Asian Journal of Urology 10 (2023) 467–474

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/ajur

Surgery Alive

Initial experience of laparoendoscopic single-site radical prostatectomy with a novel purpose-built robotic system

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Received 23 March 2023; received in revised form 10 June 2023; accepted 2 August 2023
Available online 18 August 2023

KEYWORDS
Laparoendoscopic single-site surgery;
Robotic surgical procedure;
Prostatectomy;
Prostatic cancer

Abstract *Objective:* This prospective single-arm clinical trial aimed to evaluated the feasibility and safety of the application of the SHURUI system (Beijing Surgerii Technology Co., Ltd., Beijing, China), a novel purpose-built robotic system, in single-port robotic radical prostatectomy.
Methods: Sixteen patients diagnosed with prostate cancer were prospectively enrolled in and underwent robotic radical prostatectomy from October 2021 to August 2022 by the SHURUI single-port robotic surgical system. The demographic and baseline data, surgical, oncological, and functional outcomes as well as follow-up data were recorded.
Results: The mean operative time was 226.3 (standard deviation [SD] 52.0) min, and the mean console time was 183.4 (SD 48.3) min, with the mean estimated blood loss of 116.3 (SD 90.0) mL. The mean length of postoperative hospital stay was 4.50 (SD 0.97) days. Two patients had postoperative complications (Clavien-Dindo Grade II), and both patients improved after conservative treatment. All patients' postoperative prostate-specific antigen levels decreased to below 0.2 ng/mL 1 month after discharge. The mean prostate-specific antigen level further decreased to a mean of 0.0219 (SD 0.0641) ng/mL 6 months after surgery. Thirty days postoperatively, 12 out of 16 patients reported using no more than one urinary pad per day, and all patients reported satisfactory urinary control without the need for pads 6 months after surgery.
Conclusion: The SHURUI system is safe and feasible in performing radical prostatectomy via both

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Peer review under responsibility of Tongji University.
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https://doi.org/10.1016/j.ajur.2023.08.002

transperitoneal and extraperitoneal approaches. Tumor control and urinary continence were satisfying for patients enrolled in. The next phase involves conducting a large-scale, multicenter randomized controlled trial to thoroughly assess the effectiveness and safety of the new technology in a broader population.

1. Introduction

Robotic laparoendoscopic single-site surgery (R-LESS) offers numerous advantages compared to traditional surgery, including less trauma, faster recovery, and less pain [1]. However, despite surgeons' continuous efforts to improve techniques, R-LESS has been hindered by many limitations, particularly those challenges posed by the surgical system itself. Hence R-LESS has yet to achieve widespread application and promotion. The introduction of specifically designed single-port robotic surgical systems has successfully addressed the limitations associated with previous single-port surgeries [2—4]. These developments highlighted the significance of hardware improvements, specifically the innovation of the surgical system, in advancing R-LESS procedures. With the potential to accelerate the progress of R-LESS, developing novel systems holds promise for benefiting a larger population of patients.

Recognizing the challenges faced in previous R-LESS procedures, our team embarked on the development of a tailored single-port robotic surgical system. This system has been designed to meet the specific technical requirements of R-LESS, leading to improved surgical outcomes and surgeons' experience. Leveraging the theoretical innovation of Deformable Dual-Continuum Design, we embarked on a collaborative endeavor with medical engineers to create the SHURUI single-port robotic surgical system (Beijing Surgerii Technology Co., Ltd., Beijing, China) [5]. Our primary goal was to enhance the effectiveness and safety of R-LESS procedures. The SHURUI single-port robotic surgical system could provide enhanced payload capacity and superior intracorporeal dexterity, aligning with the specific technical requirements of single-incision surgeries [6].

Following extensive laboratory research and subsequent animal experiments, we conducted a single-arm prospective clinical trial on a small cohort of patients (Idea, Development, Exploration, Assessment, Long-term follow-up [IDEAL] Stage 2b) [7]. Our aim in this clinical trial was to evaluate the efficacy, feasibility, and safety of the SHURUI robotic surgical system in overcoming the challenges associated with R-LESS procedures, specifically in the context of single-port robotic radical prostatectomy performed by SHURUI system (SR-RARP).

