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METİN KILIÇ

AHMET TUNÇ ÖZDEMİR

SERKAN ALTINOVA

ALİ FUAT ATMACA

ABDULLAH ERDEM CANDA

See next page for additional authors

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What is the best radiological method to predict the actual weight of the prostate?

Metin KILIÇ[1], Ahmet Tunç ÖZDEMİR[2], Serkan ALTINOVA[2,*], Ali Fuat ATMACA[3], Abdullah Erdem CANDA[2], Mevlana Derya BALBAY[4]

[1]Department of Urology, Yozgat State Hospital, Yozgat, Turkey
[2]Urology Clinic, Atatürk Training and Research Hospital, Ankara, Turkey
[3]Urology Clinic, Faculty of Medicine, Yıldırım Beyazıt University, Ankara, Turkey
[4]Department of Urology, Memorial Şişli Hospital, İstanbul, Turkey

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Aim: We compared the weight of the prostate specimen extracted after radical prostatectomy with preoperatively estimated weights of the prostate by different imaging techniques.

Materials and methods: Prostate weights were estimated by transabdominal ultrasonography (TAUS), transrectal ultrasonography (TRUS), and computed tomography (CT) preoperatively before radical prostatectomy. Prostatectomy specimens were weighed postoperatively and the actual prostate weights were calculated. Statistical analyses were done using 95% confidence intervals with repeated measurement analysis of variance and intraclass correlation coefficients.

Results: Of the 163 patients enrolled in the study, the mean age was 64.2 ± 6.4 (range: 45 to 76) years. The mean postoperative prostate weight was 54.7 ± 27.9 g. Preoperative mean prostate volumes calculated by TAUS, TRUS, and CT were 50.2 ± 24.1, 50.7 ± 24.6, and 62.7 ± 28.2 mL, respectively ($P < 0.001$). The actual prostate weight measured using an electronic scale was correlated with the estimated prostate weight in each of 3 methods, the best of which was that of TRUS.

Conclusion: The actual prostate weight is best estimated by measurements done with TRUS. However, clinicians should consider that some errors and deviations may occur with these imaging techniques.

Key words: Prostate, prostate volume, ultrasound, transrectal ultrasonography, computed tomography

1. Introduction

Benign prostatic hyperplasia (BPH) is one of the most common diseases in older men. The new studies on the natural course of the disease revealed that BPH is a progressive disease (1). Prostate cancer is one of the most commonly seen malignancies in older men (2,3). Age, prostate-specific antigen (PSA), prostate volume, and symptoms were used to assess the risk of disease progression, but the 2 most deeply investigated risk factors are PSA and prostate volume (4). Prostate volume is an important parameter in diagnosis and treatment of both benign and malign prostate disease (5,6). For BPH, prostate volume is important in predicting response to 5α-reductase therapy and is also used to select which surgical treatment modality is the best for the patient (7,8). In calculating PSA density, prostate volume is used as the denominator (9). If there is a problem deciding on the number of cores to be removed, prostate volume is involved again (10). A preference for the use of perineal, robotic, or retropubic approaches is also based on the prostate volume (11,12). Lastly, prostate volume is used for calculating the radiotherapy doses to be delivered in external beam or brachytherapy, and in planning therapies such as high-intensity focused ultrasound for prostate cancer (13,14).

Our aim is to compare the actual weight of surgically removed prostate tissue with the estimated weight by transrectal ultrasonography (TRUS), transabdominal ultrasonography (TAUS), and computed tomography (CT) and to determine the best estimating radiological methods in making diagnostic and treatment decisions in patients with benign and malignant prostatic diseases.

2. Materials and methods

Patients with a diagnosis of prostate adenocarcinoma who underwent radical prostatectomy between January 2005 and June 2009 at the Ankara Atatürk Training and Research Hospital First Urology Clinic were enrolled in

* Correspondence: saltinova@yahoo.com

the study. Patients who were treated with transurethral prostatectomy, androgen deprivation, or radiation therapy were excluded.

