Abstract. Aim: We investigated the relationship between a new index considering the estimated working space and difficulty of robot-assisted radical prostatectomy (RARP) using our database. Patients and Methods: Working height was calculated by the obstetric conjugate diameter minus the bladder and rectal wall thicknesses minus the thickness of postvesical fat minus the rectal fat thicknesses measured using preoperative magnetic resonance imaging (MRI). The proportion of working height was calculated by dividing the working height by the obstetric conjugate diameter. Results: A total of 112 RARP cases were enrolled. The mean obstetric conjugate was 105 mm and the mean proportion of working height was 72.5%. Multivariate linear regression analysis indicated that the proportion of working height was an independent predictive factor for both console time and estimated blood loss. Conclusion: The difficulty of RARP can be predicted by measuring the fat thicknesses around the rectum and bladder before surgery.

Robot-assisted radical prostatectomy (RARP) has been widely adopted all over the world and several studies have reported predictors of prolonged operative time and estimated blood loss (1-3). Recently, we encountered a case in which RARP was extremely difficult. The patient was 63 years old, 156 cm in height, 65 kg in body weight and had a prostate volume of 74 ml, as determined by transrectal ultrasound. The patient’s body mass index (BMI) was 26.7 kg/m². Magnetic resonance imaging (MRI) before the operation (Figure 1A) revealed a large prostate with median lobe protrusion. During the operation, it was necessary to perform RARP in a very narrow working space, especially with regard to the height of the working space. Therefore, it was difficult not only to remove the prostate but also to perform urethrovesical anastomosis because it was difficult to bring the neck of the bladder close to the urethral stump. There have been several reports that large prostate and median lobes were associated with prolonged operative time and estimated blood loss (1-4) and some reports indicated that the operative time of RARP was longer and the estimated blood loss was higher in obese patients (5-7). In the pelvic cavity, the ratio of prostatic volume to estimated pelvic volume (8) and the distance between true conjugate and prostate apex (pelvic depth) (9) are associated with longer operative time and higher estimated blood loss; however, bony pelvic dimensions do not seem to be associated with operative duration, estimated blood loss or complications in RARP (10, 11). In the present case, BMI was high and the prostate was large with protruding median lobe; however, it was difficult to explain the relation between narrow working space and difficulty of RARP. BMI cannot distinguish between fat and other organ weight or between visceral and subcutaneous fat. Several reports indicated that BMI was not associated with operative difficulty in RARP (1, 12). We considered that the working space during surgery may be associated with difficulty of manipulation based on our experience and that it may be possible to predict operative difficulty by measuring the pelvic cavity and pelvic visceral volume including fat using MRI prior to surgery.

Here, we investigated the relationship of a new index considering the estimated working space and difficulty of RARP using our database.

Patients and Methods

Patients and measurements. With the approval of the Ethics Committee of Kanazawa University, we have maintained a database to prospectively follow patients treated with RARP. We reviewed cases of RARP by a single surgeon, excluding the initial 10 cases.
under the learning curve, between May 2011 and September 2013. Pelvic MRI was performed in all cases to evaluate prostate cancer status before surgery. We analyzed various clinical and operative variables from our Institution’s prospective RARP database. The weight of removed specimen was recorded after operation and included the prostate, seminal vesicle and vasa deferentia stumps.

Preoperative MRI was performed with a 1.5-Tesla MRI system (Sigma HDx; GE Medical Systems, Milwaukee, WI, USA) using a SENSE_FLX_M coil (Philips Medical Systems, Best, The Netherlands). Bony measurements and soft tissue measurements were made at the pelvic midplane on sagittal first spin echo T2-weighted image (TR3200ms, TE 113ms, 3 mm slice thickness) (Figure 1A). The obstetric conjugate diameter (Figure 1A, a) was defined as the closest distance from the pubic symphysis to the sacral promontory. The anterior and posterior bladder wall thicknesses (Figure 1A, b, c) were defined as the means of the bladder wall thickness at 1, 3 and 5 cm from the junction of the bladder and prostate. MRI was performed from 30 to 60 min after urination and estimated bladder capacity in each case was 30 – 100 ml based on MRI results. The anterior and posterior rectal wall thicknesses (Figure 1A, f, g) were measured at the collapsed position of the rectum. The thickness of postvesical fat (Figure 1A, d) was measured at the thickest postvesical fat points because the top of the bladder falls cephalad after bladder taking down due to the steep head-down position during RARP. The posterior rectal fat thickness was measured at the junction level of bladder and prostate (Figure 1A, e). The anterior and posterior rectal fat thickness (Figure 1A, h) was measured at the obstetric conjugate. In cases with difficulty of measuring posterior rectal fat thickness on the line of the obstetric conjugate because of the colon position, the fat thickness was measured on a line parallel to the obstetric conjugate at the caudalmost point from the sacral promontory where the rectum clearly attaches to the sacrum. Working height was calculated by the obstetric conjugate diameter (Figure 1A, a) minus the anterior and posterior bladder wall thicknesses (Figure 1A, b, c) minus the anterior and posterior rectal wall thicknesses (Figure 1A, f, g) minus the postvesical fat thickness (Figure 1A, d) minus the anterior and posterior rectal fat thicknesses (Figure 1A, e, h). The proportion of working height was calculated by dividing the working height by the obstetric conjugate diameter.