2. Patients and methods

2.1. Design

This study was a single-arm, non-controlled prospective clinical trial, where all enrolled patients underwent SR-RARP. All cases were performed by an experienced surgeon (Wang L), who has over 15 years of experience in single-port and robotic laparoscopy surgery, currently completing over 300 robotic surgeries each year and a total of more than 3000 single-port and robotic surgeries.

2.2. Participants

We prospectively collected the clinical data of 16 cases who met the inclusion criteria and underwent SR-RARP in single center (Changhai Hospital, Naval Medical University, Shanghai, China) from October 2021 to August 2022. All patients included were diagnosed with prostate cancer (clinical tumor stage 1 [cT1] or cT2a-b) confirmed by transperineal prostate biopsy, with a Gleason score of 7 or less and preoperative prostate-specific antigen (PSA) level of $\leq$20 ng/mL. The patient must be at least 18 years old, with a body mass index between 18.5 kg/m^2 and 30 kg/m^2, and classified as Grades I—III according to the American Society of Anesthesiologists physical status classification system [8]. The patient must also be able to comply with the follow-up and relevant examinations as specified in the follow-up plan. All patients must return to the hospital for follow-up at least once, 1 month after surgery.

2.3. Intervention

2.3.1. Surgical system

All surgical procedures (SR-RARP) were performed by using the SHURUI system, which consists of a surgeon console with a high-definition three-dimensional display, a vision cart, and a patient-side cart with deformable arms (Fig. 1). The deformable arms are composed of 20 nickel-titanium alloy structural bones. After entering the abdomen through a customized single-port multi-channel sheath, the nickel-titaniumalloy structural bones can be pushed and pulled to bend and unfold the mechanical arm, constructing a triangular operation plane for the surgery (Fig. 2).

Figure 1 Components of the SHURUI system (Beijing Surgerii Technology Co., Ltd., Beijing, China). The SHURUI system comprises a surgeon console, a vision cart, and a patient-side cart (from left to right).

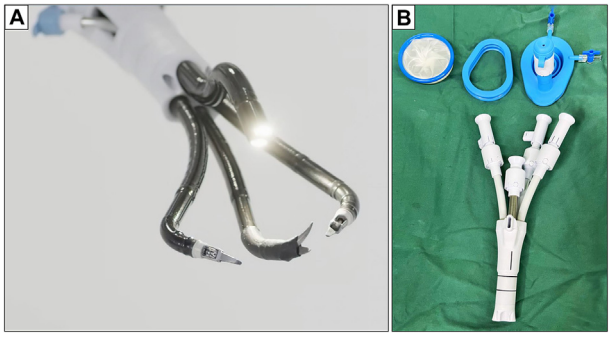

Figure 2 Instruments and accessories on patient-side carts of SHURUI system. (A) A schematic diagram depicting intracorporeal operation by the deformable robotic arms; (B) The customized Y-configuration sheath and port for single-port surgery.

2.3.2. Patient position and trocar placement

All surgical procedures were performed through either an extraperitoneal or transperitoneal approach. After successful general anesthesia, the patient was placed in the lithotomy (Trendelenburg position) and the surgical site was routinely disinfected and draped. In the extraperitoneal approach, a 4 cm incision was made below the umbilicus. In transperitoneal approach, the surgical incision was made at the umbilicus. The customized single-port multi-channel sheath was then inserted. If necessary, an additional 12 mm auxiliary trocar could be added 8 cm from the side of the single-port multi-channel sheath for assistance.

