Estimation of clinically significant prostate volumes by digital rectal examination: a comparative prospective study

Sarfraz Ahmad, PhD, Rustom Pervez Manecksha, FRCS, Ivor Michael Cullen, MRCSI, Robert Joseph Flynn, FRCS, Thomas Eugene Dermott McDermott, FRCS, Ronald Grainger, FRCS, John Alan Thornhill, FRCS

Department of Urology, The Adelaide and Meath Hospital incorporating the National Children's Hospital, Tallaght, Dublin, Ireland

AHMAD S, MANECKSHA RP, CULLEN IM, FLYNN RJ, MCDERMOTT TED, GRAINGER R, THORNHILL JA. Estimation of clinically significant prostate volumes by digital rectal examination: a comparative prospective study. The Canadian Journal of Urology. 2011;18(6):6025-6030.

Introduction: *Reliable quantification of prostate volume is important to correctly select patients with benign prostatic hyperplasia (BPH) most likely to benefit from medical therapy [e.g. 5 alpha-reductase inhibitors (5-ARIs)] and in selecting appropriate surgical approach. We aim to determine the reliability of digital rectal examination (DRE) in estimation of prostate volume which may be helpful in patient selection for 5-ARIs therapy.*

Materials and methods: *Patients requiring transrectal ultrasound (TRUS) guided prostate biopsy were recruited in this prospective study. DRE was performed twice for each patient. Clinicians categorized prostate volume on DRE into small, medium and large, and estimated prostate volume. Volume estimated by DRE at the first examination was intentionally unavailable at second DRE. TRUS volumes were measured using 2101 Falcon ultrasound machine.*

Results: *Comparative analysis of prostate volume (n = 248) by DRE and TRUS was performed. There was no significant difference between DRE-estimated prostate volume at the first and second examinations (p = 0.8). DRE-estimated volumes for prostates categorized as small, medium or large were underestimated in 59%, 58% and 53% of patients respectively. However, for clinical relevant volumes (> 30 cc), 94.5% patients were accurately estimated on DRE.*

Conclusions: *We have shown that DRE had positive predictive value of 94% in identifying prostate above 30 cc. Hence, when considering treatment with 5-ARIs, DRE may be sufficient to identify suitable patients for 5-ARIs therapy. However, for prostate volumes between 25 cc-30 cc and above 80 cc, TRUS may be required.*

Key Words: BPH, digital rectal examination, prostate volume

Introduction

Estimation of prostate volume is a prerequisite for therapeutic decision making, especially in symptomatic benign prostatic hyperplasia (BPH). Although, men with large prostates may be asymptomatic, a bigger gland is associated with greater risk of disease progression and acute urinary retention.[1] Prostate volume with baseline prostate-specific antigen (PSA) are best predictors of response to 5 alpha-reductase inhibitors (5-ARIs) and both of these parameters can distinguish benign disease from prostate cancer.[2,3] Furthermore, prostate volume measurement is also helpful in planning brachytherapy, HoLep or transurethral resection of the prostate.[4]

Accepted for publication August 2011

Address correspondence to Dr. Sarfraz Ahmad, Department of Urology, The Adelaide and Meath Hospital, incorporating the National Children's Hospital, Tallaght, Dublin, Ireland

The efficacy of 5-ARIs (finasteride, dutasteride) correlate with prostate volume. Long term analysis of the MTOPS[5] study confirmed that finasteride resulted in significant reduction in total prostate volume and improvement in symptoms score, in symptomatic BPH patients with prostate volume > 40 cc. Similarly, the CombAT[6] study also showed superior results with combination therapy (alpha-blocker and dutasteride) in men with prostates > 30 cc. In both of these studies, prostate volumes were calculated by transrectal ultrasound (TRUS) but, in clinical practice, digital rectal examination (DRE) probably remains the commonest method of prostate volume estimation in men with lower urinary tract symptoms. Therefore, it is vital to determine the reliability of DRE in assessment of clinical relevant prostate volume. For management of symptomatic BPH, three catergories of clincally relevant prostate volumes are: a) prostate volumes < 30 cc (suitable for alpha-blocker monotherapy), b) prostate volumes > 30 (suitable for combination therapy) and, c) prostate volumes > 80 cc (typically, the cut off volume, above which open prostatectomy or HoLep are considered for patients requiring surgery).