Statistical analysis. The categorical variables used to calculate the incidence and percentage of each factor and the continuous variables are summarized as mean±standard deviation (SD). Univariate and multivariate analyses were used to establish which predictor variables were significantly related to the console time and estimated blood loss. To investigate the correlations between factors, the Pearson’s correlation coefficient was calculated. For continuous variables, linear regression analysis was performed. Subsequently, multivariate analysis was performed. All data analyses were performed using SPSS for Windows (SPSS Inc, Chicago, IL, USA). In all analyses, \( p<0.05 \) was taken to indicate statistical significance.

Results

The characteristics of the patients included in this study are shown in Table I. A total of 112 cases of RARP performed by a single surgeon were included. All surgeries were performed safely without any severe complications or open conversion. Neoadjuvant hormone therapy was performed in 44 patients (39.3%); however, no other treatment for prostatic cancer, including radiation or seeding, was performed before RARP. A total of 46 cases (41.1%) had a history of abdominal surgery, including 38 cases of appendectomy, 2 cases of laparoscopic cholecystectomy, 2 cases of open cholecystectomy, 2 cases of open cholecystectomy, 2 cases of open herniorrhaphy and 2 cases of enteroctomy. Nerve-sparing RARP was performed unilaterally in 46 patients and bilaterally in 14 patients depending on the cancer status.
The results of each parameter from MRI are shown in Table II. No definite lesions were observed in the bladder and rectal wall in MRI. Mild bladder wall irregularities were observed in several cases. However, there were no cases with extreme bladder or rectal wall thickness. The SD of the bladder and rectal wall thickness were small. The mean obstetric conjugate was 105 mm, the mean height of the working space (working height) was 76.8 mm and the mean proportion of working height was 72.5%.

According to univariate linear regression analysis, the BMI, specimen weight and proportion of working height were predictive factors for console time, while BMI, neoadjuvant hormone therapy, specimen weight, obstetric conjugate and the proportion of working height were predictive factors for the estimated blood loss. However, on multivariate linear regression analysis, only the proportion of working height was an independent predictive factor for both console time and estimated blood loss (Table III).

**Discussion**

There have been no previous reports regarding the association of intrapelvic fat, including fat surrounding the bladder and rectum, and difficulty of RARP. To our knowledge, this is the first report of a relation between difficulty of RARP and intrapelvic fat. During RARP, the greatest problem was due to the narrow working space considered to be incomplete urethrovesical anastomosis. Therefore, we assumed the situation of approaching bladder neck to urethral stump after removal of the prostate (Figure 1B) to evaluate the difficulty of the case of RARP and we measured the diameter of obstetric conjugate, which is the narrowest anteroposterior distance of the pelvic bone and the thicknesses of bladder, rectum and intrapelvic fat at the obstetric conjugate thought to occupy the pelvic space by MRI before the operation (Figure 1A). Then, we calculated the prospective height of the working space (working height) using these measurements. This calculation seemed to be reasonable because the apex of the bladder fell downward in the cephalad direction due to the steep Trendelenburg position during RARP after opening the Retzius space and the bladder taking down. The thickness of postvesical fat was measured at the thickest fat position by MRI. However, the thickness did not differ markedly at any position. The thicknesses of the bladder and rectal wall changed due to the inner capacity. MRI was performed at a constant time after urination and therefore the bladder capacity calculated by MRI and the thickness of the bladder wall did not differ markedly in each case and the SD was not large. The thickness of the rectal wall is affected by movement and inner capacity and therefore we measured the thickness of the rectal wall at the collapsed part; the thickness of the rectal wall did not differ markedly in each case and the SD was also not large. At our Institution, many doctors perform placement of the trocar cannula, docking of the robot and wound closure, and therefore we evaluated console time performed by a single surgeon and estimated blood loss as an indicator of the difficulty of RARP in this study. On multivariate analysis, only the working height was a predictor of console time and estimated blood loss.

In a case of extremely difficult RARP that we encountered recently, the BMI was 26.7 kg/m² and estimated volume of the prostate was 74 ml with middle lobe hypertrophy. The operative time was 6 h, the console time was 5 h and the estimated blood loss was 1350 ml; however, the hemoglobin level was 9.2 g/dl and blood transfusion was not necessary.
The resected specimen weight was 77 g. The postoperative course was uneventful and the urethral catheter was removed with no leakage in cystography at one week after the operation, as scheduled. The console surgeon responsible for this difficult operation had performed over 100 cases of RARP. We compared the MRI findings both before (Figure 1A) and after (Figure 1B) the operation. One of the reasons for difficulty in the operation was the large prostate with median lobe protrusion in this case. The obstetric conjugate was 82 mm, the working height was only 30 mm and the proportion of working height, which was 37%, was markedly lower than in other cases.