In the 163 patients who matched the criteria, prostate volumes were measured by TRUS (B-K, Denmark), TAUS (B-K, Denmark), and CT, with all volumes calculated using an ellipsoid formula. The volumes measured by TRUS, TAUS, and CT were compared with the weight of the surgically removed prostate specimen directly, because the specific gravity of the prostate gland is 1.050.

The prostate volumes measured preoperatively by TRUS, TAUS, and CT were compared with the weight of the surgically removed specimen, including the seminal vesicles and vas deferens, using an electronic scale within 5 min after removal and just before fixation within formalin. TRUS was done in our clinic by only one surgeon (SA) and all other radiological techniques were done by the same radiologist. Seminal vesicles were not removed from the surgical specimen so as not to compromise pathologic evaluation.

Because of the fact that all cancers of the prostate are significant under the age of 60, we divided the patients into 2 groups according to age: 60 years or under, and over 60 years. Repeated measurement analysis of variance was used to determine whether there was any statistically significant difference between actual prostate weight, and the prostate weight estimated by TAUS, TRUS, and CT. In the cases where a significant difference was seen in repeated measurement analysis of variance, a correcting Bonferroni multiple comparison test was used to determine the condition that caused the difference. An intraclass correlation coefficient with 95% confidence interval was used to understand if the actual prostate weight and the prostate weights estimated by TAUS, TRUS, and CT were compatible.

3. Results

The mean age of the patients undergoing radical prostatectomy for prostate carcinoma was 64.2 ± 6.4 (range: 45–76) years at the time of surgery. The final PSA levels within 1 month before surgery were within the interval of 10.6 ± 7.7 ng/mL. Apart from 13 patients who underwent perineal prostatectomy and 4 patients who underwent robot-assisted laparoscopic prostatectomy, the remaining 146 patients underwent radical retropubic prostatectomy procedures.

The average actual prostate weight was measured as 54.7 ± 27.9 g using an electronic scale. The average prostate volumes measured with TAUS, TRUS, and CT were 50.2 ± 24.1, 50.7 ± 24.6, and 62.7 ± 28.2 mL, respectively (Figure 1).

The estimated prostate weights obtained by TAUS and TRUS were lower (8.2% and 7.3%, respectively) when compared with the actual prostate weights, whereas the estimated prostate weights were higher when CT was used to calculate the prostatic weights (14.6%). The difference between the actual prostate weight and the estimated prostate weights measured by TAUS, TRUS, and CT was statistically significant (P < 0.001) (Table 1).

Weight estimated by CT compared with the actual prostate weight yielded the best estimates when the actual prostatic weight was over 80 g (average weight difference for actual prostatic weights ≤40 g of +11.7, between 41 and 60 g of +9.1, between 61 and 80 g of +6.0, and >80 g of –2.6). However, in the group with an actual prostate weight of ≤40 g, the best estimation was achieved by TRUS (average difference of weight for TRUS of –0.2, for TAUS of +2.6, and for CT of +11.7) (Table 2; Figure 1).

The average actual weights for patients 60 or younger (n = 46, range: 45–60) and older than 60 (n = 117, range: 61–76) were 48.1 ± 24.1 g and 57.2 ± 28.9 g, respectively.

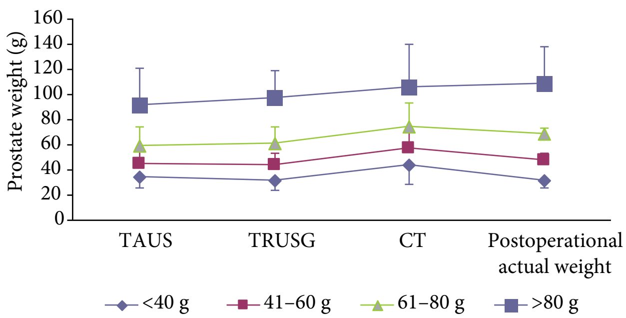

Figure 1. Actual weight and estimated weight levels measured by imaging methods according to the weight of the prostate.

Table 1. Actual weight, average prostate weight measured by imaging techniques, and 95% confidence interval for all cases.