2.3.3. Surgical procedures

The extraperitoneal space was further freed to expose the neck of the bladder, the apex of the prostate, and the pelvic fascia on both sides. The fascia on both sides of the pelvis was opened, and the prostate capsule was freed and the puboprostatic ligament was cut to free the apex of the prostate. The deep dorsal vein complex of the penis was fully exposed and sutured with barbed suture. The urethral neck and posterior wall were opened; the vas deferens and seminal vesicles were exposed; and the seminal vesicle was completely freed after ligating the vas deferens. The Denonvilliers fascia was opened and freed on the back of the prostate, and the prostate was freed to the apex and both sides. The prostatic pedicles on both sides were ligated to the apex; the urethra was cut; and the bladder neck and urethra were anastomosed with continuous suture using barbed suture. A drainage tube was left in place; the specimen was removed, and the incision was closed layer by layer. The Supplementary Video 1 shows the intricate surgical steps involved in SR-RARP through an extraperitoneal approach.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ajur.2023.08.002

As for the transperitoneal approach, the bladder needed to be pulled down after establishing space of pneumoperitoneum. The remaining steps were the same as those for the extraperitoneal approach (Fig. 3).

2.4. Outcome measures

The primary endpoint of the study was the success rate of the surgical procedure. The success of surgery was defined as adhering to the planned surgical procedure without any deviation, including no intraoperative conversion or the use of more than one assistant trocar, and no intraoperative blood transfusion. Additionally, there should be no need for a second surgery within 24 h after the initial procedure due to severe intraoperative or postoperative complications.

The secondary endpoints were to evaluate the clinical outcomes of patients and surgical parameters. Patients' general and demographic information, oncological parameters, surgical approach, number of incisions, operation time, console time, estimated blood loss, perioperative complications, Visual Analog Scale for pain rating [9], Vancouver Scar Scale for scar evaluation [10], pathological results, and follow-up postoperative PSA and the status of urinary control were recorded. The biochemical recurrence was defined as PSA level of $>$0.2 ng/mL. The postoperative incontinence was defined as the use of more than or equal to one pad.

The learning curve was comprehensively evaluated by the combination of the success rate of the surgical procedure, operation time, console time, estimated blood loss, and perioperative complications.

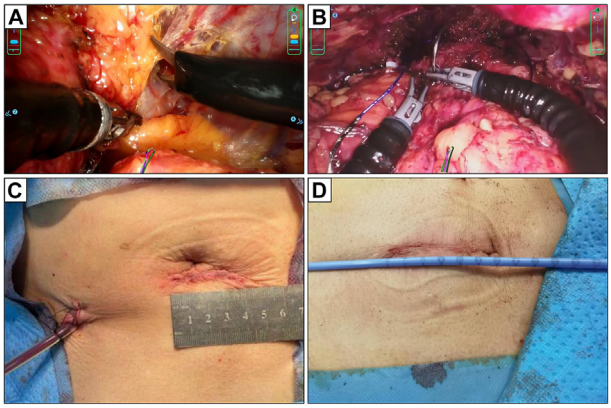

Figure 3 Deformable surgical instruments and incisions. (A) Establishing space by scissors and forceps; (B) Suturing the urethra and the bladder neck with needle drivers; (C) The incision of transperitoneal approach; (D) The incision of extraperitoneal approach.

2.5. Statistical analyses

Statistical analyses were conducted with SPSS 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were employed to summarize the data, with mean and standard deviation utilized for continuous variables, and percentages used for categorical variables.

2.6. Surgeons' feedback

Following each surgical procedure, the surgeons completed a comprehensive questionnaire to assess their experience. The questionnaire comprised a total of 20 questions, with each question assigned a score of 5, resulting in a maximum total score of 100. The questionnaire encompassed two main domains: system performance, consisting of 12 questions accounting for 60 points, and ergonomic design for comfort, comprising eight questions worth 40 points. Through a collaborative approach, the development team engaged in regular communication with the surgical team, utilizing the questionnaire results to drive iterative enhancements and improvements.

2.7. Ethical considerations and patient consents

Necessary approvals were obtained from the Ethics Committee of the First Affiliated Hospital of Naval Medical University (CHEC2021-143), and all enrolled patients were provided with detailed information about the potential risks associated with the surgery. Informed consents were obtained from all patients prior to the operation, and it was ensured that they voluntarily agreed to undergo the procedure.

3. Results

3.1. Baseline parameters

In this particular context, a prospective database was established to systematically capture patient information. The demographic data of 16 patients who underwent the SR-RARP were listed in Table 1. Most patients (13/16) presented with elevated PSA levels as the initial sign and were diagnosed with prostate cancer after undergoing prostate biopsy. Three patients were diagnosed with incidental prostate cancer on postoperative pathology after undergoing surgery for benign prostate hyperplasia at other hospitals.

