Transvesical robotic radical prostatectomy

Mihir M. Desai, Monish Aron, Andre Berger, David Canes, Robert Stein, Georges-Pascal Haber, Kazumi Kamoi, Sebastien Crouzet, Rene Sotelo and Inderbir S. Gill

Department of Urology, Glickman Urological and Kidney Institute, Cleveland Clinic, Cleveland, OH, USA

Accepted for publication 18 June 2008

INTRODUCTION

Laparoscopic [1] and robotic radical prostatectomy [2] (RRP) is being increasingly used for the surgical treatment of organ-confined prostate cancer, with results comparable to open retropubic RP. Recently, the availability of various single-port devices and articulating instruments has led to an increasing use of single-port laparoscopy for ablative or reconstructive laparoscopic procedures [3,4].

We recently reported a novel percutaneous transvesical approach for simple prostatectomy in large-volume obstructive BPH, using a novel single-port device inserted percutaneously into the bladder [5]. We found adequate space in the bladder after creating pneumovesicu m to perform all the critical manoeuvres necessary for simple prostatectomy. This encouraging initial experience made us realise the potential of using the natural space provided by the CO₂-insufflated bladder for performing RP. The insufflated bladder might actually provide an optimal portal of access to the prostate for RP, by automatically eliminating contact with the peritoneal cavity and its contents, and providing a direct in-line exposure of the prostate and relevant peri-prostatic anatomy. The transvesical approach also obviates the need for mobilizing the bladder and dissecting the prevesical space, and might further reduce the trauma of dissection during RRP. With this rationale we attempted transvesical RRP (TRRP) in two fresh cadavers, and herein present the technique and results of this novel approach.

MATERIALS AND METHODS

TRRP was performed in two fresh male cadavers (prostate volume 46 and 30 mL). In the first procedure we used four laparoscopic transvesical trocars and in the second a single-port device was placed percutaneously into the bladder. Pneumovesicu m was established in both cases and the da Vinci-S robotic system (Intuitive Surgical, Sunnyvale, CA, USA) was used for the TRRP. All steps of the procedure, including dissection of the seminal vesicles and vas deferens, ligation of prostatic pedicles, release of neurovascular bundles, apical dissection, urethral transection, and urethro-vesical anastomosis, were done transvesically and robotically. Real time transrectal ultrasonography monitoring was used in the first cadaver.

RESULTS

Both procedures were technically successful transvesically with no need for additional ports or conversion to standard laparoscopy. The operative duration for the multi-port procedure was 3 h and for the single-port procedure was 4.2 h. Clashing of the da Vinci arms was the primary technical difficulty with the single-port procedure, but did not occur in the multi-port procedure.

CONCLUSIONS

TRRP under pneumovesicum is technically feasible using multiple-port or a single-port approach in the cadaver. The clinical application of this novel approach is imminent. Further refinement of technique and instruments might lead to an increasing role of percutaneous intraluminal surgery in various surgical disciplines.

KEYWORDS

radical prostatectomy, robotics, transvesical, single-port
inlets protected by a thermoelastomer valve. It also has a separate inlet for insufflation and one for venting smoke. The da Vinci S was docked to the Quadport by inserting the 8-mm trocars through two of the inlets and the telescope through one inlet. The fourth inlet was used for introducing a bedside assistant instrument as and when required. We switched from 0° to 30° (up and down) for various steps of the procedure to reduce instrument clashing that was a frequent occurrence with the single-port approach.

After docking the da Vinci robotic system all steps of TRRP were similar in both cadavers (Fig. 2). The initial step consisted of a high incision of the posterior bladder neck distal to the ureteric orifices, which were clearly identified (Fig. 3). The posterior bladder neck incision was deepened through the full thickness of the detrusor to expose the vasa and seminal vesicles (Fig. 4). The vasa were divided bilaterally and both seminal vesicles were mobilized completely and maintained on anterior retraction by the patient-side assistant. Denonvilliers’ fascia was incised and posterior dissection performed along the pre-rectal fat up to the prostatic apex. The posterior bladder neck incision was extended on both sides to encircle the bladder neck.