Variables	Mean weight (g)	95% Confidence interval	Mean weight difference (g)	Percentage of mean weight difference (%)
TAUS	50.2 ± 24.1	0.838 (0.774–0.883)	–4.5	–8.2
TRUS	50.7 ± 24.6	0.898 (0.835–0.933)	–4	–7.3
BT	62.7 ± 28.2	0.780 (0.653–0.855)	+8.0	+14.6
Actual weight	54.7 ± 27.9			
P	<0.001			

Table 2. Actual weight and estimated weight levels measured by imaging methods according to the weight of the prostate.

	≤40 g (n = 52)			41–60 g (n = 61)			61–80 g (n = 27)			>80 g (n = 23)		
Variables	Average weight (g)	Average difference of weight (g)	Average difference of weight %	Average weight (g)	Average difference of weight (g)	Average difference of weight %	Average weight (g)	Average difference of weight (g)	Average difference of weight %	Average weight (g)	Average differenc of weight (gr)	Average difference of weight %
TAUS	34.3 ± 9.0	+2.6	+8.2	44.9 ± 11.8	−3.0	−6.3	59.4 ± 15.3	-8.9	−13.0	91.1 ± 30.3	−17.3	−15.9
TRUS	31.5 ± 8.0	−0.2	0.6	43.6 ± 9.6	−4.3	-8.9	60.9 ± 13.3	−7.4	-10.8	96.8 ± 21.9	−11.6	−10.7
CT	43.4 ± 15.1	+11.7	+36.9	57.0 ± 15.4	+9.1	+19.9	74.3 ± 18.9	+6	+8.8	105.6 ± 34.5	−2.8	−2.6
Actual weight	31.7 ± 6.3			47.9 ± 5.5			68.3 ± 5.3			108.4 ± 29.9		
P	<0.001			<0.001			<0.001			0.002		

The average weights obtained by TAUS, TRUS, and CT were 44.8 ± 19.5, 44.8 ± 23.2, and 52.2 ± 20.6 and 52.2 ± 25.5, 52.7 ± 24.9, and 66.5 ± 29.8 for patients aged ≤60 and >60 years, respectively (Table 3).

The difference between the actual prostate weights and the weights measured with imaging methods were statistically significant (P = 0.002 and P < 0.001, respectively) (Table 3; Figure 2).

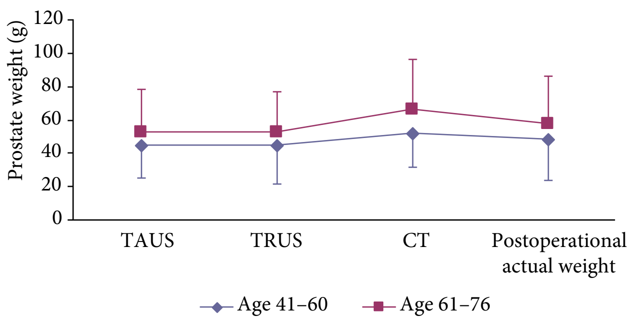

Figure 2. Actual prostate weights and the weight measured by imaging techniques according to age groups

4. Discussion

In this study, we compared the prostate volumes measured by TRUS, TAUS, and CT with the actual weight measured after prostatectomy by using the data from our own clinic in patients undergoing radical prostatectomy.

In our study, the seminal vesicles and vas deferens were not removed before measuring the weight of the surgical specimen on the electronic scale so as not to compromise pathological evaluation. In an earlier study, Rodriguez et al. (15) reported that seminal vesicles contribute an average of 3.8. g to the weight (range: 2.2 to 4.6). Referring to the actual prostatic weight in this study (54.7 ± 27.9 g), we believe that the inclusion of the seminal vesicles and vas deferens in the measurement of prostatic weight did not cause a significant error in our calculations.