Table 1 Demographics and baseline data.

Parameter	SR-RARP ($n=16$)
Age, year	69.5±7.1
BMI, kg/m^2	25.1±2.2
Medical history	
Hypertension	8 (50.0)
Diabetes mellitus	2 (12.5)
Coronary artery disease	1 (6.2)
Stroke	1 (6.2)
ASA physical status classification	
II	14 (87.5)
III	2 (12.5)
Biopsy GS	
3+3	8 (50.0)
3+4	5 (31.2)
4+3	3 (18.8)
Preoperative PSA, ng/mL	9.60±3.96
Preoperative creatine, μmol/L	85.1±19.7

SR-RARP, single-port robotic radical prostatectomy performed by SHURUI system; ASA, American Society of Anesthesiologists; GS, Gleason score; PSA, prostate-specific antigen.
Note: values are presented as mean±standard deviation, or *n* (%).

3.2. Surgical outcomes

The mean operative time was 226.3 (standard deviation [SD] 52.0) min, and the mean console time was 183.4 (SD 48.3) min. The estimated blood loss was 116.3 (SD 90.0) mL. Of the surgical approaches used, 6 (37.5%) were transperitoneal and 10 (62.5%) were extraperitoneal. All patients underwent surgery with a 4-cm incision for single-port and a 12-mm additional port for assistance. The mean length of postoperative hospital stay was 4.50 (SD 0.97) days (Table 2).

3.3. Safety evaluation

Throughout the series of 16 cases, there were no major intraoperative complications, transfusions, or conversions.

Two patients had postoperative complications, which were classified as Clavien-Dindo Grade II, including one case of fever and one case of decrease in hemoglobin levels at the first day after surgery (Table 2). Both patients improved after conservative treatment.

In addition, two other patients experienced urinary tract infection as adverse events, which were successfully treated with antibiotics.

3.4. Oncological outcomes

Regarding the pathology, the proportions of patients in different pathological tumor stages (pTs) were as follows: 31.2% (pT2a), 43.8% (pT2c), 18.8% (pT3a), and 6.2% (pT3b) (Table 3). In three cases, the tumor had invaded unilateral side or bilateral sides of the prostatic capsule. In one case, the tumor invaded the seminal vesicle on both sides.

The postoperative Gleason scores of eight patients were 3+3 (50.0%); six patients were 3+4 (37.5%); and two patients were 4+3 (12.5%). The postoperative pathological findings were generally consistent with the preoperative biopsy results, with only one patient having a downgrade from 4+3 to 3+4. Positive surgical margins (PSMs) were present in 4 (25.0%) patients. Among patients with pT2

Table 2 Perioperative data.

Parameter	SR-RARP (n=16)
Operative time, min	226.3±52.0
Console time, min	183.4±48.3
Estimated blood loss, mL	116.3±90.0
Surgical approach	
Transperitoneal	6 (37.5)
Extraperitoneal	10 (62.5)
Cases with additional trocar	16 (100.0)
Length of postoperative hospital stay, day	4.50±0.97
Postoperative complication	
Clavien-Dindo Grade II	2 (12.5)
VAS[a]	
On surgery day	
0	3 (18.8)
1	12 (75.0)
2	1 (6.2)
Postoperative 24 h	
0	2 (12.5)
1	14 (87.5)
Before discharge	
0	9 (56.2)
1	7 (43.8)
VSS[b]	
0 or 0.5	2 (12.5)
1 or 1.5	10 (62.5)
2 or 2.5	3 (18.8)
3 or 3.5	1 (6.2)
Satisfaction scores of surgeon	92.4±8.7
System performance	56.2±4.1
Comfort level	32.4±4.0

SR-RARP, single-port robotic radical prostatectomy performed by SHURUI system; VSS, Vancouver Scar Scale; VAS, Visual Analog Scale.
Note: values are presented as mean±standard deviation, or n (%).
[a] Postoperative pain scoring was assessed using the VAS from the completion of the surgical procedure until discharge.
[b] In this study, the VSS, a validated tool, was used to evaluate surgical scars, with two assessors conducting meticulous assessments based on predefined criteria; the final VSS score for each patient was determined by calculating the mean score from the two assessors.

tumors, 2 (16.7%) patients had PSMs, while the rate was higher among those with pT3 tumors at 50% (Table 3). All these PSMs located at the apex.

