Anatomical foundations and surgical manoeuvres for precise identification of the prostatovesical junction during robotic radical prostatectomy

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OBJECTIVE

To develop a technique to identify the bladder neck during robotic radical prostatectomy (RRP) using anatomical and patient studies, and to evaluate its efficacy during and after surgery.

PATIENTS AND METHODS

The data for this study were from 10 fresh cadaveric dissections and 50 consecutive athermal RRPs performed at our institution. We used a technique we term 'the bimanual bladder neck pinch'.

RESULTS

The technique helped us to identify the prostatovesical junction and to decrease the time required to dissect the bladder neck, and the time for urethrovesical anastomosis. Urinary continence requiring 0–1 pads was 29% at 1 week , 62% at 6 weeks, 88% at 12 weeks, and 95% at 16 weeks. No patient in the series had a clinically significant leak or urinary retention.

CONCLUSIONS

Our technique of the 'bimanual pinch' is easy to learn and has reduced the difficulty of bladder neck transection. It improved the outcome both during and after RRP in our series.

KEYWORDS

prostate cancer, robotic prostatectomy, bladder neck, identification

INTRODUCTION

It is estimated that, in 2005, ≈232 090 men in the USA were diagnosed with prostate cancer and 30 350 men died from the disease [1]. While open radical prostatectomy (RP) offers an effective cure for localized prostate cancer, [2–4] associated morbidity led to the introduction of minimally invasive surgeries such as robotic RP (RRP). The dissection in RRP proceeds in an antegrade fashion, and is different from the familiar open technique, which involves tackling the apex before the seminal vesicle and bladder neck dissection. It is also different from the classical laparoscopic approach, which dissects the seminal vesicles through the pouch of Douglas before bladder neck transection [5,6]. The transection of the anterior bladder neck, finding a precise junction between the prostate and detrusor fibres, and exposing the posteriorly hidden seminal vesicles, are new challenges for surgeons embarking on RRP. The anatomy of the bladder neck is unclear and there are no familiar landmarks. Many surgeons therefore find this to be one of the most challenging steps in RRP [7].

We therefore reviewed the anatomical foundations of the prostatovesical junction (PVJ), to develop surgical strategies for precisely identifying and preserving the bladder neck in selected patients, and to facilitate the ease of posterior dissection, especially when glands are large and/or have a median lobe. We hypothesized that such precision in identifying the PVJ would potentially contribute to early continence and avoid thermal damage to the laterally located proximal neurovascular plate (PNP) [8]. It would also reduce the time for this surgical step and avoid inadvertent entry into the prostate, 'buttonholing' of the trigone and injury to the ureteric orifices. We describe here our findings from cadaveric studies and a standardized surgical step 'the bimanual bladder neck pinch' for identifying the PVJ.

PATIENTS AND METHODS

The aims of this study were: (i) to develop a technique for precisely identifying the bladder neck during RRP using anatomical and patient studies; (ii) to preserve the bladder neck and avoid damage to the bladder neck fibres with possible benefits in terms of continence; and (iii) to evaluate the outcomes during and after surgery, and the oncological result of RRP.

The data for this study were from 10 fresh cadaveric dissections and 50 consecutive cases of athermal RRP performed at our institution by one surgeon (A.T.) [9]. The aim of the cadaveric studies was to delineate the anatomical landmarks for the PVJ and describe its relationship to other important structures such as the pelvic plexus and seminal vesicles. Male cadavers were selected if they were >40 years of age, had no previous pelvic or urethral surgery, and were known to have normal prostates and urinary bladders. The cadavers were frozen 12–36 h after death and stored at −20 °C until dissection. No macroscopic tumour was evident in the abdominal and pelvic regions of these cadavers. The dissections were performed using operating microscopes. The anatomy and relationships of the bladder neck, ureteric orifices, vas deferens, seminal vesicles, prostatic pedicles and pelvic plexus was noted and documented using still photographs and intraoperative videotapes. The tissue was fixed and routinely stained with haematoxylin and eosin; in selected cases, specialized staining was done for smooth muscle (desmin) and nerves (SA 100).