TRUS is considered more accurate for measurement of prostate volume.[7] Underestimation of prostate volume by DRE has been reported previously by Roehrborn et al.[8] However, the effect of this underestimation in selecting management of patients was not addressed. We proposed a prospective comparative study to determine the accuracy of DRE in estimation of clinical relevant prostate volume which will be helpful in therapeutic decision making.

Materials and methods

Patients and study design

In our institution currently TRUS is most commonly performed in the context of prostate biopsy. Hence this group of patients was selected to compare DRE and TRUS measured volumes. Each patient had DRE twice in independent clinical settings; 1st DRE at first presentation and 2nd DRE at time of TRUS biopsy. DRE was performed either by a consultant urologist or by a registrar (mean urology experience of registrars = 4.2 years). Clinicians recoded PSA, prostate size (small, medium, large), estimated prostate volume (cc) and clinical stage (e.g. clinically benign, T2, T3, T4). The second clinician, blinded to the 1st DRE, performed 2nd DRE and recorded findings (as above) before TRUS. TRUS measurement of prostate volumes was computer generated by taking measurements in three planes (transverse, anteroposterior and longitudinal) using 2101 Falcon ultrasound machine.

Statistical analysis

The primary outcome variable of statistical analysis was prostate volume in each patient measured by DRE and by TRUS. Prostate volumes were divided into subgroups according to size (small, medium, large) and clinical relevant volumes (< 30 cc, 30 cc-79.9 cc, > 80 cc). Each subgroup was compared independently. A two sampled t-test was used to determine difference between groups. A p value < 0.05 interpreted as a significant difference. Microsoft Excel 10.0 and SPSS 17.0 were used for data analysis.

Results

Patient demographics

Consecutive 248 patients were recruited (median age: 64.2 years, range: 44-85 years). Median PSA was 7.6 ng/mL (range: 2.6 ng/mL-91 ng/mL). All of these patients were required to have TRUS biopsy of the prostate for high PSA and/or abnormal DRE. Mean time interval between 1st and 2nd DRE (+ TRUS) was 10 days.

Estimation of prostate volume by DRE in independent clinical settings

A significant positive correlation was seen between 1st and 2nd DRE estimates of prostate volume ($r = 0.866$, $p < 0.01$). DRE categorization of the prostate into small, medium and large sizes at 1st and 2nd DRE was also comparable. On the 1st DRE, 77 prostates were categorized as small; of these 77, three were categorized as medium prostates on the 2nd DRE. Similarly, out of 43 prostates categorized as large, four were recorded as medium on the 2nd DRE. Out of 128 medium categorized prostates on the 1st DRE, only seven were recorded as small and two as large on the 2nd DRE.

DRE estimation for clinically relevant prostate volumes

As both the 1st and 2nd DRE provided comparable estimation of prostate volume, for comparative analysis with TRUS, we are presenting only the 1st DRE data (similar results were obtained when compared with the 2nd DRE – data not shown). Overall, the DRE estimates and TRUS measurements, had a positive correlation ($r = 0.67$), Figure 1a. Positive correlations were also observed for different subgroups of prostate volumes, Figure 1b-1d.