The volumes measured by TRUS, TAUS, and CT were compared with the weight of the surgically removed prostate specimen directly, because the specific gravity of the prostate gland is 1.050 (15). The weights measured with TAUS and TRUS were seen to correlate well with actual prostate weight (0.898 and 0.838) despite being

Table 3. Actual prostate weights and the weight measured by imaging techniques according to age groups

Variables	Age ≤60 (n = 46)			Age >61 (n = 117)		
	Average (g)	Difference (g)	%	Average (g)	Difference (g)	%
TAUS	44.8 ± 19.5	−3.3	−6.9	52.2 ± 25.5	−5	−8.7
TRUS	44.8 ± 23.2	−3.3	−6.9	52.7 ± 24.9	−4.5	−7.9
BT	52.2 ± 20.6	+4.1	+8.5	66.5 ± 29.8	-9.3	+16.3
Actual weight	48.1 ± 24.1			57.2 ± 28.9		
P	0.002			<0.001		

estimated as lower than the actual weight (8.2% and 7.3%). On the other hand, CT correlated well with the actual weight (0.780), despite estimating it to be 15% larger than the actual weight.

Sajadi et al. compared the prostate weight measured with TRUS and the weight of the excised specimen in 497 patients who underwent radical prostatectomy (16). They reported that TRUS is an imperfect alternative with significant errors. They reported that more accurate results were obtained with large prostates (above 40 g). In our study, the compliance rate of TRUS was 0.744, and more accurate results were obtained with prostates heavier than 80 g on the scale. Sajadi et al. associated the error rates in TRUS with measurement errors. Furthermore, they reported that prostate weight may decrease before fixation due to loss of blood during radical prostatectomy, and because seminal vesicles and vasal ends contribute to the weight and these cannot be measured with imaging techniques (16).

In our study, the estimated weight was always lower than the actual weight with TAUS and TRUS, whereas with CT the estimated weight was higher than the actual prostate weight, except for the group with prostates heavier than 80 g. Kälkner et al. compared CT and TRUS prostate volumes of patients who were to be treated with conformal radiotherapy and brachytherapy combination for localized prostate cancer (17). They observed that prostate volumes on CT were 48% greater than the prostate volumes calculated with the TRUS ellipse formula. They reported that the angle of cross-section affected the measured prostate volume. We performed TAUS and CT with patients in the supine position and TRUS in the left lateral decubitis position with knees pulled up to the abdomen. In more horizontal sections the anterior-posterior dimension increases, whereas the cranio-caudal size decreases. However, Kälkner et al. noted that this cross-sectional angle difference cannot fully explain the variations in size alone (17).

Another reason for the incorrect measurements with abdominal or transrectal ultrasonography may be the doctor's experience and the device used. Kim et al. calculated prostate volume with TRUS performed by 3 radiologists with different experience levels (novice, trained, and specialist) by using transrectal ultrasounds and abdominal ultrasounds in 94 patients and using transrectal ultrasounds and 3-dimensional ultrasounds in 54 patients. They reported that experience is an important factor in calculating the prostate volume with ultrasonography (USG) and that bladder volume during the measurement is not important (18).

Huang Foen Chung et al. measured prostatic weights in 100 patients. In the first group, TAUS and TRUS were performed. In the second group, 2 different devices were used for transabdominal measurements. Transrectal USG was performed by 3 researchers whereas the transabdominal USG examinations were performed by the same investigator. No significant differences were found between TAUS and TRUS measurements within the first group, between transabdominal measurements using 2 devices, or between results of different investigators (19).

Our study showed that actual prostate weight is best estimated by TRUS measurement when the radiographic modalities used as imaging methods are TAUS, TRUS, and CT. The average weight differences and the percentage differences in average weights were higher in CT measurements. As the prostate weight increases, especially over 80 g, the average weight difference and the percentage difference in average weights on CT seemed to decrease compared to those obtained with TAUS and TRUS. As the prostate weight decreases, especially below 40 g, average weight difference and the percentage difference in average weights on TRUS seemed to decrease compared to those of TAUS and CT. Measuring the prostate volume can be useful in deciding which technique should be used according to the pathology. Clinicians should be aware that there may be errors and deviations in prostatic weights obtained by imaging methods when planning to use it for diagnostic purposes and the planning of treatment.