The patient studies involved standardization of technique, data collection and evaluating the outcome in 50 consecutive patients undergoing RRP by one surgeon (A.T.) from mid-September to the end of November 2005. Included were patients with no previous prostatic surgery, who were neurologically normal, and who had a body mass index (BMI) of <35 kg/m^2. Excluded were men with neurogenic bladder, associated bladder pathology or extensive cancers (T3 and T4) in whom the nerves were widely excised.

We prospectively collected preoperative baseline demographic data such as age, BMI, serum PSA level, prostate volume, Gleason score and TNM clinical staging. The patients completed standardized forms before and after RRP, and were followed at 1 week, 6 weeks, 3 months and 6 months after surgery.

All surgery was were recorded digitally and the time was recorded for the bladder neck dissection (from the start of the anterior dissection to the exposure of the vasa deferentia and seminal vesicles). The time taken for urethrovesical anastomosis was also recorded. The postoperative variables studied were hospital stay, pathological stage, Gleason score and margin rates, duration of catheterization, urinary retention, complications and continence status.

The patients were ambulated and discharged home on the morning after surgery. The patients were prescribed oral phosphodiesterase inhibitors and α-blockers at discharge. They returned 7–10 days later for a cystogram, followed by catheter removal if there was no extravasation.

The different variables were entered in a custom made database created in Microsoft Excel (Microsoft, Redmond, WA, USA).

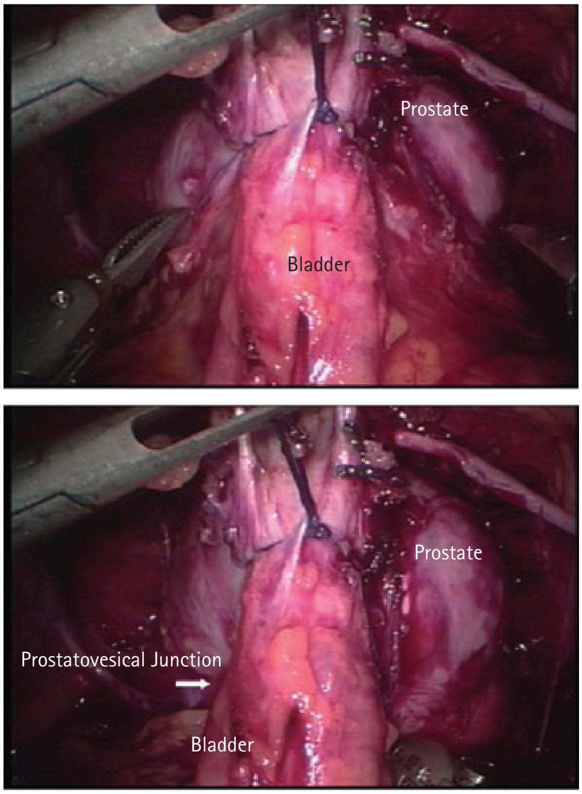

FIG. 1.
Superficial traction suture on prostate. The prostate is trapped between robotic forceps and pulled towards the bladder delineating the junction.

RESULTS

We used this technique successfully in 10 cadavers and 50 consecutive cases of RRP performed at our institute between September and November 2005.

