Title

Accurate Prostate Volumes from Manual Calculations-A Comparison of PI-RADS v2 and v2.1 Measurement Techniques.

Journal

Academic Radiology, 28(11)

Authors

Fowler, Kathryn
An, Julie

Publication Date

2021-11-01

DOI

10.1016/j.acra.2021.03.027

Peer reviewed

Published in final edited form as:

Acad Radiol. 2021 November ; 28(11): 1557–1558. doi:10.1016/j.acra.2021.03.027.

Accurate Prostate Volumes from Manual Calculations—A Comparison of PI-RADS v2 and v2.1 Measurement Techniques

Julie Y. An, MD,

Kathryn J. Fowler, MD

Department of Radiology, University of California San Diego, San Diego, 9500 Gilman Drive, 0888 California.

Abstract

There is a theoretical risk of volume overestimation if prostate AP dimension is taken on axial imaging given the anatomic obliquity of the gland on axial plane. This is analogous to slicing a salami sausage diagonally rather than perpendicularly to obtain larger slices.

The most recent PI-RADS update (v2.1) now recommends obtaining the anterior-posterior measurement on sagittal imaging to mitigate the theoretical risk of the so called “salami effect” when using the ellipsoid formula for volume calculations.

The authors of the recent article *Comparison of PI-RADS Versions 2.0 and 2.1 for MRI-based Calculation of the Prostate Volume* found the theoretical “salami effect” may not be as significant as originally thought, and perhaps slight overestimation of the AP diameter on axial measurements may yield more accurate volume estimates. Future validation studies are needed for to validate their findings.

In this contemporary study, there is excellent interreader agreement among radiologist’ three dimensional measurements–confirming manual calculation can be reliably replicated in practice settings where of software-based segmentation tools are not available.

Keywords

MpMRI; Standardized reporting; PIRADS; v2.1; MRI; Magnetic resonance imaging

The most recent Prostate Imaging—Reporting and Data System (PI-RADS) update (v2.1) recommends reporting of prostate volume using segmentation tools from planimetric software or via three-dimensional calculation using the ellipsoid formula (AP × longitudinal × transverse × π/6). In keeping with the v2.0 recommendations for gland measurements, transverse and longitudinal diameters are still obtained on axial and sagittal images, respectively (1). What is new in v2.1 is the recommendation to obtained the anterior-posterior (AP) measurements on sagittal imaging to mitigate the theoretical risk of the “salami effect” (2).

Address Correspondence to: Julie Y. An, j1an@ucsd.edu.

As Ghafoor et al, authors of the recent paper *Comparison of PI-RADS Versions 2.0 and 2.1 for MRI-based Calculation of the Prostate Volume* explained, there is a theoretical risk of volume overestimation if prostate AP dimension is taken on axial imaging given the anatomic obliquity of the gland on axial plane (3). This is analogous to slicing a salami sausage diagonally rather than perpendicularly to obtain larger slices.

To evaluate whether this measurement change would lead to more accurate prostate volumes, the authors of this recent article compared estimated volumes obtained from v2.0 and v2.1 measurement against volumes from manual segmentation.

Interestingly, the theoretical "salami effect" may not be as significant as originally thought, and perhaps slight overestimation of the AP diameter on axial measurements may yield more accurate volume estimates. Using v2.0 measurements (AP dimension measured on axial plane), the authors found that there was a slight underestimation of volume by 0.4mL. In comparison, v2.1 measurements (AP dimension measured on sagittal plane) resulted in an even greater underestimation by 2.6 mL. Both measurement methods underestimated the true prostate volume—but measuring the AP diameter on axial resulted in less underestimation and yielded volumes which are nearly identical to the segmentation volumes. The minimal 0.4mL underestimation from the ellipsoid formula is unlikely to be of clinical significance.

Accuracy of estimated volumes using orthogonal calculations may also have to do with the presence of benign prostatic hyperplasia. As one can easily imagine, a prostate is not a perfect ellipsoid, and prostates with more asymmetrically bulging components in any non-anatomically orthogonal direction can be underestimated using the ellipsoid formula. The slight over-estimation of the AP diameter may actually be helping to compensate for some lost volume not accounted for in the ellipsoid morphology assumption. As this study demonstrated, portions of the gland are not being accounted for using more conservative three-dimensional measurements.

