The effects of pelvic dimensions on radical retropubic prostatectomy

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Introduction: *To determine the effects of pelvic dimensions on margin status, preoperative and postoperative estimated blood loss (EBL), operative time and transfusion rate (TR) during radical retropubic prostatectomy (RRP).*
Materials and methods: *Data from 94 patients with preoperative prostate MRI were analyzed. Pelvic dimensions, including interspinous distance (ISD), bony (BFW) and soft tissue (SW) pelvic width, apical prostate depth, upper conjugate (UC), lower conjugate (LC) were measured by preoperative MRI. Indexes for pelvic dimensions (PDI), bony width (BWI) and soft-tissue width (SWI) were defined as ISD/AD, BFW/PD, and SW/AD, respectively. As indicators of surgical difficulty, TR and EBL were assessed. SPSS version 17.0 was used for statistical analyses.*
Results: *Correlational analysis revealed no significant relationship between pelvic dimensions and parameters reflecting operative difficulty (p > 0.05). For EBL, there were significant indirect correlations between the BFW/AD, ISD/AD, and SW/AD indexes (p < 0.01, p < 0.01, p < 0.05; respectively). Additionally, the correlations between AD and TR (p < 0.05) and between AD and EBL (p < 0.05) were significant. Consequently, TR was significantly correlated with BFW/AD, ISD/AD and SW/AD (p < 0.01, p < 0.05, p < 0.01; respectively). Correlational analysis revealed that prostate volume (PV) was significantly correlated with EBL and TR (p < 0.01). Multivariate analyses revealed that PV was a significant predictor of TR (p = 0.06). None of the pelvic dimensions were significantly associated with recovery of urinary continence (RUC) (p > 0.05).*
Conclusions: *Analyses of pelvic dimensions as significant factors influencing operative difficulty during RRP yielded mixed results. PV seems to be the strongest factor related to operative difficulty. Future studies about pelvic dimensions should be conducted.*

Key Words: radical prostatectomy, pelvic dimensions, operative difficulty, surgical outcome

Introduction

To perform a successful radical retropubic prostatectomy (RRP) with optimal clinical and pathological outcomes, factors influencing the performance of the procedure should be clearly defined. Prostate size and obesity have been reported to have a significant effect on the pathological and functional results of RRP.[1-5] Body mass index (BMI) > 25 kg/m^2 was found to be significantly related to higher transfusion rates (TRs) and more estimated blood loss (EBL).[3] By contrast, another study reported no relation between BMI and an indicator of operative difficulty, but this study found higher TRs (p = 0.05) and EBL (p = 0.02) in prostates greater than 50 mL. The same study found no association involving continence or erectile function on either TR or EBL.[2] Prior data evaluating the impacts of prostate size and BMI on morbidity, operative time, EBL, hospital stay, surgical margin (SM) status, continence and potency in patients who underwent laparoscopic radical prostatectomy (LRP) are also available.[6,7]

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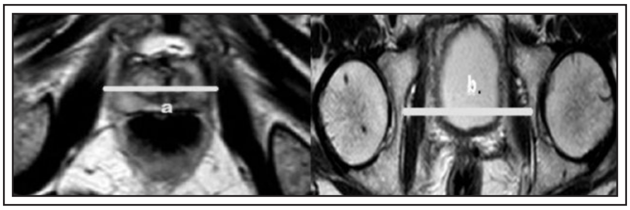

Figure 1. a) The soft tissue width (SW) was defined as the narrowest distance between the levator muscles on the axial T2-weighted sequence images. **b)** (BFW) Bony femoral width was defined as the bony width of the pelvis at the midfemoral head level.

Some publications have mentioned that performing RRP in patients with a wide and shallow pelvis might be easier than in patients with a narrow and deep pelvis.[5,6,8,9] As a predictor of operational success, Hong et al used the pelvic dimension index (PDI). The PDI is defined as the interspinous distance (ISD) on an MRI divided by the apical depth (AD), which corresponds to the craniocaudal distance from the most proximal margin of the symphysis pubis to the level of the distal margin of the prostatic apex as measured on a mid-sagittal MRI. They demonstrated that variations in the bony pelvic dimensions may have an impact on RRP.[8] In addition to PDI, we investigated the bony femoral width (BFW)/AD index and soft tissue width (SW)/AD index as predictors of operative difficulty

