Comparative Analysis of Robot-Assisted, Laparoscopic, and Open Radical Prostatectomy Regarding Lower Urinary Tract Symptoms: A Longitudinal Study

Shogo Inoue*, Tetsutaro Hayashi, Jun Teishima, Akio Matsubara
Department of Urology, Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima, Japan

Abstract

Purpose: This study aims to assess lower urinary tract symptoms (LUTS) after radical prostatectomy (RP) and compare longitudinally the short-time LUTS changes of three techniques: robot-assisted RP (RARP), laparoscopic RP (LRP), and open RP (ORP). Materials and Methods: We reviewed prospectively the collected longitudinal data on the International Prostate Symptom Score (IPSS) from patients who performed RP for localized prostate cancer. One-year longitudinal data (preoperatively and at postoperative 3, 6, and 12 months) on IPSS were available for 322 patients. The number of patients was 231 for RARP, 42 for LRP, and 49 for ORP. LUTS was assessed on the basis of the IPSS and the IPSS quality of life (QOL) score. Results: The IPSS and IPSS related QOL scores were significantly improved over the baseline score not for the LRP and ORP but for the RARP. For patients with moderate to severe LUTS preoperatively, the RARP group immediately improved in terms of preoperative LUTS differently from both LRP and ORP groups. Only RARP significantly improved in terms of voiding symptom composites (VSC) differently from both LRP and ORP procedures. However, none of the procedures changed in terms of storage symptom composites (SSC) longitudinally. Conclusions: The improvement of LUTS for RARP may contribute to the improvement of not only SSC but also VSC.

Keywords: Longitudinal study, lower urinary tract symptoms, quality of life, radical prostatectomy

Introduction

Prostate cancer (PCa) is a major cause of the increased cancer-related mortality worldwide and the second most commonly diagnosed cancer among men.[1] Localized PCa is a good indication for radical prostatectomy (RP), radiation therapy, or active surveillance. Many of them with organ-confined PCa and a longer life expectancy prefer RP. The gold standard for RP was open RP (ORP).[2,3] Minimally invasive surgery of PCa has been increasingly performed. The evolution from pure laparoscopic RP (LRP) to robot-assisted RP (RARP) may be assigned to the steeper learning curve and technical...
considerations associated with LRP. Advantages of RARP include three-dimensional viewing, improved ergonomics, elimination of physiologic hand tremor, and refined dexterity.\[^{[4,5]}\]

To date, the assessment of urinary symptoms after RP has focused primarily on urinary incontinence.\[^{[6]}\] However, there is little study on the impact of RP on lower urinary tract symptoms (LUTS). Although it is well known that irritative voiding symptoms are common in patients with PCa who performed RP, these symptoms significantly affect their quality of life (QOL).\[^{[7-9]}\]

Several studies have reported both short-term and long-term improvement in LUTS after ORP, especially in patients with severe LUTS preoperatively.\[^{[10-12]}\] however, there is little study comparing LUTS between various procedures of RP. This improvement in LUTS is likely because of immediate and definitive ease of bladder outlet obstruction (BOO) from the removal of the prostate gland. The impact of the improvement in LUTS is generally underestimated because of postoperative emergence of urinary incontinence.

Nevertheless, during RP, dissection of the trigone, posterior urethra at the bladder neck, and posterolateral neurovascular bundle cause dysfunctions to the lower urinary tract induced by ischemic changes and denervation.\[^{[13]}\] Besides, RP causes anatomic changes to the lower urinary tract, induced by removal of the prostate and subsequent reanastomosis of the urethra and bladder neck. The surgical procedure of RP transiently injuries the bladder and urethra, leading to temporarily lower urinary tract dysfunction in the early stage after surgery. Therefore, almost all patients temporarily experience not only storage but also voiding symptoms after RP.

Because the correct nature of LUTS after RP has not been proved, we investigated longitudinally the changes in LUTS, including voiding and storage symptoms, after RP by using the International Prostate Symptom Score (IPSS). Moreover, we evaluated potential factors that predict symptom changes at postoperative time points after RP. A comparative analysis on the LUTS of RARP, LRP, and ORP has yet to be conducted. The purpose of this study was to compare longitudinally the LUTS change of these three procedures.