For the anatomical landmarks, there is a very subtle and gradual transition of bladder to prostate, which makes identifying the PVJ difficult. Anteriorly, the detrusor fibres continue distally to fuse with the puboprostatic ligaments, and often contain branches of the dorsal venous complex. Laterally, the bladder effaces with the prostatic pedicle, inferior vesical artery and the PNP, and fuses with the periprostatic and levator fascia. Posteriorly, the fibres of the bladder neck continue distally as the retrotrigonal layer, and fuse with the proximal prostate anterior to the attachment of vasa and seminal vesicles [10]. There are a few anatomical landmarks that indicate this visually evasive junction. Menon [7] described a consistent lateral tongue of fat, which might help in identifying the junction. However, this step requires starting the surgical transection laterally, which is not without danger because of its proximity to the vessels, plexus and the PNP. Another strategic area is located anteriorly, where a mucosal tube joins the bladder mucosa to the urethra. This tube is usually superficial and covered by a thin layer of detrusor apron and the proximal extension of dorsal venous complex. After a back-bleeding suture is placed in the mid-prostate and another suture bunches up the veins on the bladder side, development of this anterior plane is easy, and with little bleeding. We used this anteriorly located anatomical path for the bladder neck dissection. Our technical points are presented here.

SURGICAL TECHNIQUE

This part of the dissection is performed with a 30° lens angled downwards. We place a suture on the anterior surface of the prostate to prevent back-bleeding and also for traction. Another bunching suture is placed in the bladder superficially for traction (Fig. 1). Using blunt robotic instruments, the prostate is trapped on both sides and pulled proximally until there is a sudden feeling of 'giving way' at its junction with the collapsed bladder. At this point, the PVJ can be easily identified. The left-side assistant pulls the prostatic traction suture to the foot of the patient, and the surgeon provides firm counter-traction with the da Vinci forceps. The surface is scored to precisely mark the PVJ anteriorly. The anterior bladder neck is then incised in a curvilinear manner (Fig. 2). We use a Maryland bipolar forceps and hot shears with 1 : 1 scaling for adequate coagulation of the bleeders. The dissection is deepened until the Foley catheter is seen (Fig. 3).

Identifying the Foley catheter ensures that the anterior bladder neck has been incised appropriately. The catheter is delivered from the bladder. The Foley balloon is then deflated

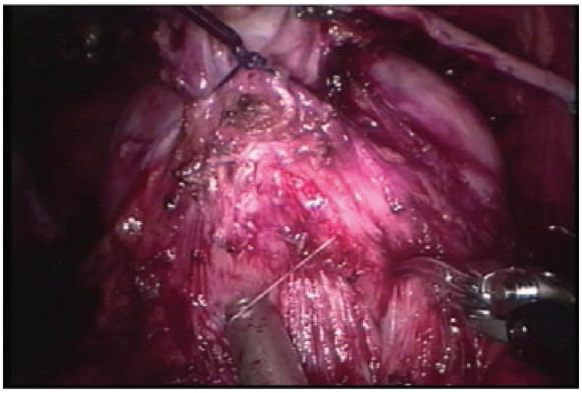

FIG. 2. Incision of the anterior bladder neck.

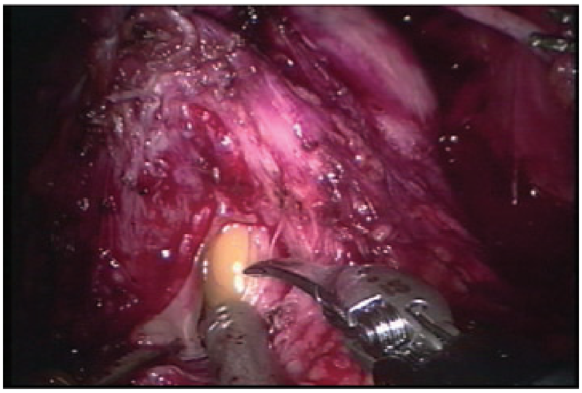

FIG. 3. Foley catheter seen after anterior bladder neck is opened.