References

1. Fong YK, Milani S, Djavan B. Natural history and clinical predictors of clinical progression in benign prostatic hyperplasia. Cur Opin Urol 2005; 15: 35–8.
2. Akpolat N, Büyük Y, Uzun İ, Geçit İ, Kurnaz G. Prevalence of latent prostate cancer and prostatic intraepithelial neoplasia in İstanbul, Turkey: an autopsy study. Turk J Med Sci 2012; 42: 449–56.
3. Gülkesen HK, Köksal İT, Özdem S, Saka O. Prediction of prostate cancer using decision tree algorithm. Turk J Med Sci 2010; 40: 681–6.
4. Roehrborn CG, McConnell J, Bonilla J, Rosenblatt S, Hudson PB, Malek GH, Schellhammer PF, Bruskewitz R, Matsumoto AM, Harrison LH et al. Serum prostate specific antigen is a strong predictor of future prostate growth in men with benign prostatic hyperplasia. PROSCAR long-term efficacy and safety study. J Urol 2000; 163: 13–20.
5. Hoffelt SC, Marshall LM, Garzotto M, Hung A, Holland J, Beer TM. A comparison of CT scan to transrectal ultrasound-measured prostate volume in untreated prostate cancer. Int J Radiat Oncol Biol Phys 2003; 57: 29–32.

6. Uğurlu Ö, Çetinkaya M, Özden C, Öztekin ÇV, Akdemir AÖ, Memiş A, Yarış M. An abnormal digital rectal examination is an independent predictor of high radical prostatectomy Gleason's score (≥7) in patients with clinically localized prostate cancer. Turk J Med Sci 2009; 39: 755–60.
7. Strom KH, Gu X, Spaliviero M, Wong C. The effects of 5α-reductase inhibition on benign prostatic hyperplasia treated by photoselective vaporization prostatectomy with the 120 Watt GreenLight HPS laser system. J Am Coll Surg 2011; 212: 244–50.
8. Watanabe H, Igari D, Tanahashi Y, Harada K, Saito M. Measurements of size and weight of the prostate by means of transrectal ultrasonotomography. Tohoku J Exp Med 1974; 114: 277–85.
9. Nogueira L, Corradi R, Eastham JA. Prostatic specific antigen for prostate cancer detection. Int Braz J Urol 2009; 35: 521–9.
10. Ochiai A, Troncoso P, Chen ME. The relationship between tumor volume and the number of positive cores in men undergoing multisite extended biopsy: implication for expectant management. J Urol 2005; 174: 2164–8.
11. Canda AE, Atmaca AF, Akbulut Z, Asil E, Kılıç M, İsgören AE, Balbay MD. Results of robotic radical prostatectomy in the hands of surgeons without previous laparoscopic radical prostatectomy experience. Turk J Med Sci 2012; 42 (Sup. 1): 1338–46.
12. Mouraviev V, Nosnik I, Sun L. Financial comparative analysis of minimally invasive surgery to open surgery for localized prostate cancer: a single-institution experience. Urology 2007; 69: 311–4.
13. Pinkawa M. External beam radiotherapy for prostate cancer. Panminerva Med 2010; 52: 195–207.
14. Ahmed HU, Zacharakis E, Dudderidge T. High-intensity-focused ultrasound in the treatment of primary prostate cancer: the first UK series. Br J Cancer 2009; 101: 19–26.
15. Rodriguez E Jr, Skarecky D, Narula N, Ahlering TE. Prostate volume estimation using the ellipsoid formula consistently underestimates actual gland size. J Urol 2008; 179: 501–3.
16. Sajadi KP, Terris MK, Hamilton RJ, Cullen J, Amling CL, Kane CJ, Presti JC Jr, Aronson WJ, Freedland SJ. Body mass index, prostate weight and transrectal ultrasound prostate volume accuracy. J Urol 2007; 178: 990–5.
17. Kälkner KM, Kubicek G, Nilsson J, Lundell M, Levitt S, Nilsson S. Prostate volume determination: differential volume measurements comparing CT and TRUS. Radiother Oncol 2006; 81: 179–83.
18. Kim SH, Kim SH. Correlations between the various methods of estimating prostate volume: transabdominal, transrectal, and three-dimensional US. Korean J Radiol 2008; 9: 134–9.
19. Huang Foen Chung JW, de Vries SH, Raaijmakers R, Postma R, Bosch JL, van Mastrigt R. Prostate volume ultrasonography: the influence of transabdominal versus transrectal approach, device type and operator. Eur Urol 2004; 46: 352–6.