The bladder neck incision was initially deepened from the 7 o’clock to 11 o’clock position on the left side and the 1 o’clock to 4 o’clock position on the right side. This gave exposure to the lateral prostate surface medially and the levator fibres laterally. These incisions were joined in the midline at the 12 o’clock position to expose the anterior surface of the prostate and the dorsal vein complex. The lateral prostate pedicles were divided using robotic scissors and the neurovascular bundles were released from the prostate capsule (Fig. 5). The dorsal vein was stapled using a single fire of a vascular load of the EndoGIA stapler (Covidien; Fig. 6). The urethra was divided just distal to the apex of the prostate. The completely mobilized prostate was placed within the bladder. The vesico-urethral anastomosis was made in a continuous fashion using 4-0 polyglactin sutures, and the remainder of the bladder was closed anteriorly in a racket-handle fashion from within the bladder (Fig. 7). The prostate was extracted and examined grossly for adequacy of excision.
RESULTS

Both procedures were technically successful through the transvesical route. The total operative duration was 3 and 4.2 h, the time to obtain transvesical access was 20 and 30 min, and the anastomotic suturing time was 30 and 50 min in cadaver 1 and 2, respectively. As expected, there was significant instrument clashing in the single-port (cadaver 2) procedure compared with the four-port procedure. There appeared to be no undue tension on the vesico-urethral anastomotic suture-line. There were no intraoperative complications, e.g. rectal injury, in either procedure. The extracted prostate specimen appeared to be intact in both cases. Intraoperative real-time TRUS navigation was successfully used to identify various anatomical landmarks in the first cadaver.

DISCUSSION

There has been a rapid increase in the use of minimally invasive surgery for treating organ-confined prostate cancer. Both laparoscopic and robotic-assisted RP are emerging as attractive first-line alternatives to open RP [1,2]. Efforts are ongoing to further reduce the morbidity and improve cosmetic outcomes of laparoscopic surgery. The availability of specialized multichannel single-port access devices and bent and articulating laparoscopic instruments has enabled various extirpative and reconstructive laparoscopic procedures through a single abdominal incision, typically concealed within the umbilicus [3,4].

As an extension of the concept of single-port laparoscopic surgery, we recently reported the initial experience with transvesical simple prostatectomy in three patients with moderate to large BPH [5]. A specialized single-port device (R-port, Advanced Surgical Concepts, Wicklow, Ireland) was inserted percutaneously directly into the bladder. The unique design of the R-port provides an effective seal and an airtight entry into the bladder through which three laparoscopic instruments (telescope and two working instruments) can be inserted to perform the simple prostatectomy. All three cases were technically successful with good early functional results [5].

We were impressed by the amount of intravesical working space provided by the insufflated bladder, and the access to and exposure of the prostate via the transvesical route. This prompted us to further extend the scope of minimally invasive transvesical surgery and explore the possibility of performing RP via this approach. There are several potential advantages of the transvesical approach for RP. With the transvesical approach there is no need to mobilize the bladder or dissect the pre-vesical space, and the operation is confined to the area of the deep bony pelvis around the prostate gland. This could minimize the dissection trauma of robotic prostate surgery. There is no handling or dissection of the bowel and peritoneal contents with the transvesical approach. Even with extravesical laparoscopic or robotic-assisted RP there is invariably seepage of CO₂ within the peritoneum, potentially leading to some degree of bowel irritation and possible ileus. The pneumovesicum confines CO₂ to the deep bony pelvis and eliminates the need for any bowel retraction. The avoidance of...
Transperitoneal transgression might also potentially reduce the incidence of bowel adhesions, mechanical obstruction and port-site hernias. The transvesical approach allows the creation of pneumovesicuim with no need for pneumoperitoneum. Pneumovesicuim would have minimal effects on the mechanics of ventilation, potentially enabling the procedure to be performed under regional (spinal, epidural) anaesthesia, as opposed to the routine use of general anaesthesia in trans- or extraperitoneal robotic or laparoscopic RP. Pneumovesicuim is also likely to minimize CO₂ absorption compared to pneumoperitoneum. Finally, the gas-insufflated bladder acts as a self-retaining retractor that keeps the peritoneal cavity and its contents and the prevesical fibro-fatty tissue away from the area of the operation. This might help to reduce the number of retracting instruments and trocars required for RRP. Thus, the transvesical approach might enable single-port RRP to be performed efficiently. Also, as the insufflated bladder automatically keeps the peritoneum and its contents away from the operative area, this obviates the need for any significant degree of Trendelenberg tilt and its resultant sequelae.