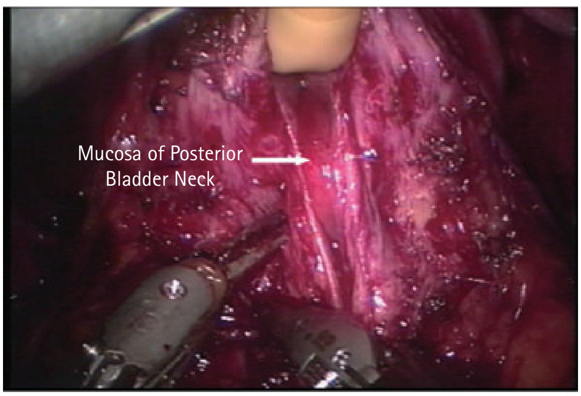

FIG. 4. Foley catheter under traction and demarcation of posterior bladder neck.

and the left-side assistant grasps the tip of the catheter with firm anterior traction. The anterior bladder neck incision is widened laterally with cautery in the fibrofatty plane between the bladder and the prostate. With traction on the shaft of the catheter, the exact location for the posterior incision becomes visible (Fig. 4) and the mucosa of the posterior bladder neck is now incised precisely. Every precaution is taken to preserve the bladder neck as far as possible and avoid injury to the ureteric orifices. The posterior incision is modified according to the size and configuration of the prostate. The incision is deepened keeping tangential to the prostate and avoiding any undermining into the substance of the prostate. Vertical downward dissection also protects against inadvertent undermining of the trigone or 'buttonholing' of the bladder. Brisk bleeding from fibromuscular tissue at this stage is a warning that the dissection might have extended into the prostate. The catheter is now withdrawn into the urethra and the left-side assistant retracts the posterior prostatic base anteriorly. We then develop a plane behind the posterior wall of the bladder neck that exposes the retrotrigonal layer. Cutting this layer opens a 'window' through which the vasa and the seminal vesicles are seen [11]. Electrocautery is avoided from this point on. With the 'bimanual pinch', the bladder neck is defined precisely, so that the initial dissection is limited to the anterior aspect. We normally defer the division of the dorsal vein complex until the time of transection of the urethra, when the prostate is mobile.

Table 1 summarizes the characteristics of the cohort; 50 consecutive patients had athermal RRP from mid-September to the end of November 2005. Eight men were excluded from the study based on the exclusion criteria, thus 42 men were eligible for the study. The mean (range) age of the men was 57.4 (44.9–70.46) years; the mean BMI was 26.7 (21–35) kg/m^2. The duration of catheterization was 7–10 days. No patients required re-catheterization after removal of the catheter for either a clinically significant urinary leak or urinary retention. Overall, the time required for bladder neck dissection was 5–15 min and for urethrovesical anastomosis, 8–15 min.

The continence data are also summarized in Table 1, showing that 12 men (29%) were continent within a week of catheter removal, 26 (62%) were continent by 6 weeks, 37 (88%) by 12 weeks and 95% by 16 weeks. Only 5% of patients were using >1 pad beyond 16 weeks after catheter removal. In our institute the previous 50 consecutive patients had a greater delay in achieving continence and only 43% were continent at 6 weeks. On histopathology, 39 patients (93%) had pT2 disease and three (7%) had pT3 disease. No patient had a positive margin at the bladder neck.

DISCUSSION

RRP is a relatively new procedure and surgical techniques are still developing. The dissection in RRP proceeds differently from open RP and the transection of the bladder neck is one of the most challenging steps of this operation. It is therefore important for the surgeon to be familiar with the anatomy as the antegrade dissection proceeds differently from the open retrograde approach.

The bladder base, the thickest and most fixed part of the bladder, is continuous with the prostate inferiorly. Posteriorly it is related to the seminal vesicles, ampullae of the vasa deferentia, and terminal ureter. The bladder neck, at the internal urethral meatus, rests 3–4 cm behind the midpoint of the symphysis pubis. Both the circular middle layer and longitudinal outer layer participate in continence at the bladder neck. The recently described retrotrigonal layer is an important landmark of posterior bladder neck dissection in the antegrade technique of RRP. The PNP located lateral to the bladder neck is prone to injury during bladder neck transection if started laterally.

