tewari et al.\textsuperscript{26} compared two groups of 50 patients using barbed suture for posterior reconstruction and urethrovesical anastomosis, and they found reductions on operative times for posterior reconstruction (40s vs. 60s) and vesicouethral anastomosis (7 min vs. 12 min) associated with the barbed suture.

Our six-month experience with the bidirectional barbed suture to date is certainly encouraging. Our impression is that the barbed suture does ease the reconstruction steps by keeping the tissue in place and eliminating the need for knot tying. In spite of these characteristics, we still do not feel comfortable with leaving the urethrovesical anastomosis untied. Currently, clinical studies are being performed by our group in order to confirm whether or not this technology can improve perioperative outcomes such as leakage, operative times and continence rates.

In summary, our experience suggests that the bidirectional barbed suture could simplify the reconstructive steps during radical prostatectomy by keeping the tissue together and eliminating the need for knot tying. Comparative studies will ultimately establish the benefits of this technology in comparison to the traditional absorbable monofilament.

Conflict of interest
The authors declare that they have no conflict of interest.

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