Concordance of prostate volume estimates using multidimensional computer tomography and transrectal ultrasonography

Hyun Suk Yoon, Jung Hyun Shin, Myung Soo Kim, Tae Young Shin, Ho Young Ryu, Wansuk Kim, Dong Hyeon Lee, Jaewon Lee[1], Woo Sik Chung

Dept. of Urology, Ewha Womans Univ., Seoul, Rep. of Korea
Dept of Urology, Bundang Jaesaeng General Hospital, Seongnam, Rep. of Korea[1]

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Purpose: The ellipsoid method (EM) using transrectal ultrasound (TRUS) is the most widely used technique for measuring the prostate volume. However, computed tomography (CT) is also often used clinically to measure it. Herein, we compared the prostate volumes measured using TRUS and CT images in axial, coronal, and sagittal views.
Materials and Methods: The study population of this single-center retrospective study included males who underwent TRUS in 2017 and subsequently underwent multidimensional enhanced abdominal-pelvic CT within 6 mo. The prostate volume was calculated using EM on TRUS and axial, coronal, and sagittal CT scans (VolTRUS, VolAx, VolCor, and VolSAg, respectively). Volumes were compared using Pearson's correlation and linear regression tests. The agreement between modalities was assessed using Bland–Altman analysis to evaluate the concordance of measurements of the same variable obtained by two different methods. If the two volume measurements differed within the limits of agreement (SD* 1.96), they were considered interchangeable. The clinical limit was defined as a mean difference of ±10 cm^3.
Results: A total of 38 patients with a median age of 69 y and a median prostate specific antigen (PSA) level of 2.59 ng/mL were included. The estimated volume of TRUS EM-calculated axial, coronal, and sagittal volumes from the CT scan demonstrated correlation coefficients >0.9 and modified R2 values >0.8 in lineal regression tests. The mean differences between the VolTRUS and the VolAx, VolCor, and VolSag were -2.3 ± 6.4, -6.8 ± 4.6, and -8.9 ± 3.9, respectively. The Bland–Altman plot showed that the sagittal volume was not outside the clinically acceptable range in any case.
Conclusions: Sagittal CT scans could be an alternative for TRUS for prostate volume estimations. However, it is important to acknowledge that the prostate volume measured using CT is relatively larger than that measured by TRUS.

Introduction

The measurement of prostate volume informs the clinical diagnosis and treatment of benign prostatic hyperplasia (BPH), including the decision to treat with a 5-alpha-reductase inhibitor or surgery (1). The most widely used method for measuring prostate volume is the ellipsoid method (EM; V = L × H × W × 0.523 cm^3) on transrectal ultrasound (TRUS) (2). However, some patients are unable or reluctant to undergo TRUS. In these cases, computed tomography (CT) is often performed. Here, we compared prostate volumes measured on CT and TRUS images in the axial, coronal, and sagittal views.

Methods and Materials

This was a single-center retrospective study. Among the males who underwent prostate ultrasonography at our hospital from January to December 2017, those who subsequently underwent multidimensional enhanced abdominal-pelvic CT within 6 months were included in our study. Patients who were diagnosed with acute prostatitis or underwent prostate surgery were excluded. Prostate volume was derived from the ellipsoid volume measured on ultrasound and axial, coronal and sagittal CT scans (Fig. 1). The volumes were compared using Pearson's correlation tests and linear regression tests. Agreement between modalities was assessed using Bland-Altman analysis, which is widely applied to evaluate the concordance of measurements of the same variable obtained by two different methods. It is useful for identifying the degree of discrepancy (bias) between observations, presence of outliers, and data trends. If there is a difference between two volume measurements within the limits of agreement (standard deviation × 1.96), they can be considered interchangeable. Here, the clinical limit was designated as the mean value ± 10 cm3.