On the basis of TRUS defined values of clinically relevant prostate volume, we divided the data into three subgroups; first, prostate volumes < 30 cc , second, prostate volumes between 30 cc-79.9 cc and, third, prostate volumes > 80 cc. On TRUS measurements, 87 patients had < 30 cc prostate volume, of whom, 44 patients (50.6%)

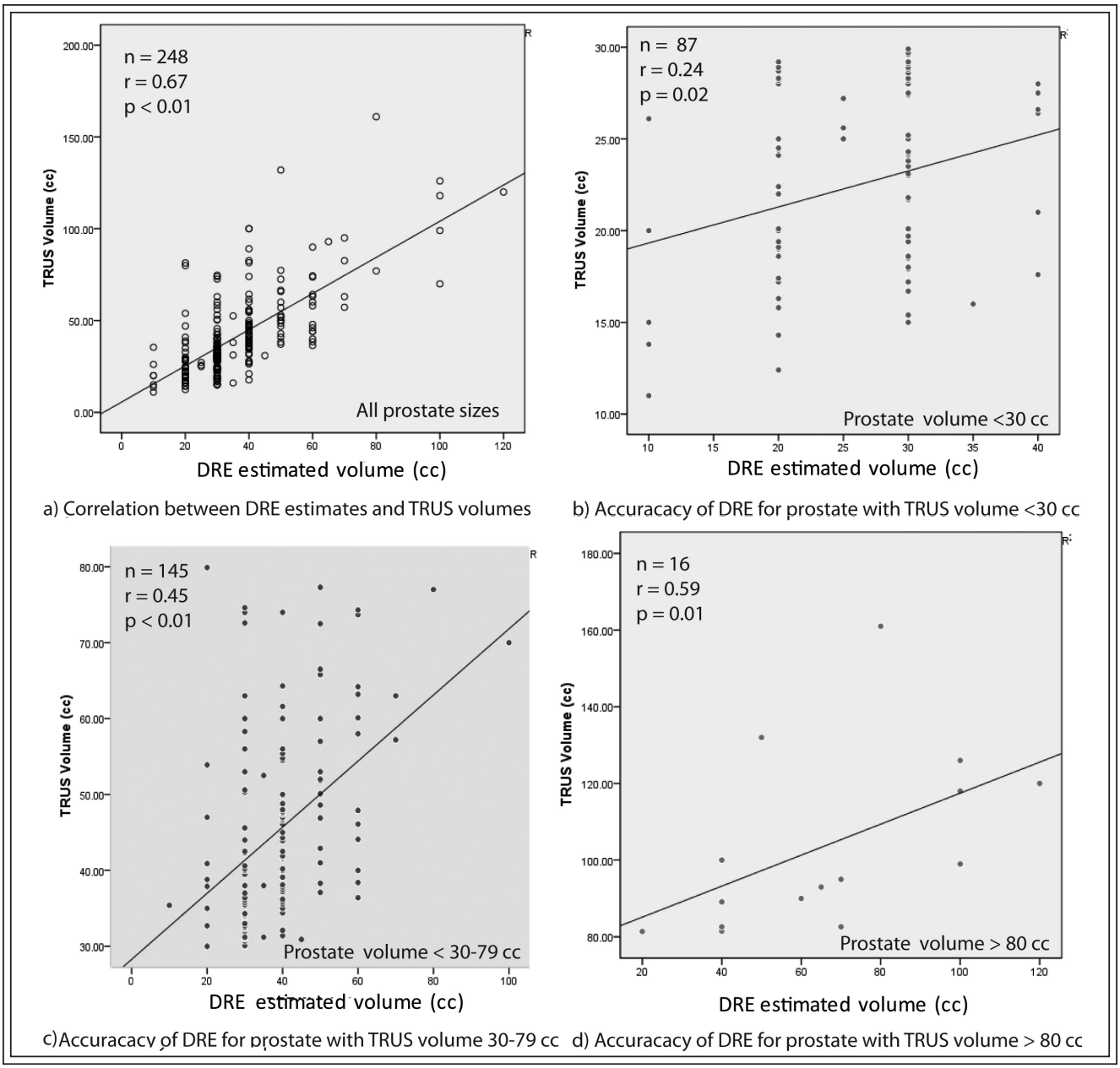

Figure 1. Correlation between DRE (1st DRE) estimates and TRUS volumes - DRE estimates and TRUS measured volumes were correlated significantly ($p < 0.05$) for all prostate volumes, indicating DRE estimates correlated with TRUS measurements.

were estimated as > 30 cc on DRE. Another, 25 patients were estimated as exactly 30 cc on DRE while TRUS volume ranged between 25 cc-29.9cc. Additionally, in the < 30 cc prostate there was no discrepancy if one corrects for standard deviations. Prostate volume of between 30 cc-79.9 cc (n = 145) were accurately estimated on DRE in most of patinets (94.5%). While, prostate volumes > 80 cc were underestimated on DRE in 62.5% of patients, Table 1.