3.5. Surgeons' feedback

The satisfaction scores of surgeons are presented in Table 2. The overall satisfaction score was found to be 92.4 (SD 8.7). Specifically, the score for system performance was 56.2 (SD 4.1), indicating high levels of satisfaction in terms of the system's performance. The comfort level score was 32.4 (SD 4.0), reflecting a positive perception of the ergonomic comfort provided by the system. The surgical system received high ratings in terms of instrument performance, range of motion, grasp strength, and relative interference.

Table 3 Pathological data.

Pathology	SR-RARP (n=16)
pT, n (%)	
2a	5 (31.2)
2c	7 (43.8)
3a	3 (18.8)
3b	1 (6.2)
Postoperative Gleason score, n (%)	
3+3	8 (50.0)
3+4	6 (37.5)
4+3	2 (12.5)
Positive surgical margin, n/total (%)	4/16 (25.0)
For pT2a-c patients	2/12 (16.7)
For pT3a-b patients	2/4 (50.0)

SR-RARP, single-port robotic radical prostatectomy performed by SHURUI system; pT, pathological tumor stage.

The mean scores for these mentioned aspects reached 4.85 (SD 0.1; out of 5) based on the corresponding questions.

3.6. Follow-up

The mean duration of follow-up was 11.4 (range 6.6–16.1) months. All patients demonstrated a decrease in PSA level to below 0.2 ng/mL 30 days after discharge. The mean postoperative PSA level was 0.0332 (SD 0.0437) ng/mL 30 days after discharge. Moreover, the PSA level further decreased to a mean of 0.0219 (SD 0.0641) ng/mL 6 months after discharge (Table 4).

Among all patients, only one patient (pT3b) experienced biochemical recurrence. The patient's PSA level initially decreased to 0.03 ng/mL 30 days after surgery but slowly rose afterward, eventually peaking at 0.8 ng/mL, indicating biochemical recurrence. The patient received radiation therapy on the surgical area. Three months later, the PSA level decreased to 0.03 ng/mL.

Table 4 Follow-up data.

Oncological and functional follow-up	SR-RARP (n=16)
Postoperative PSA, ng/mL	
30 days after discharge	0.0332±0.0437
6 months after discharge	0.0219±0.0641
Postoperative creatine, μmol/L	
1 day postoperatively	76.8±12.6
1 day before discharge	79.8±13.7
1 month after discharge	88.0±18.7
Postoperative incontinence	
30 days after discharge	
No urinary pads required	9
1 urinary pad required within 24 h	3
2 urinary pads required within 24 h	4
6 months after discharge	
No urinary pads required	16

SR-RARP, single-port robotic radical prostatectomy performed by SHURUI system; PSA, prostate-specific antigen.
Note: values are presented as mean±standard deviation, or n.

As to the functional outcomes showed in Table 4, 30 days after surgery, nine patients who maintained general continence, reported slight urinary leakage during physical activities, but did not require the use of pads. Three patients experienced urinary incontinence requiring the use of one pad per day. Four patients have moderate urinary control issues and require two urinary pads per day.

Six months after surgery, none of the patients required any urinary pads (Table 4). Out of 16 patients, 14 reported complete urinary continence under all circumstances. Only two patients reported slight urinary leakage during vigorous physical activity or intense coughing, and experienced nocturia that was significantly alleviated through medication. One patient presented with a complaint of slightly reduced urinary stream, suggestive of urethral obstruction likely due to scar hyperplasia at the bladder—urethral junction. In this case, medical intervention was not necessary as it had no significant impact on quality of life.