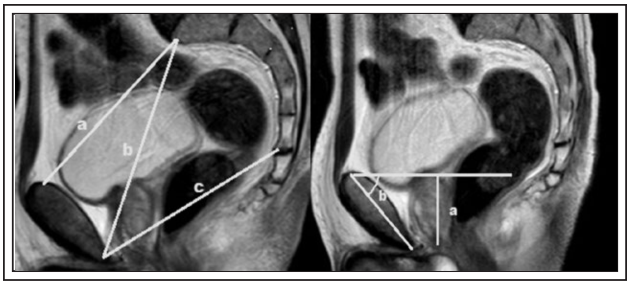

Figure 2. Left inferior a) The upper conjugate (UC) was defined as the distance from the inner most aspect of the top of the symphysis pubis to the sacral promontory on the mid-sagittal plane. **b)** The pelvic depth (PD) was defined as the distance between the promontorium and the lower symphysis pubis. **c)** The lower conjugate (LC) was defined as the distance from the lower symphysis pubis to the sacrococcygeal junction determined on the midsagittal plane.
Right a) The apical depth was defined as the distance between the highest point of the symphysis pubis to the prostatic apex. **b)** The symphysis angle (SA) was defined as the angle between the long axis of the symphysis pubis and the horizontal mid-sagittal plane.

and functional outcomes of RRP in our study. A point that distinguishes our study from other reports is the complementary evaluation of prior variables with variables such as BFW/AD, SW/AD, upper conjugate (UC) and lower conjugate (LC), Figure 1 and 2. MRI is superior to CT for soft tissue imaging, which was especially necessary in our study to determine certain key variables.

The purpose of our study was to investigate the impact of various pelvic dimensions as measured by MRI on indicators of the technical difficulty of the procedure, including operative time, EBL in mL, TR (I/U)), the recovery of continence (RUC) and SM status in patients who underwent RRP in our clinic.

Materials and methods

Our study included 94 patients who underwent RRP between the years of 2006-2009 in our clinic and were evaluated using MRI to obtain measurements of pelvic dimensions. MRI was performed as a standard protocol in our clinic. All procedures were performed by the same surgeon in a training and research hospital in Turkey. The socioeconomic status and ethnic origin of the patients were similar. None of the patients had a history of previous trauma or surgery. Patients who received prior radiotherapy or hormone therapy were excluded from the study. Age, BMI, preoperative PSA, pathological stage, Gleason score sum, PV, continence and pelvic dimensions were recorded preoperatively. Additionally, the patients were divided based on BMI into three groups designated as normal (BMI $\leq$ 25 kg/m^2), overweight (BMI 25-30 kg/m^2) and obese (BMI $\geq$ 30 kg/m^2). Based on PV measured by transrectal ultrasound, patients were also classified into three groups designated as < 35 mL, 35 mL-50 mL and > 50 mL. Operation time, intraoperative EBL, TR, SM status and RUC were recorded as factors related to the surgical outcome. Continence was defined as the use of less than one pad per day. Transfusion was given to patients with perioperative blood loss more than 600 mL or with a hemoglobin level lower than 10 gr/dL perioperatively and postoperatively.

The technique of RRP performed in our clinic

We routinely place patients in a 30 degree Trendelenburg position with overextension of the pelvis. We use a Bookwalter self-retaining retractor. Pneumatic intermittent calf compression devices are used routinely. Xenon head light and 4-power loops were also used. A 18 Fr urethral catheter is placed and a lower midline incision performed. After incision cavum retzii is exposed bluntly and adjacent fat tissue is removed to expose the endopelvic fascia. Endopelvic fascia is incised near from pelvic sidewall to anteromedial, preserving the puboprostatic ligaments. For nerve sparing, the neurovascular bundle is carefully rolled off the lateral prostate after incision of the periprostatic fascia. Bleeding from pelvic wall is stopped with bipolar forceps. Deep Santorini's plexus is bunched in a curved Babcock clamp and ligated over the apical prostate and at the bladder neck. The dorsal ven complex is divided with a knife and a by sharp scissors over the ventral aspect of the prostate to avoid damage to the urethral sphincter. The prostatic apex is approached directly along the lateral side of the prostatic capsule towards the membranous urethra. The urethra is transected with sharp scissors at the level of the distal verumontanum. Bleeding from Santorini's plexus is controlled with a 2-0 Vicryl suture between Santorini's plexus and the rhabdosphincter in a coronal plane. The cranial prostate pedicle is divided about 0.5 cm-1 cm from the prostate. In the nerve sparing technique, the pedicle is divided by sharp, atraumatic dissection with ligation close to the prostatic capsule to avoid damage to the proximal portion of the neurovascular bundle. Bleeding from the nuerovasculer bundle is controlled with superficial 4-0 Vicryl sutures. Electrocautery is not used in this part of the procedure.