DRE estimation for all volumes of prostate

The clinical significant prostate sizes were estimated correctly by DRE in majority of patients. However, we observed that DRE generally underestimated prostate volume comparing with corresponding exact TRUS measurements. For all patients, the mean (± SD) estimated volume at 1st DRE was 35.8 (± 16) cc and 2nd DRE was 35.7 (± 16) cc, while mean (± SD) TRUS measured volume was 40.9 (± 22) cc. In over 50% patients, DRE underestimated

TABLE 1. **DRE for clinically relevant prostate volumes**

TRUS measured Prostate volumes	Correctly estimated on DRE	Underestimated on DRE	Overestimated on DRE
< 30 cc (n = 87)	49.4% (n = 43)	0%	50.6% (n = 44)
30-79.9 cc (n = 145)	94. 5% (n = 137)	5.5% (n = 8)	0%
> 80 cc (n = 16)	37.5% (n = 6)	62.5% (n = 10)	0%

DRE = digital rectal examination

the prostate volumes when compared with TRUS, Table 2. This difference was statistically significant (p = 0.01) and medium (p = 0.001) size prostates; for large size prostates the difference between DRE and TRUS was not significant (p = 0.12).

Effect of prostate cancer staging on prostate volume estimation

Regarding cancer detection by DRE, the majority of prostates in this cohort were felt clinically benign (70%, n = 174) while 30% (n = 74) prostates were categorized as malignant. Biopsy results revealed 34.7% (n = 86) patients had prostate cancer (51% unilobar disease, 49% bilobar disease) and 65.3% (n = 162) patient had no malignancy. Among biopsy detected prostate cancer, 50% patients had clinically malignant prostates. Hence, the positive predictive value of DRE in detecting malignant disease was 50%. Furthermore, 80% (n = 130) patients were correctly recorded as benign on DRE when compared with final biopsy results. Thirty-two patients with benign histology had malignant feeling prostates (T2a = 18, T2b = 10, T2c = 4), thus the positive predictive value of DRE for detection of benign disease benign prostate was 80%.

The detection of clinically malignant gland on DRE did not influence the accuracy of prostate volume when compared with TRUS. Overall trends of underestimation were observed with DRE in both clinically benign and malignant prostates. The mean (± SD) volume for clinically malignant and benign prostates measured by TRUS was 34.4 cc (± 17) and 30.9 (± 11) cc respectively. Overall the difference between DRE estimates and TRUS measured volumes for malignant prostates was not statistically significant (p = 0.1). However, for medium sized clinical malignant prostates, the difference between DRE estimates and TRUS measured volumes was statistically significant (p = 0.03). For clinically benign prostates, overall there was statistically significant underestimation observed with DRE (p = 0.01). But for large size clinically benign prostates this difference did not reach statistical significance (p = 0.8), Table 3.

TABLE 2. **DRE estimates and TRUS measured prostate volumes**

DRE categorized prostate size	Mean ± SD DRE estimated prostate volume (cc)	Mean ± SD TRUS measured prostate volume (cc)	% of patients with under estimated volume on DRE	Mean ± SD under estimation (cc)	% of patients with over estimated volume on DRE	Mean ± SD over estimation (cc)	% of patients with no difference between DRE and TRUS volumes
Small (n = 77)	23.5 ± 6.5	27.3 ± 11.3	59	5.4 ± 9.6	35	2.3 ± 4.7	6
Medium (n = 128)	35.2 ± 7.9	40.2 ± 16.2	58.5	7.2 ± 11.5	39	2.7 ± 5.5	3
Large (n = 43)	61.7 ± 18.5	70 ± 29.9	53.5	13.8 ± 20.9	41.8	4.6 ± 7	4