3.7. Pain management and cosmetic outcomes

On the day of surgery, three patients did not experience any pain, while the remaining 13 patients experienced mild to moderate pain, which have been attributed to the residual effects of the anesthesia. On the first day after surgery, the proportion of patients who reported pain slightly increased (14/16), but all 14 patients experienced mild pain. By the time of discharge, more than half of the patients reported no pain, while the others reported only mild pain, which demonstrated the superior pain control of the single-incision surgery (Table 2).

4. Discussion

This study aimed to validate the feasibility and safety of a novel purpose-built single-port robotic surgical system, the SHURUI system, in radical prostatectomy. This is the first clinical report on the application of the SHURUI system in robotic radical prostatectomy (RARP).

Binder et al. [11] first reported the application of robotic system in radical prostatectomy. In 2002, Menon et al. [12] presented a prospective trial proving the safety and efficacy of RARP. After the development and advancement of robotic surgical systems, RARP has been widely adopted globally over the past two decades as a standard treatment option for patients with localized prostate cancer due to its superior oncological and functional outcomes [13—17]. In 2010, Haber et al. [18] attempted to use the VeSPA surgical instruments with da Vinci Si surgical system (Intuitive Surgical Inc., Sunnyvale, CA, USA) for R-LESS in porcine model in laboratory. Subsequently, many surgeons have attempted single-port surgeries and continually refined their surgical techniques and instruments. In comparison to traditional multiport RARP, single-port RARP (SP-RARP) can further reduce trauma and pain, reducing scar, and accelerate postoperative recovery [19,20].

Our team are committed to providing our patients with high-quality minimally invasive surgeries. To this end, we have made certain attempts to perform SP-RARP by using the da Vinci Si system through single incision with a customized quadri-channel port [21]. Although our experience demonstrated the advantages of R-LESS techniques in urology, particularly in providing shorter hospital stays, less postoperative pain, and comparable oncologic and functional outcomes in radical prostatectomy, the bulky size of multiport robotic systems presents challenges for surgeons, with repeated collisions with external robotic arms and less ergonomic design, making it difficult for assistants to provide support. This, coupled with longer operating times and a steep learning curve, also increases the risk of intraoperative complications.

Therefore, the introduction of a customized single-port robotic surgical platform would provide great convenience for surgeons to perform R-LESS. Due to the limitations such as availability, the use of da Vinci SP surgical systems has not been widely adopted on a global scale, especially in China. Based on our previous efforts to explore laparoendoscopic single-site surgery and R-LESS techniques and surgical innovations since 2008, we have collaborated with an engineering team to develop a new type of single-port robotic surgical system, the SHURUI system. The SHURUI system equips with deformable robotic arms, which were developed based on a dual continuum mechanism [5]. The continuum segments of the SHURUI system enable the robotic arms to bend in arbitrary directions with a maximum bending angle that exceeds 135-degree. This remarkable feature empowers the system with unparalleled maneuverability during surgical procedures, thereby allowing it to cover a larger surgical area with superior dexterity and precision. With the help of the SHURUI system, we hope to address various issues that have existed in previous single-port robotic surgeries and promote the application and popularization of single-port surgery [22—25].

In our study, 16 patients diagnosed with prostate cancer were enrolled in and underwent SR-RARP. All surgeries were completed successfully without any major intraoperative complications, conversions, or blood transfusions. No secondary surgery was required due to intraoperative complications. The operation time and console time were similar to those previous clinical reports [26,27].

Multiple surgical approaches were applied to perform SP-RARP, such as transperitoneal [28], extraperitoneal, and transvesical [29]. Kaouk et al. [26] demonstrated the similar outcomes between transperitoneal and extraperitoneal approaches in various aspects. In our study, the SHURUI system exhibited the capability to perform transperitoneal and extraperitoneal surgeries, owing to its robotic arms which could effectively cover a relatively large surgical area, while also being able to expand in narrow spaces, thus rendering it suitable for a variety of surgical approaches.