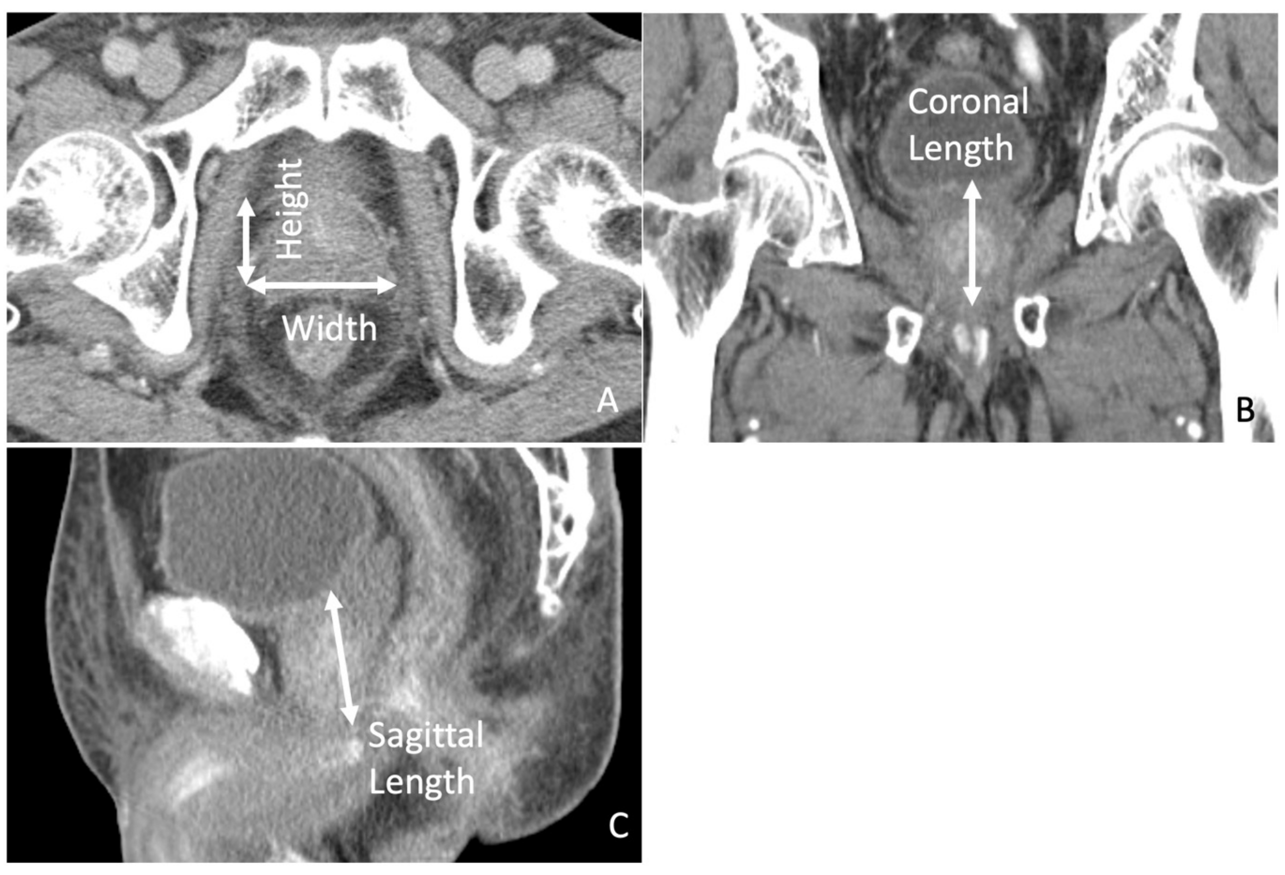

Figure 1. Measurement of prostate volume with ellipsoid method from CT scan. (A) Width (transverse diameter) and height (anteroposterior diameter) are measured by axial image (B) Coronal length (craniocaudal diameter) is measured by coronal image (C) Sagittal length is measured by sagittal image

Results

TRUS scans were performed in 1,844 patients for 1 year, and multidimension CT scans were performed in 38 patients within 6 months of the date of ultrasonography. The median patient age was 69 (range: 48–85) years, and the median PSA was 2.59 (range: 0.21–45.73) ng/ml. The width and height correlation coefficients obtained for TRUS and axial CT were 0.868 and 0.844 ($p<0.001$ and $p<0.001$), respectively, and the length correlation coefficients were 0.689, 0.704, and 0.750 ($p<0.001$, $p<0.001$, and $p<0.001$) for the axial, coronal, and sagittal views, respectively. All volumes from CT scans showed a correlation coefficient of ≥ 0.9 (0.921, 0.957, and 0.970; $p<0.001$, $p<0.001$, and $p<0.001$, respectively). The mean differences between the VolTRUS and VolAx/VolCor/VolSag were -2.3 ± 6.4, -6.8 ± 4.6, -8.9 ± 3.9, respectively. The Bland-Altman plot, used to compare the TRUS volume with each calculated volume showed that axial measures for three patients (7.9%) and coronal measures for two patients (5.3%) were outside the clinically acceptable range. The sagittal volume was not outside the clinically acceptable range in any case (Fig. 2).