We describe a relatively simple technique of identifying the bladder neck anteriorly. At this point, the mucosal tube between bladder and urethra is superficial. The groove between the bladder and prostate is easily visualized by laterally pinching and pulling the prostate towards the bladder. Other techniques have been described before. Menon [7] mentioned a distinct lateral plane demarcated by fat between the bladder and prostate, and dissection is started at this point. However, this might place the PNP and vessels of the prostatic pedicle at risk.

Costello *et al.* [12] sweep the periprostatic tissue proximally and medially with suction to identify the correct location to divide the bladder neck, but do not state whether the dissection is started anteriorly or laterally.

The step of bladder neck dissection is particularly difficult in cases of a large prostate or a large median lobe, which can distort the anatomy and lead to technical difficulties in posterior bladder neck transection in RRP. In these cases, identifying the PVJ is particularly difficult; our technique is then especially useful. Because of the precision with which the PVJ is identified, dissection into the prostate is avoided and therefore there is a minimal chance of positive margins and bleeding from fibromuscular tissue. There is no danger of dissecting deep into the trigone with the possibility of ureteric injury or detrusor instability.

The PNP is prone to injury during bladder neck transection, especially if started laterally. Caution is needed at the time of transection, and preventive measures include limiting initial dissection to the anterior third of the PVJ.

The advantage of our technique is that it is simple and easy to learn. It is a simple aid to identifying the bladder neck in the absence of other anatomical landmarks, it has helped in reducing the time required for bladder neck dissection, and it causes less bleeding. We have also been able to preserve the anatomical bladder neck, in most cases helping an early return of continence. We have also been able to avoid thermal damage to the laterally located pelvic plexus. It has facilitated dissection of the posterior bladder neck in large prostates, and helped us to avoid dissection into either the bladder or prostate.

TABLE 1
Characteristics of the 42 patients

Variable	Value
Baseline	
Mean (median, range):	
Age, years	57.4 (56.8, 44.9–70.5)
BMI, kg/m^2	26.7 (25.7, 21–35)
IPSS	7.18 (6, 0–30)
PSA level, ng/mL	6.08 (4.69, 0.9–30.68)
Prostate volume, mL	55.65 (51.5, 23.3–175.7
Biopsy Gleason score, n (%)	
2–6	35 (85.7)
7 (3 + 4)	5 (11.9)
7 (4 + 3)	1 (2.4)
8–10	1 (2.4)
Clinical stage, n (%)	
T1b	1 (2.4)
T1c	39 (90.5)
T2a	2 (4.8)
T2b	–
T2c	1 (2.4)
T3	–
Pathological stage, n(%)	
T2a	7 (16.6)
T2b	2 (4.8)
T2c	30 (71.4)
T3a	2 (4.8)
T3b	1 (2.4)
Intraoperative	
Mean (range) time (min) for:	
bladder neck dissection	12 (5–15)
urethrovesical anastomosis	12 (8–15)
Postoperative	
Mean (median, range) duration (days) of:	
hospitalization	1.4 (1)
catheterization	8 (8.5, 7–10)
N (%):	
Clinical urinary leak	0
Urinary retention	0
Positive margin at the bladder neck	0
Continence* ≤1 week	12 (29)
Continence* after catheter removal:	
4–6 weeks	26 (62)
8–12 weeks	37 (88)
≤16 weeks	40 (95)

**Continence, 0–1 pad status.*

In conclusion, this technique of the 'bladder neck pinch' is a simple manoeuvre that helps to precisely identify the PVJ during bladder neck transection and avoid injury to the surrounding structures. There are improved functional results in terms of return to continence.

CONFLICT OF INTEREST

None declared.

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Abbreviations: **RRP**, robotic radical prostatectomy; **PNP**, proximal neurovascular plate; **BMI**, body mass index; **PVJ**, prostatovesical junction.