Following incision of Denonvillier's fascia care is taken to mobilize the seminal vesicles without causing any trauma. Trigone is transected 3 mm-5 mm caudal of the interureteric ridge and the prostate is removed. Bladder-neck sparing is not attempted. The bladder outlet is narrowed (0.8 cm-1 cm) with 2-0 Vicryl continous seromuscular sutures using a tennis rocket technique. Five 3-0 Vicryl sutures with a UR-6 needle are placed along an 18 Fr urethral catheter without eversion of the bladder mucosa to ensure a direct mucosa-to-mucosa anastomosis between the resected margin of the proximal urethra and the reconstructed bladder neck. The sutures at 5 and 7 o'clock are passed medial to the neurovascular bundles through the remnant of Denonvillier's fascia and the urethral stump, taking approximately 4 mm of the outer part of the urethra but only including the edge of the mucosa. Two stitches are placed laterally at 3 and 9 o'clock. The suture at 12 o'clock are anchored to ligated Santorini's plexus to avoid traction on the sphincter muscle. Postoperative day 8 the transurethral catheter is removed, after confirming an intact anastomosis with cystography. If extravasation is present, catheter drainage is continued until the radiologic examination shows an intact anastomosis. Most of the patients were discharged postoperative day 2. Early mobilization on the evening of the procedure is performed with most of patients.

MRI was conducted using a 1.5-T system (Achievo, Philips Medical Systems, the Netherlands), and a sense body coil was used for signal reception. All imaging was carried out 1 month after the prostate biopsy. Thin-section, high-spatial-resolution axial, coronal and sagittal T2-weighted fast spin-echo images were obtained with the following parameters: repetition time/echo time, 3500 ms/80 ms; section thickness, 5 mm; intersection gap, 0.8 mm, matrix, 352 x 512.

MRI images were reviewed by radiologists who were blind to the patients' features. The variability between the measurements of the radiologists was assessed with Kendall's tau B, gamma, and kappa values. $P < 0.05$ was considered significant. Pelvic dimensions were measured with the Extreme PACs CD program version 3.3.0.50. Various pelvic dimensions on MRI images are meant to reflect the pelvic depth and width of the patients. UC was defined as the distance from the innermost aspect of the top of the symphysis pubis to the sacral promontory on the mid-sagittal plane. LC was defined as the distance from the lower symphysis pubis to the sacrococcygeal junction determined on midsagittal-plane. The symphysis angle (SA) was measured as the angle between the long axis of the symphysis pubis and the horizontal mid-sagittal images. Pelvic depth (PD) was defined as the distance between the promontorium and the lower symphysis pubis. The ISD was measured on the axial plane between the tips of the ischial spines. The BFW of the pelvis at the mid-femoral head level on the axial plane was also assessed on the images. The SW was defined as the narrowest distance between the levator muscles on the axial T2-weighted sequence images. All pelvic dimensions that were used in the study were described in Figure 1. The BFW is likely to be a more representative measure of the width of the bony pelvis encountered by the urologist during RRP than the ISD.[10] BFW-, ISD- and SW index were defined as BFW/AD, ISD/AD and SW/AD, respectively. Therefore, in a deep and narrow pelvis, a lower index should be expected.

Statistical analysis

Data were analyzed using SPSS version 17.0. Bivariate correlation analyses (Pearson correlation analyses, r = correlation coefficient), independent samples t-tests and ANOVA were used to assess relationships between two variables. Also, multivariate analysis was performed via linear regression analysis.

Results

Patient characteristics and frequencies are listed in Table 1 and 2.