**Subjects and Methods**

After we obtained approval from the Institutional Review Board (IRB) of Hiroshima University Hospital, we reviewed prospectively the collected longitudinal data on the IPSS of men who performed RP for localized PCa between September 2009 and February 2014. We excluded patients who were treated with either adjuvant or salvage radiotherapy from this investigation because of the potential impact on urinary function. We also excluded the first 20 cases in the RARP and LRP groups because we considered the influence of learning curve for both procedures. One-year longitudinal data sets (preoperatively and at 3, 6, and 12 months after RP) on IPSS were available for 322 cases. All procedures were performed by anterior approach. We also reviewed age, body mass index (BMI), serum prostate-specific antigen (PSA) at diagnosis, clinical tumor classification, biopsy Gleason score, and operative outcomes to investigate factors that may predict the changes of urinary symptoms following RP.

The study protocol was approved by the IRB of Hiroshima University Hospital (IRB No. 255). Informed consent was confirmed by the IRB.

LUTS was assessed on the basis of the IPSS and the IPSS QOL score, and both instruments were validated.\[^{[14,15]}\] The IPSS is a self-administered seven-item questionnaire comparing items of incomplete emptying, intermittency, straining, weak stream (voiding symptom composites [VSC]) and voiding frequency, nocturia, and urgency (storage symptom composites [SSC]). Each scale is scored separately from 0 to 5, with a higher score indicating a worse symptom. The IPSS is scored from 0 to 35 in all, with scores of 0–7, 8–19, and 20–35 indicating absent or mild, moderate, and severe symptoms, respectively.\[^{[14,15]}\] The IPSS QOL score is a questionnaire that quantifies the QOL for LUTS and is scored from 0 to 6, with a higher score representing a worse health state.

All patients agreed to participate in this study and signed an informed consent form. They received from their urologists a questionnaire and an envelope for returning it at preoperative baseline and at 3, 6, and 12 months postoperatively. The baseline characteristics were compared with a one-way ANOVA between RARP, LRP, and ORP. The outcome at each interval after RP was compared with the baseline level. Statistical analyses were made using the JMP version 10 statistical software package (SAS Institute Inc., Cary, NC, USA), and \( P < 0.05 \) was considered as statistically significant.

**Results**

A total of 322 patients were employed in our study, and the baseline characteristics of the patients for all procedures are listed in Table 1. The number of cases was 231 for RARP, 42 for LRP, and 49 for ORP. The mean age and serum PSA value at diagnosis were 66.3 years and 9.84 ng/ml, respectively. The median excision weight was 37.4 g. The mean operative time and estimated blood loss were 207.2 min and 286.6 ml, respectively.

There was no significant difference in age (\( P = 0.9637 \)), BMI (\( P = 0.7268 \)), and serum PSA at diagnosis (\( P = 0.1252 \)). On the other hand, clinical tumor classification was significantly higher in the RARP group (\( P = 0.0084 \)), and the biopsy Gleason score was significantly higher in the ORP group (\( P = 0.0408 \)). However, there was no significant difference in worse tumor characteristics represented by higher risk stages according to the D’Amico risk classification (\( P = 0.2984 \)). Operative time was significantly longer, and the estimated blood loss volume was higher in the ORP group (each \( P < 0.0001 \)) [Table 2].

In only the RARP group, the overall mean total IPSS, which was 9.40 before RARP, decreased over time after 6 months.
from RARP and reduced significantly to 7.57 at 6 months (19% reduction, \( P = 0.0065 \)) and to 6.88 at 12 months after surgery (27% reduction, \( P = 0.0004 \)). The mean scores of IPSS postoperatively and at 3, 6, and 12 months were 8.22, 10.76, 8.85, and 7.64 in the LRP group and 9.88, 11.83, 10.21, and 7.53 in the ORP group, respectively. In comparison, in both the LRP and ORP groups, the overall mean total IPSS was not significantly improved compared with the score before surgery. The trend of the mean IPSS QOL score was similar to that of the overall IPSS. In only the RARP group, the mean IPSS QOL score was reduced significantly to 2.66 at 6 months (13% reduction, \( P = 0.0171 \)) and to 2.44 at 12 months after surgery (20% reduction, \( P = 0.0005 \)) [Figure 1].

When the data were analyzed in accordance with the symptom severity at the preoperative point, 52.6% of the patients had moderate to severe LUTS preoperatively. There were no significant differences in the portion of severe LUTS between the three techniques (\( P = 0.4394 \)). For the patients with low IPSS (0–7) all patients recovered to the baseline at 12 months after surgery. In comparison, in the patients with high IPSS (8–35), the patients with LUTS who underwent LRP did not recover to the baseline level before surgery. In the RARP (14.3–9.02; 37% reduction, \( P = 0.0001 \)) and ORP groups (14.1–8.96; 36% reduction, \( P = 0.0058 \)), the patients with LUTS improved significantly at 12 months after surgery over the baseline levels [Figure 2].