The depth of the pelvic cavity was reported to be associated with difficulty of RARP (9); however, the bony pelvic dimensions seem not to affect the difficulty and outcome of RARP (10, 11). In our study, the BMI was not a predictive factor for console time and estimated blood loss. The correlation between BMI and the proportion of working height was strong ($r=-0.536$, $p<0.001$) in our study, and the possibility that the difficult case of RARP was included in high-BMI cases was considered. There are differences among individuals in the distributions of fat area (13) and therefore not all high-BMI cases have large amounts of visceral fat in the pelvic cavity and RARP can only be performed with difficulty (1, 3, 5-7). On the other hand, a large prostate is thought to result in difficulty of RARP (1, 3, 4, 14).

The space of the pelvic cavity is defined by the pelvic bone and the sigmoid colon must be detached from the abdominal wall and moved cephalad to gain a large working space in the deep pelvic cavity during RARP. In the first step after the bladder taking down, the fat in front of the prostate is removed to allow clear visualization of the Retzius space. However, we

| Table III. Results of linear regression analysis to predict console time and blood loss by analyzing each parameter. |
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| | Console time | | Estimated blood loss | |
| | Univariate | Multivariate | Univariate | Multivariate | |
| | $p$-Value | $p$-Value | $\beta$ (95%CI) | $p$-Value | $p$-Value | $\beta$ (95%CI) |
| Age (years) | 0.062 | 0.059 |
| Body mass index (kg/m$^2$) | 0.027 | 0.443 |
| Neoadjuvant hormone therapy (yes vs. no) | 0.188 | 0.025 | 0.996 | 0.311 |
| Previous abdominal surgery (yes vs. no) | 0.720 | 0.557 |
| Specimen weight (g) | 0.005 | 0.132 | 0.004 | 0.274 |
| Obstetric conjugate (mm) | 0.262 | 0.034 | 0.889 |
| Proportion of working height (%) | $<0.001$ | $<0.001$ | $-2.557 (-3.535$ to $-1.579)$ | $<0.001$ | $<0.001$ | $-11.666 (-18.348$ to $-4.985)$ |

Figure 2. Urethral stump status in the pelvic cavity without (A) and with (B) pressure on the perineum.
are not able to remove the fat around the rectum and bladder during RARP. Therefore, a large volume of fat around the rectum and bladder becomes problematic for the operation because it results in a narrow working space. In such cases, it may be difficult to bring the bladder neck close to the urethral stump during urethrovesical anastomosis and there is a risk of tearing of the urethra or bladder at anastomosis when approaching the bladder neck to the urethra. The urethral stump can be pushed toward the pelvic cavity by about 1-2 cm by the assistant applying pressure to the perineum in the operative field (Figure 2A and 2B) and this maneuver is thought to enable or facilitate urethrovesical anastomosis in difficult cases. In our case, we failed to perform urethrovesical anastomosis at the first try because of tearing of the urethral stump due to tension of the suture caused by difficulty of approaching the bladder neck to the urethral stump. However, we successfully performed urethrovesical anastomosis at the second try by pushing the perineum as described above.

The difficulty of RARP can be predicted by measuring the fat thicknesses around the rectum and bladder using MRI or computed tomography before the operation. In the initial period of RARP, it is recommended to avoid cases in which the working space is predicted to be narrow.

We occasionally encounter difficult cases of RARP, especially of urethrovesical anastomosis (15) and our study demonstrated that one of the reasons for this difficulty is fat around the rectum and bladder. However, we were unable to establish a clear standard and cut-off level of difficulty of RARP by measuring the thickness around the rectum and bladder. The thicknesses of the rectal and bladder walls can change due to inner volume. However, the bladder is collapsed by the indwelling urethral catheter during RARP and the content in the rectum is excreted almost completely by intestinal tract cleaning before RARP. The thickness of the bladder wall is almost the same except in cases of extreme neurogenic bladder and the thickness of the rectal wall is also almost the same because patients scheduled for RARP do not have rectal lesions. To evaluate the thicknesses of fat and rectal and bladder walls, it may be difficult to achieve uniform MRI conditions, for example, when to urinate or evacuate. Therefore, when predicting the difficulty of RARP by measuring each value on MRI before the operation, it may be reasonable to use values of 6 mm and 9 mm for the thicknesses of the bladder and rectum, respectively, which are the sums of rough mean values of the anterior and posterior walls of the bladder and rectum in this study. We showed in this study that lower working height makes RARP more difficult. However, we were unable to determine how much space is needed to perform RARP safely, although this naturally depends on the surgeon’s experience with the RARP procedure. Further investigations and accumulation of cases are required to establish the standard and cut-off level of difficulty for RARP.

**Conclusion**

The difficulty of RARP can be predicted by measuring the fat thicknesses around the rectum and bladder by MRI before surgery. The assistant can push the urethral stump toward the pelvic cavity by about 1-2 cm by pushing from the perineum in the operative field with this maneuver enabling or facilitating urethrovesical anastomosis in difficult cases.

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**References**


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