Correlational analysis revealed no significant relationship between UC, LC, PD, SA, BFW, SW or ISD and the parameters reflecting operative difficulty ($p > 0.05$). In the case of EBL, there were significant indirect correlations between the BFW/AD, ISD/AD, and SW/AD indexes ($r = -0.275^{**}$, $p < 0.01$; $r = -0.217^{*}$, $r = -0.244^{*}$, $p < 0.05$, respectively). Additionally, the correlation between AD and TR ($r = 0.209^{*}$, $p < 0.05$) and between AD and EBL ($r = 0.218^{*}$, $p < 0.05$) was significant. Consequently, TR was significantly correlated with BFW/AD, ISD/AD and SW/AD ($p < 0.01$, $r = -0.276^{**}$; $p < 0.05$, $r = -0.224^{*}$ and $p < 0.01$, $r = -0.286^{**}$, respectively).

Further correlational analysis revealed that PV was significantly correlated with EBL and TR ($r = 0.0319^{**}$, $r = -0.319^{**}$; $p < 0.01$); however, BMI showed no relationship with these parameters ($p > 0.05$). One way analysis of variance demonstrated a significant effect of PV on the EBL and TR ($F = 9.159$, $p < 0.01$ and $F = 8.839$, $p < 0.01$; respectively). Posthoc tests (Tukey's b) suggested that each category of PV significantly differed from the other category with respect to EBL and TR values. To investigate the impact of BMI on EBL and TR in detail, one way analysis of variance was performed. The outcome of this variance analysis for the BMI groups was insignificant and provided support for the results of our correlational analysis ($p > 0.05$).

TABLE 1. **Patient characteristics**

Variable	**Mean ± SD (range)**
Age (yrs)	61.65 ± 6.93 (44-77)
Serum PSA (ng/dL)	10.23 ± 10.82 (1.8-93)
EBL (cc)	767.5 ± 671.6 (200-5000)
TR (IU/per case total)	1 ± 1.16 (0-5)
RUC (days)	53.7 ± 75.33 (1-360)
Operative time (min)	139 ± 26.4 (116-194)
PD (cm)	12.67 (10.54-14.2)
SA (degrees)	41.1 (25-56)
UC (cm)	10.87 (8.11-13.1)
LC (cm)	10.7 (8-13)
BFW (cm)	10.18 (8-11.25)
SW (cm)	4.89 (3.92-6.4)
ISD (cm)	9.07 (7.44-10.88)
AD (cm)	2.61 (1.6-4.5)
BFW/AD	4.07 (2.21-6.63)
SW/AD	1.99 (0.95-4.29)
ISD/AD	3.58 (1.72-5.86)
PV (mL)	47.5 ± 17.89 (13-106)
BMI (kg/m^2)	26.52 ± 2.47 (20.7-33.8)

PSA = prostate-specific antigen; EBL = estimated blood loss; TR = transfusion rate; RUC = recovery of urinary continence; PD = pelvic dimension; SA = symphysis angle; UC = upper conjugate; LC = lower conjugate; BFW = bony; SW = soft tissue; ISD = interspinous distance; AD = apical depth; PV = prostate volume; BMI = body mass index

TABLE 2. **Frequencies**

Pathological stage	N (%)
pT2a	27 (28.7)
pT2b	27 (28.7)
pT2c	22 (23.4)
pT3a	12 (12.7)
pT3b	5 (5.2)
pT4a	1 (1.1)
Postoperative continence	
Positive	88
Gleason score	
5	7
6	38
7	40
8	7
9	2
Surgical margin status	
Positive	11
BMI < 25 kg/m^2	35
BMI 25-30 kg/m^2	47
BMI >30 kg/m^2	12

BMI = body mass index

The variables related to operative difficulty were evaluated with regard to other factors that may potentially affect them. Multivariate analyses revealed that PV was a significant predictor of TR, and BFW/AD and AD were nearly significant, Table 3. Operative time and EBL were not related to any variable in multivariate analyses.

None of the pelvic dimensions, age, PV, PSA, BMI reflectors of operative difficulty and BMI were significantly associated with RUC ($p > 0.05$), but the ISD/AD and TR index were near to significance ($p = 0.094$, $p = 0.083$, respectively). The patients were divided into two groups based on the time of RUC designated as early RUC (< 30 days) and late RUC (> 30 days). An independent samples t-test revealed significant difference between the two RUC categories

TABLE 3. **Factors potentially affecting transfusion rate (F = 1.597, p = 0.095, r2 = 0.285)**