DRE = digital rectal examination; TRUS = transrectal ultrasound

TABLE 3. **Effect of clinical stage of prostate on DRE estimates**

DRE categorized clinical status	DRE categorized size	Mean ± SD DRE estimated prostate volume (cc)	Mean ± SD TRUS measured prostate volume (cc)	p value
Benign (n = 174)	Small (n = 50)	24.8 ± 5.7	29.5 ± 12.4	0.01
	Medium (n = 88)	35 ± 6.7	39 ± 14.5	0.006
	Large (n = 36)	64.4 ± 19.5	73 ± 30.6	0.11
Malignant (n = 74)	Small (n = 27)	21.2 ± 7.5	23.5 ± 7.4	0.2
	Medium (n = 40)	33.6 ± 7.3	38.5 ± 16.1	0.03
	Large (n = 7)	52.8 ± 7.5	54.3 ± 21.5	0.8

DRE = digital rectal examination; TRUS = transrectal ultrasound

Accuracy of DRE volume estimation and clinician's experience

Clinical experience could potentially influence estimation of prostate volume on DRE. We compared data of 41 patients who had been assessed by consultants at 1st DRE and by registrars at 2nd DRE. Out of these 41 patients, prostate volumes of 21 patients (51%) were underestimated (mean (± SD) underestimated volume 12.8 cc ± 10 cc) by consultants. On DRE assessment by registrars, 21 patients were underestimated with mean (± SD) 10.5 (± 8) cc. The difference in estimation of volume by DRE between consultants and registrars was not statistically significant ($p > 0.05$). These findings indicated that the accuracy of DRE volume estimation compared with TRUS measurements was not influenced by consultant and trainee status.

Discussion

We have shown that DRE underestimates prostate volume when compared with exact TRUS measurements, consistent with findings by others.[8,9] The logical explanation of this underestimation is prostate shape and anatomical location, an examiner cannot ascertain the anterior/posterior extension of the prostate with DRE.[8] However, this underestimation may not be significant in selecting BPH patients requiring 5-ARIs, as prostate volumes between 30 cc-79.9 cc were estimated accurately in most patients (94.5%) on DRE. Additionally, prostate volume > 80 cc were underestimated in 62.5% patients but DRE estimated prostate volumes in this cohort were still > 30 cc and therefore, selection of these men for 5-ARIs therapy would not have been affected. However, when surgery is being considered (e.g. TURP versus open prostatectomy or HoLep), TRUS may be preferable for accurate volume measurement. Interestingly prostates with volume < 30 cc were overestimated in half of cases. However, among this overestimated group, 56% of prostates were estimated as exactly 30 cc on DRE while TRUS volumes for these prostates were between 25 cc-29.9 cc. This narrow range of volume may explain DRE overstimation in these patients.

Clinical experience has been shown to have effect on reliable DRE estimation of prostate volume.[10,11] We compared 41 patients examined by consultants and trainees registrars (in independent clinical settings) and did not identify statistical significant difference between DRE estimates. However, the numbers of patients for comparisons were small. Larger studies may be needed to draw significant conclusions. But adequate clinical experience is vital for reliable estimation of prostate volume. We also observed that the DRE estimation of prostate volume in individuals with body mass index (BMI) of > 30 is less accurate compared with TRUS (data not shown). This difference was due to body habitus, making DRE difficult. However, the number of patients with BMI > 30 was too small to be meaningfully interpreted.

The limitation of this study was the patient cohort, those with high PSA and suspected prostate cancer.

Application of these findings to a benign cohort may be questionable. However, clinically palpable disease did not affect the DRE estimates. Hence, DRE can estimate prostate volume without bias from clinical stage of disease and results from this study can be applied for volume estimation in benign disease.