There are also potential limitations of TRRP. The inability to perform lymph node dissection makes it unsuitable for patients with high-risk prostate cancer who require pelvic lymphadenectomy. The bladder neck opening is likely to be wider than with conventional laparoscopy and robotics. Although it can be adequately reconstructed from within the bladder, implications in terms of urinary leak and early continence need to be determined. As this is a novel approach, it is likely to require considerable training and experience. The transvesical approach necessitates making one to four incisions in the anterior bladder wall that need to be suture-repaired. The ability to achieve reliable haemostasis and perform nerve-sparing cannot be demonstrated in cadaveric tissues and need to be assessed clinically.

There are a few technical points with the transvesical approach. We placed the ports low in the abdomen within the suprapubic skin crease to ensure that the ports did not traverse through the peritoneum. Despite the ports being so close to the pubic symphysis, we could easily access the prostate and periprostatic anatomy, as the da Vinci S system provided significant manoeuvrability because of its EndoWrist technology. In this preliminary experience we found that the posterior dissection, including dissection of the vasa and seminal vesicles, was quite straightforward. Also, we had no difficulty accessing the apical area or making a tension-free urethral-vaginal anastomosis. The somewhat larger bladder neck could be reconstructed with little difficulty in a tennis-racket manner, using conventional robotic suturing from within the bladder lumen. The visualization during both procedures was excellent under pneumovesicuim. We feel that the pressure of the pneumovesicuim will aid in keeping the field relatively clean by venous tamponade in the clinical setting. We did not note any collapse or reduction of working space, after completely dividing the bladder neck, from CO₂ leakage. That the operation is confined by the bony pelvis all around, which does not collapse, and the lifting effect of the transvesical ports (similar to the abdominal lifting in gas-less laparoscopy) maintains adequate working space even after dividing the bladder neck. Although there was significantly more instrument crowding and clashing in the second cadaver using a single-port trocar compared to four separate trocars used in the first cadaver, it was not prohibitive. Indeed, the need to close only one bladder incision at the end of the procedure might be sufficient reason to prefer the single-port approach over three separate trocars. Eventually, the availability of robotic platforms specifically designed for the single-port method might help to further refine and simplify the transvesical technique.

In addition to the possible applicability for treating benign and cancerous conditions of the prostate, we think that the transvesical approach provides the basis for performing complex intraluminal reconstructive, ablative and extirpative intraluminal surgical procedures in other hollow organs through a single percutaneous portal of entry. Following the concept of transvesical prostatectomy, the development of similar single-port percutaneous intraluminal procedures within the fields of bariatric, gastrointestinal and general surgery, and colorectal surgery, is currently underway at our institution.

In conclusion, we showed the technical feasibility of TRRP in the fresh human cadaver. The clinical applicability of this novel approach in selected patients with low-risk organ-confined prostate cancer is imminent. This might herald the beginning of percutaneous intraluminal single-port surgery across other surgical disciplines.

CONFLICT OF INTEREST
None declared.

REFERENCES
1 Touijer K, Eastham JA, Secin FP et al.
3 Desai MM, Rao PP, Aron M et al.
Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. BJU Int 2008; 101: 83–8
4 Kaouk JH, Haber GP, Goel RK et al.
5 Desai MM, Aron M, Canes D et al.

Correspondence: Mihir M. Desai, Director, Stevan B. Steem Center for Endourology, Glickman Urological and Kidney Institute, Cleveland Clinic, 9500 Euclid Avenue/A100, Cleveland, OH 44195, USA. e-mail: desaim1@ccf.org

Abbreviation: (T)(R)RP, (transvesical) (robotic) radical prostatectomy.

ADDENDUM
Since submitting this report we have successfully performed the first clinical case of TRRP in a 65-year-old man with Gleason 6 (3 + 3) prostate cancer and a PSA level of 4.9 ng/mL. Three ports (a midline 12-mm balloon port and two pararectal R-ports) were inserted into the bladder suprapublically under cystoscopic control. TRRP with bilateral nerve-sparing was performed. The total operative duration was 8 h, the blood loss was 50 mL and the hospital stay was 2 days. There were no complications during or after surgery.