Independent variable	ß	T	P
Constant	0.11	0.991	
Prostate volume	0.258	2.101	0.040*
BFW/AD	-0.700	-1.774	0.081
ISD/AD	0.84	0.289	0.774
UC	0.367	1.680	0.098
AD	-0.652	-1.940	0.057
LC	-0.178	-1.188	0.239
BFW	0.226	1.362	0.178
ISD	0.059	0.373	0.710
SW	-0.148	-0.891	0.376
PD	-0.192	-0.945	0.348
SPA	0.184	1.235	0.221
RUC	0.111	0.881	0.381
BMI	0.066	0.554	0.581
SW/AD	-0.164	-0.673	0.503
PT	-0.140	-1.187	0.239
PSA	0.094	0.740	0.462

p < = 0.05; ß = coefficient of regression
BFW = bony; AD = apical depth; ISD = interspinous distance; UC = upper conjugate; LC = lower conjugate; SW = soft tissue; PD = pelvic dimension; RUC = recovery of urinary continence; BMI = body mass index; PSA = prostate-specific antigen;

with respect to age (t = -1.782, p < 0.05). The mean age in the early RUC group was 60.3 and the mean age in the late RUC was 63.0. According to this result, earlier RUC was observed in younger patients.

By contrast, multivariate analyses demonstrated independent association between RUC and EBL (p = 0.031). Also, association between RUC and PV (p = 0.089) were nearly significant. In relation to RUC, neither the pelvic variables, BMI, PV, PSA, TR, nor operative time were statistically significant.

Univariate analysis revealed that UC (p = 0.02), the extracapsular extension (p = 0.01), the pathological stage (p = 0.01) and the Gleason score sum (p = 0.013) were all significantly associated independently with the SM status. Moreover, capsular invasion showed significance with respect to SM status in Fisher's exact test (p = 0.001). Furthermore, the association between PV and SM status approached significance (p = 0.076). With respect to SM positivity, there was not a statistically significant relation on EBL and TR, similarly (p < 0.05). High concordance was defined in the measurements of various pelvic dimensions from MRI by the radiologists (Kendall's tau B, gamma and kappa of (0.739, 0.832,and 0.712, respectively); all p < 0.001).

Analysis of relation between pathological stage and EBL did not yield a statistically significant finding (p > 0.05) and there was an insignificant relation between the stage of the disease and TR (p > 0.05).

Discussion

The use of radiography for the assessment of pelvic dimensions has been superseded by MRI. MRI is an adequate and reliable imaging technique for defining pelvic dimensions. In this study, pelvic MRI, which reveals the pelvic anatomy with high quality images and is known as a sufficient technique for the staging of prostate cancer, was utilized to assess pelvic dimensions.[9,11,12] We used transrectal ultrasound for measuring PV. Terris and Stamey noted strong correlation between surgical specimen weight and the transrectal ultrasound estimation of PV.[13]

Several studies have reported effects of PV on operational outcomes such as EBL. For instance, Hsu et al suggest that EBL of patients with PV over 50 mL was determined to be 1.2 times higher than the EBL of patients with PV under 25 mL.[14] However, PV failed to be predictive of the need for transfusion in another report, although it was shown to be correlated with operative time.[15] In many laparoscopic series, PV and operative time were found to be correlated, but there have also been studies claiming that PV and operative time are unrelated.[6,16,17] Moreover, association was found between EBL, operative time and PV was found by univariate analyses in robot-assisted laparoscopic prostatectomy (RALP), furthermore EBL was significantly associated with operative time and PV by multivariate analyses.[18] In contrast, Dach et al asserted that the relationship between EBL and PV is stronger than those between EBL and other relevant factors (p < 0.01).[19]

In our study, PV was significantly related to TR and EBL in a correlation analysis in which the patients were divided into three groups based on PV. One way analyses of variance revealed higher TR and EBL values in the larger prostate (> 50 mL) group. Our results are similar to other reports in the literature using univariate analyses. In multivariate analyses, PV was an independent predictor of TR, but it was not predictive of operative duration or EBL. As a critique, subgroups of PV could have been of greater value for increased total number of subjects in the study.