We evaluated the mean total IPSS before and after RP between the three techniques [Figure 3] and found that there was no significant difference between each technique. For the patients with high IPSS, the patients who underwent RARP more quickly recovered from LUTS from the baseline score than did the other two groups.

![Table 1: Patient characteristics](image1)

| Characteristics                          | No. of patients (%) |
|-----------------------------------------|---------------------|
| Approach                                 |                     |
| RARP                                     | 231 (72)            |
| LRP                                      | 42 (13)             |
| ORP                                      | 49 (15)             |
| Age, year, mean                          | 66.3                |
| BMI, kg/m², mean                         | 23.3                |
| D’Amico risk group                       |                     |
| Low                                      | 53 (16)             |
| Intermediate                             | 171 (53)            |
| High                                     | 98 (30)             |
| Serum PSA at diagnosis, ng/m             |                     |
| \( \leq 4 \)                              | 20 (6)              |
| 4.1-10                                   | 197 (61)            |
| 10.1-20                                  | 84 (26)             |
| \( > 20 \)                               | 21 (7)              |
| Clinical tumor classification             |                     |
| T1                                       | 198 (61)            |
| T2                                       | 119 (37)            |
| T3                                       | 5 (2)               |
| Biopsy Gleason score                     |                     |
| \( \geq 6 \)                              | 68 (21)             |
| 7                                        | 173 (54)            |
| \( \leq 8 \)                             | 80 (25)             |
| Excision weight, g, mean                 | 37.4                |
| Operative time, min, mean                | 207.2               |
| Estimated blood loss, mL, mean           | 286.6               |

![Table 2: Patient characteristics stratified by approach](image2)

| Characteristics                          | RARP (\( n = 231 \)) | LRP (\( n = 42 \)) | ORP (\( n = 49 \)) | \( P \) |
|-----------------------------------------|-----------------------|--------------------|--------------------|--------|
| Age, yr, mean                           | 66.3                  | 66.5               | 66.2               | 0.9637 |
| BMI, kg/m², mean                        | 23.3                  | 22.9               | 23.2               | 0.7268 |
| D’Amico risk group                      |                       |                    |                    | 0.2984 |
| Low                                     | 35 (15)               | 11 (26)            | 7 (14)             |        |
| Intermediate                            | 121 (52)              | 23 (55)            | 27 (55)            |        |
| High                                    | 75 (32)               | 8 (19)             | 15 (31)            |        |
| Serum PSA at diagnosis, ng/ml           |                       |                    |                    | 0.1252 |
| \( \leq 4 \)                            | 14 (6)                | 3 (7)              | 3 (6)              |        |
| 4.1-10                                  | 150 (65)              | 25 (60)            | 22 (45)            |        |
| 10.1-20                                 | 51 (22)               | 13 (31)            | 20 (41)            |        |
| \( > 20 \)                              | 16 (7)                | 1 (2)              | 4 (8)              |        |
| Clinical tumor classification            |                       |                    |                    | 0.0084 |
| T1                                      | 129 (56)              | 33 (79)            | 36 (73)            |        |
| T2                                      | 98 (42)               | 8 (19)             | 13 (27)            |        |
| T3                                      | 4 (2)                 | 1 (2)              | 0 (0)              |        |
| Biopsy Gleason score                    |                       |                    |                    | 0.0408 |
| \( \geq 6 \)                            | 49 (21)               | 14 (33)            | 5 (10)             |        |
| 7                                       | 127 (55)              | 21 (50)            | 25 (52)            |        |
| \( \leq 8 \)                            | 55 (24)               | 7 (17)             | 18 (38)            |        |
| Excision weight, g, mean                | 37.8                  | 33.9               | 39.3               | 0.1497 |
| Operative time, min, mean               | 201.4                 | 221.9              | 246.4              | <0.0001|
| Estimated blood loss, mL, mean          | 166.9                 | 489.5              | 1348.9             | <0.0001|
We measured the IPSS for each of the seven composites including VSC and SSC before and after RP between each technique. For all composites excluding incomplete emptying in VSC only after RARP, the difference from the baseline was significant at 3 months after surgery and beyond. In the incomplete emptying score after RARP, the difference from the baseline was significant at 6 months after surgery and beyond. However, in both LRP and ORP groups, the difference from the baseline was not significant at all points after RP. For all SSC after RARP and LRP, the difference from the baseline significantly worsened only at 3 months after RP, and the SSC recovered from 6 months. However, in the only ORP group, SSC excluding urgency did not change at all points after RP [Figure 4].