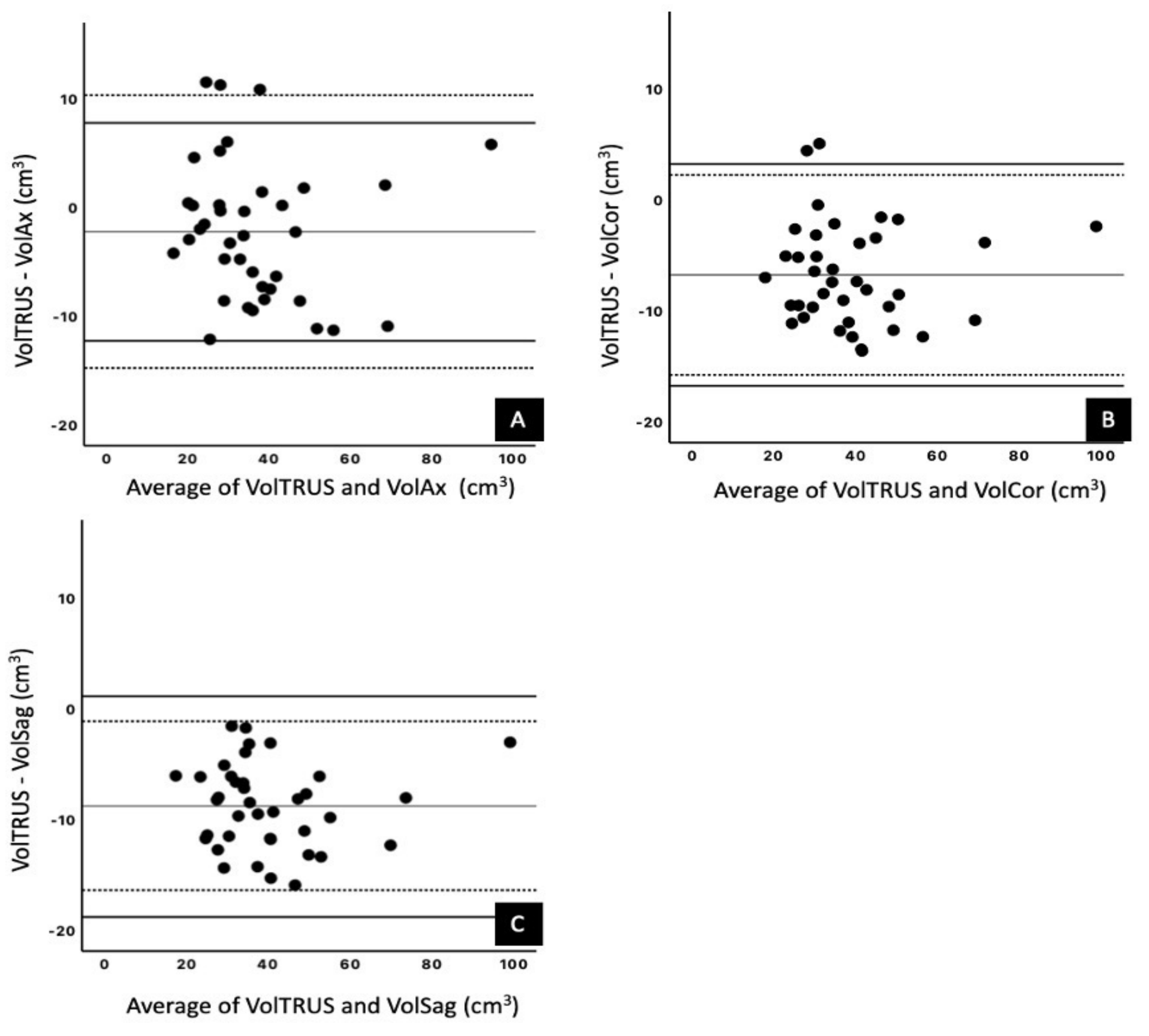

Figure 2. Bland-Altman analysis plot of prostate volume measured by TRUS and CT using (A) axial view, (B) coronal view, and (C) sagittal view. Upper and lower dotted lines are limits of agreement (LOA, 1.96 * standard deviation). Upper and lower solid lines are the clinically acceptable limits, defined as within 10 cm3 of the mean difference. LOA of (A) is outside the clinical limit.

Discussion

In the present study, it was difficult to distinguish between the parenchyma of the prostate and the dorsal vein complex, neurovascular bundle, and seminal vesicle in the axial view of CT, which may have hindered an accurate height measurement. Moreover, for images in axial and coronal views, lengths are measured in the same direction. Since the axial length is the summation of the number of slices with the prostate, there could be up to 6 mm of error from the top and bottom of the coronal length, if the border cannot be clearly distinguished.
When the clinical limit of the estimated volume difference was limited to a mean value ± 10 cm^3, only the sagittal volume showed agreement with TRUS. Therefore, in cases with sagittal view CT scans, VolTRUS can be calculated by subtracting the mean value of 8.9 ± 3.9 cm3 from VolSag. Furthermore, since all of the VolSag values were greater than the VolTRUS values in all patients, physicians could reconsider BPH diagnosis in patients with a small VolSag and limit 5-alpha-reductase treatment if their VolSag is < 30 cm^3.
This study had several limitations. The patients should have undergone a CT scan at least 6 mo before and after the prostate ultrasound, and any variables that might have affected the prostate volume should have been excluded. The second limitation was that the ultrasound itself had some drawbacks. Since an examiner performs ultrasound by directly contacting the patient with a probe, there may be slight variations in the angle each time the examination is performed. In addition, there may be measurement errors, since the prostatic tissue margin remains unclear on CT. Lastly, this study could not investigate the results of prostates with a large volume,

Conclusions

Sagittal CT scans could replace TRUS for prostate volume estimation. It is important to acknowledge that the prostate volume measured using CT is larger than that measured by TRUS.

References

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