Regarding BMI, no relationship was detected with TR, EBL or operative time in bivariate analyses. In contrast, obesity has been described in the literature as a hindrance to performing open RRP.[3,14] Similarly, as in open prostatectomy, obesity has been identified as a factor that increases EBL and operative time in RALP.[20,21]

Of the pelvic variables, the SM was only related to UC ($p = 0.002$). The number of the patients was a weakness concerning this analysis. Hong et al indicated in their study that men with lower PDI ($p = 0.048$), had a higher positive SM rate through univariate analysis.[8] Even for the surgical excision of rectal cancer , some have suggested that the dimensions of bony pelvis might have significant influence on the SM.[22] In one study, pelvimetric measures were not found to impact the overall positive SM or the positive SM at any region of the prostate in patients who were treated with either LRP or RRP.[12] Neill et al revealed that certain pelvic dimensions, specifically the transverse pelvic brim distance and the intertuberous distance, were predictive of SM occurrence due to capsular breech.[15]

Furthermore, the association between PV and SM status approached significance in our study ($p = 0.076$). Singh et al did not find any statistically significant relation among PV or BMI with SM.[6] Similarly, BMI was not significantly related to SM in our analysis. In contrast with our result, Hong et al showed significant relation between SM and BMI.[8] Also they signified, that the relation between SM and Gleason score was significant ($p = 0.015$), same as in our study ($p = 0.013$). Additional studies reporting effects of body habitus on positive SM have provided possible explanations for the greater risk of biochemical progression observed in obese men after RP.[23,24]

According to the results of our study AD was significantly related to the surgical parameters. When the pelvic indexes were incorporated into the analyses, all three pelvic indexes correlated more strongly with EBL than did AD alone. The same relationships were observed with respect to the pelvic indexes and TR. Furthermore, operative time was significantly correlated with BFW/AP. Additionally, AD and BFW/AD were independent predictors of TR in multivariate analyses. Moreover, we investigated the associations between the time to RUC and pelvic and non-pelvic variables. Of the pelvic dimensions, only ISD/AP approached significance ($p = 0.094$), but age was related to early RUC ($p < 0.05$).

Hong et al indicated that none of the pelvic dimensions were associated with operative time and EBL in univariate analysis, although the PDI approached significance regarding to operative time ($p = 0.095$).[8] BFW, SW and the indexes of these variables may be important indicators of the surgical field like PDI, but they were not investigated in their study. Furthermore, UC and PD which may not be the only important parameters affecting surgical difficulty in RALP and LRP were not included. The relationships between indicators of operative difficulty and the variables mentioned above had not yet been concurrently analyzed in any study, and this characteristic makes our study unique. The investigation by Neil et al did not report any significant association between pelvic dimensions and indicators of operative difficulty.[15] A weakness of that study was that only bony pelvic dimensions were measured by computed tomography.

With respect to our study, there are a few limitations that should be highlighted. One weakness of our analysis is the small number of patients. A study with a higher number of patients is needed to attain more reliable results. Despite this idea, based on our data, clinical experiences and literature, it is thought that PV and obesity would have greater significance than pelvic dimensions even in larger series. Another weakness of this study regards the representativeness of our sample of prostatectomy patients concerning the demographic characteristics such as age, socioeconomic status and ethnical background. This feature leads us to be aware of the limitations of the sample and to be conservative about applying the findings more generally. Future studies should be developed with a model that enables researchers to obtain information about and control patients' demographic characteristics as well as their operational and pathological features. Thus, the findings of these studies may be generalized and utilized with greater reliability in the future. While studying the effect of pelvic dimensions and indexes on RRP, there are various pelvic variables to be evaluated such as the amount of angulation, working space in the pelvis in relation to variables used in our study or other specific abnormalities in pelvic structure in addition to indexes and dimensions used as reflectors of surgical difficulty in our study. EBL, TR and operative time as variables affected by pelvic dimensions were studied in the current study. Moreover, hospital stay duration and complication risk could also be included among variables affected by pelvic dimensions. Another point to be mentioned as a weakness of the study is that range for values of pelvic variables is not broad as it is in the case of PV. Thus, our analysis yielded a more apparent and stronger effect on operational variables for PV rather than pelvic variables.

Conclusion

In conclusion, analyses of pelvic dimensions and indexes as significant factors influencing operative difficulty during RRP yielded mixed results. Our findings are both supported and contradicted by prior literature reports in which results are not uniform. Overall, prostate volume seems to be the strongest factor related to operative difficulty as assessed by TR and EBL. We believe that further studies should be conducted to verify the effects of various pelvic variables that may impact operative difficulty and influence the functional and pathological outcome of RRP. As these variables are more clearly delineated, surgeons performing RRP will become more confident in the outcome of patients undergoing surgery for prostate cancer. ☐

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