Figure 1: Mean total IPSS and IPSS QOL scores before and after RP. The top and bottom rows indicate the mean total IPSS and IPSS QOL scores, respectively. a and d (solid square): RARP; b and e (solid circle): LRP; c and f (solid triangles): ORP. IPSS: International Prostate Symptom Score, RP: Radical prostatectomy, RARP: Robot-assisted radical prostatectomy, LRP: Laparoscopic radical prostatectomy, and ORP: Open radical prostatectomy

Figure 2: Mean total IPSS before and after radical prostatectomy stratified by the class of preoperative total IPSS. Top row: men with baseline scores of 0–7; bottom row: men with baseline scores of 8–35. a and d (solid square): RARP; b and e (solid circle): LRP; c and f (solid triangles): ORP. IPSS: International Prostate Symptom Score, RP: Radical prostatectomy, RARP: Robot-assisted radical prostatectomy, LRP: Laparoscopic radical prostatectomy, and ORP: Open radical prostatectomy
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This present study further extended the degree of invasiveness and in our study, the IPSS and IPSS-related QOL were significantly improved over the baseline score not only for the LRP and ORP but also for the RARP. For the patients with moderate to severe LUTS preoperatively, the RARP group very immediately improved in terms of preoperative LUTS differently from the LRP and ORP groups. Only RARP significantly improved in terms of VSC differently from both the LRP and ORP procedures. However, none of the procedures changed in the SSC longitudinally. These results suggest that the improvement of LUTS in RARP may contribute to the improvement of not only SSC but also VSC.

It was reported that a substantial proportion of patients were affected by detrusor overactivity, impaired detrusor contractility, decreased compliance, and sphincter weakness in the patients with RP. It has been suggested that bladder denervation during RP may be recognized as one of the reasons for these abnormalities. Wide anatomical dissection around the prostate and bladder neck during RP may cause disruption of regional afferent and efferent innervation, and this finding induces outlet incompetence and partial denervation of the detrusor muscle. This degree of invasiveness and denervation around the bladder neck, which affects voiding function and LUTS, may differ from that associated with each procedure of RP. Our study is the first to longitudinally evaluate the impact of various RP techniques on LUTS and QOL for postoperative 1 year in patients with localized PCa.

Consistent with this concept, it was observed, via sequential urodynamic studies, that there were reductions in maximum cystometric capacity, maximum urethral closure pressure, and maximum detrusor pressure at postoperative 3 months. This postoperative reduction in overall bladder function gradually improved after 3 months but did not reach the baseline level even after 3 years. It was more interesting that the storage symptoms progressively worsened, while voiding symptoms improved in the study.

Although our study was small and lacked data on uroflowmetry and urodynamic variables, it provides important findings on the impact of RP on LUTS. Urodynamic examination would help identify underlying organic changes to the bladder and sphincters for chronic LUTS, but this examination was not
Figure 4: IPSS for each of the seven composites before and after RP between each technique. a: Incomplete emptying; b: Intermittency; c: Weak stream; d: Straining; e: Voiding frequency; f: Urgency; g: Nocturia. Top row (solid square): RARP; middle row (solid circle): LRP; bottom row (solid triangles): ORP. IPSS: International Prostate Symptom Score, RP: Radical prostatectomy, RARP: Robot-assisted radical prostatectomy, LRP: Laparoscopic radical prostatectomy, and ORP: Open radical prostatectomy
practical because of the invasiveness. The other limitation is that it is an observational study with retrospective analysis of the prospectively collected data. The strength of the study includes the length of longitudinal follow-up and inclusion of a urinary QOL instrument.

**Conclusions**

There are no studies that have reviewed postoperative outcomes in men with LUTS compared with various procedures of RP. We compare longitudinally the short-time LUTS change of three techniques: RARP, LRP, and ORP. After RARP, the patients with LUTS significantly improved in a statistically significant manner over a 1-year period over the baseline score differently from both LRP and ORP. In particular, patients who underwent RARP significantly improved in terms of VSC, which may improve LUTS. We need to recognize how the RP procedure has an impact on the improvement of LUTS.

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**Conflicts of interest**

There are no conflicts of interest.

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