The postoperative pathological results showed that Gleason scores were generally consistent with the preoperative evaluation, except for one case which was downgraded from 4+3 to 3+4 at the time of biopsy. Additionally, three patients were found to have tumors at the pT3 stage due to the involvement beyond the prostatic capsule and invasion of the seminal vesicles. The incidence of PSMs was 31.2% for the entire cohort, 25.0% (3/12) for patients with pT2 tumors, and 50.0% (2/4) for those with pT3 tumors. All positive margin located at the apex. The data are close to the preliminary research data of multi-port RARP that our center initially conducted [30]. As a comparison,

Vigneswaran et al. [19] reported that the rate of PSM was 29% for pT2 tumors and 50% for pT3 tumors, which is roughly comparable to our experimental results, as well as the operation time. Agarwal et al. [31] reported shorter surgical time (161 min), lower PSM rate (28%), but increased estimated blood loss (200 mL) for 49 patients who underwent single-port da Vinci RARP. According to a large-scale cohort study, relative high rates (30% or higher) of PSMs were commonly observed in the first 50 cases performed by the surgeon. The study also suggested that the PSM rate may decrease with an increase in surgical experience [32]. Given that this novel robotic system was applied in a clinical setting for the first time, there was a learning curve for the surgeon, and the surgical team needed more time to improve coordination. Moreover, during the surgical procedures, the entire team was constantly working to enhance the instruments and parameters of the SHURUI system. Therefore, it is expected that in future large-scale applications, surgical time, PSM rate, and other indicators could be further improved.

One month after surgery, the majority of patients showed satisfactory urinary control, with no more than one urinary pad needed per day. Furthermore, 6 months after the operation, all patients no longer needed urinary pads. This can primarily be attributed to the preservation of the urethra during the operation and the precise and effective cutting and stitching provided by the SHURUI system. Furthermore, patient education provided by the medical team has also proven to be an essential aspect of postoperative care, as pelvic floor muscle exercises have been shown to effectively improve urinary control. These findings highlight the efficacy of SR-RARP in gaining satisfying postoperative functional outcomes.

As to the surgeons' feedback, critiques regarding system performance primarily focused on hand-eye coordination. In terms of comfort, the main deficiencies were related to muscle fatigue in the hands and neck. Feedback suggested that further improvements are required in the design of the handheld portion of the console and the clutch slider. This feedback will aid in refining the device and enhancing its capabilities, ultimately facilitating its successful utilization in future extensive clinical studies.

As this study represents a preliminary exploration of the feasibility and safety of this robotic system, the following limitations exist. This study was a single-arm study with no control group. In the future, more randomized controlled trials will be conducted to compare the performance of this robotic system with other single-port or multi-port robotic systems. Additionally, the sample size of this study is relatively small, and there may be biases in the data. After verifying the safety and efficacy, larger multicenter clinical trials would be conducted in the future to further explore the advantages and disadvantages of this system. As a clinical trial, patient selection in this study was relatively strict and focused mainly on early-stage localized prostate cancer patients. In future, the surgical indications of SR-RARP may broaden, potentially allowing its application to a wider range of patients at various stages of prostate cancer. Moreover, the possibility of incorporating this robotic system for procedures such as RARP through transperineal or transvesical approaches, as well as lymph node dissection, is an area of future exploration.

5. Conclusion

The SHURUI system is safe and feasible in performing RARP via both transperitoneal and extraperitoneal approaches. Surgical outcomes, tumor control, and urinary continence were satisfying for these patients. In the next phase, a high-quality, large-scale, multicenter randomized controlled trial is planned to further validate the efficacy and safety of the new technology in a larger population. This phase will involve comprehensive evaluation and longer-term follow-up studies to assess the long-term effectiveness and safety of the intervention.

Author contributions

Study concept and design: Linhui Wang, Yi Liu, Yi He, Bo Yang.
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Drafting of manuscript: Zheng Wang.
Critical revision of the manuscript: Chao Zhang, Zhenjie Wu, Linhui Wang.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgments

The authors would like to express their gratitude to Prof. Kai Xu and his research and development team from Shanghai Jiao Tong University, Shanghai, China, for their invaluable technical support of this study. This research was funded by the National Key Research and Development Program of China (Grant No. 2022YFB4700904 to Wang L) and Research-Oriented Physicians' Innovative Transformation Training Program of Development Center, Shanghai Shenkang Hospital, Shanghai, China (Grant No. SHDC2022CRS010B to Tang S).

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