Other imaging studies have demonstrated variable results regarding whether three dimensional measurements tend to over or underestimate the gland volume—with conflicting results (4–6). However, until there are more diverse validation studies to confirm whether sagittal or axial AP measurements yield the most accurate gland volumes, it is unclear which technique is best. Prior conflicting work have suggested that the ellipsoid formula and axial measurements yields slight overestimation of gland volume, which opposes this recent study from Ghafoor et al (4). We look forward to further evaluations on this topic, which may be useful for future evidence-based guideline updates.

The authors secondarily evaluated the accuracy of the bullet formula (AP × longitudinal × transverse × π/4.8), which makes the assumption that the prostate is bullet shaped rather than ellipsoid shaped. Some authors have postulated this to be a better representation of the true prostate volume (7), though it is infrequently used in clinical practice and not mentioned in either of the recent PI-RADS updates. In this evaluation, the bullet formula did not outperform the ellipsoid formula—providing confirmatory evidence for the use of the PI-RADS recommended ellipsoid formula.

Prostate size and its derived PSA density provide valuable information to the clinician for accessing a patient's risk for clinically significant cancer and for surgical planning. Given the clinical significance of prostate volume, it is imperative to provide accurate and consistent measurements regardless of planimetric software availability. This study confirmed that when radiologists are given specific instructions for dimensional measurements, there is excellent interreader agreement. At our institution, auto-segmentation with manual adjustment is used to obtain prostate volumes for the majority of cases. However, in instances where segmentation tools are not available (for example, when outside studies are interpreted), manual calculation using the ellipsoid formula is performed. This study confirms for us that the manual measurement technique can be reliable and reproducible method for estimating prostate gland volumes, and that we as radiologists can provide accurate gland volumes with or without advance segmentation tools.

FUNDING

Author JYA is supported by the institutional NIH T32EB005970 grant as a trainee through the UCSD Clinician-Scientist Radiology Residency Program.

REFERENCES

1. Weinreb JC, Barentsz JO, Choyke PL, et al. PI-RADS prostate imaging - reporting and data system: 2015, version 2. Eur Urol 2016; 69(1):16–40. doi:10.1016/j.eururo.2015.08.052. [PubMed: 26427566]
2. Turkbey B, Rosenkrantz AB, Haider MA, et al. prostate imaging reporting and data system version 2.1: 2019 update of prostate imaging reporting and data system version 2. Eur Urol 2019; 76(3):340–351. doi:10.1016/j.eururo.2019.02.033. [PubMed: 30898406]
3. Ghafoor S, Becker AS, Woo S, et al. Comparison of PI-RADS versions 2.0 and 2.1 for mri-based calculation of the prostate volume. Acad Radiol 2020: 1–9. doi:10.1016/j.acra.2020.07.027.
4. Jeong CW, Park HK, Hong SK, et al. Comparison of prostate volume measured by transrectal ultrasonography and mri with the actual prostate volume measured after radical prostatectomy. Urol Int 2008; 81(2):179–185. doi:10.1159/000144057. [PubMed: 18758216]
5. Madewell ZJ, Yang Y, Jr IML, et al. Comparison of a commercially available prostate segmentation application to traditional prolate and biproximate ellipsoid methods for prostate volume measurement. medRxiv 2020: 1–13.
6. Matthews GJ, Motta J, Fracchia JA. The accuracy of transrectal ultrasound prostate volume estimation: Clinical correlations. J Clin Ultrasound 1996; 24(9):501–505. doi:10.1002/(SICI)1097-0096(199611/12)24:9<501::AID-JCU2>3.0.CO;2-R. [PubMed: 8906481]
7. MacMahon PJ, Kennedy AM, Murphy DT, et al. Modified prostate volume algorithm improves transrectal US volume estimation in men presenting for prostate brachytherapy. Radiology 2009; 250(1):273–280. doi:10.1148/radiol.2501080290. [PubMed: 19092098]