DRE is minimally invasive and easily performed; however, accuracy is limited because of its subjective nature. While TRUS is more accurate, inter-observer variability can be high,[10] it is more uncomfortable and significantly more resource dependent than DRE. It is arguable that TRUS findings would help appropriately tailor medical management especially in men with lower urinary tract symptoms. However, routinely subjecting all men to TRUS for estimation of prostate volume would be impractical, time-consuming and expensive. DRE had additional advantages of stage assessment in cases of prostate cancer. Accuracy of DRE for prostate cancer staging has been debatable.[12-14] Our results showed higher positive predictive value (80%) of DRE for benign disease than prostate cancer (50%).

In summary, this study has shown that DRE had a positive predictive value of 94% in identifying prostate volumes between 30 cc-79.9 cc. Hence, DRE may be used reliably for estimation of prostate volume to determine the appropriate medical therapy. For prostate volumes < 30 cc and > 80 cc, TRUS may be required for more accurate volume estimation to influence management. □

References

1. Roehrborn CG, Sech S, Montoya J, Rhodes T, Girman CJ. Interexaminer reliability and validity of a three-dimensional model to assess prostate volume by digital rectal examination. *Urology* 2001;57(6):1087-1092.
2. Nickel JC. Benign prostatic hyperplasia: does prostate size matter? *Rev Urol* 2003;5(Suppl 4):S12-S17.
3. Babaian RJ, Fritsche HA, Evans RB. Prostate-specific antigen and prostate gland volume: correlation and clinical application. *J Clin Lab Anal* 1990;4(2):135-137.
4. Roehrborn CG, Chinn HK, Fulgham PF, Simpkins KL, Peters PC. The role of transabdominal ultrasound in the preoperative evaluation of patients with benign prostatic hypertrophy. *J Urol* 1986;135(6):1190-1193.
5. McConnell JD, Roehrborn CG, Bautista OM et al. The long-term effect of doxazosin, finasteride, and combination therapy on the clinical progression of benign prostatic hyperplasia. *N Engl J Med* 2003;349(25):2387-2398.
6. Roehrborn CG, Siami P, Barkin J et al. The effects of combination therapy with dutasteride and tamsulosin on clinical outcomes in men with symptomatic benign prostatic hyperplasia: 4-year results from the CombAT study. *Eur Urol* 2010;57(1):123-131.
7. Loeb S, Han M, Roehl KA, Antenor JA, Catalona WJ. Accuracy of prostate weight estimation by digital rectal examination versus transrectal ultrasonography. *J Urol* 2005;173(1):63-65.
8. Roehrborn CG: Accurate determination of prostate size via digital rectal examination and transrectal ultrasound. *Urology* 1998;51(4A Suppl):19-22.
9. Sech S, Montoya J, Girman CJ, Rhodes T, Roehrborn CG. Interexaminer reliability of transrectal ultrasound for estimating prostate volume. *J Urol* 2001;166(1):125-129.
10. Collins GN, Raab GM, Hehir M, King B, Garraway WM. Reproducibility and observer variability of transrectal ultrasound measurements of prostatic volume. *Ultrasound Med Biol* 1995;21(9):1101-1105.
11. Roehrborn CG, Girman CJ, Rhodes T et al. Correlation between prostate size estimated by digital rectal examination and measured by transrectal ultrasound. *Urology* 1997;49(4):548-557.
12. Yamamoto T, Ito K, Ohi M et al. Diagnostic significance of digital rectal examination and transrectal ultrasonography in men with prostate-specific antigen levels of 4 NG/ML or less. *Urology* 2001;58(6):994-998.
13. Richie JP, Catalona WJ, Ahmann FR et al. Effect of patient age on early detection of prostate cancer with serum prostate-specific antigen and digital rectal examination. *Urology* 1993;42(4): 365-374.
14. Potter SR, Horniger W, Tinzl M, Bartsch G, Partin AW. Age, prostate-specific antigen, and digital rectal examination as determinants of the probability of having prostate cancer. *Urology* 2001;57(6):1100-1104.