The Impact of Prostate Volume Estimation on the Risk-Adapted Biopsy Decision based on Prostate Specific Antigen Density and Magnetic Resonance Imaging Score

Arthur Baudewyns[1], Karsten Guenzel[2], Adam Halinski[3], Charles Dariane[4], Gina Delavar[5], Julien Anract[5], Nicolas Barry Delongchamps[5], Teddy Jabbour[1], Henri-Alexandre Bourgeno[1], Yolène Lefebvre[6], Mariaconsiglia Ferriero[7], Giuseppe Simone[7], Alexandre Fourcade[8], Geroges Fournier[8], Marco Oderda[9], Paolo Gontero[9], Adrian Bernal-Gomez[10], Alessandro Mastrorosa[10], Jean-Baptiste Roche[10], Rawad Abou Zahr[11], Guillaume Ploussard[11], Gaelle Fiard[12], Katerina Rysankova[13], Alexandre Patrick Bui[14], Fayek Taha[14], Olivier Windisch[15], Daniel Benamran[15], Léonidas Vlahopoulos[16], Gregoire Assenmacher[16], Thierry Roumeguère[1], Alexandre Peltier[1], Romain Diamand[1].

[1] Department of Urology, Jules Bordet Institute-Erasme Hospital, Hôpital Universitaire de Bruxelles, Université Libre de Bruxelles, Brussels, Belgium / [2] Department of Urology, Vivantes Klinikum am Urban, Berlin, Deutschland / [3] Department of Urology, Private Medical Center "Klinika Wisniowa", Zielona Góra, Poland / [4] Department of Urology, Hôpital Européen Georges-Pompidou, Université de Paris, Paris, France / [5] Departement of Urology, Hôpital Cochin, Paris, France / [6] Department of Radiology, Jules Bordet Institute-Erasme Hospital, Hôpital Universitaire de Bruxelles, Université Libre de Bruxelles, Brussels, Belgium / [7] Department of Urology, IRCCS "Regina Elena" National Cancer Institute, Rome, Italy / [8] Department of Urology, Hôpital Cavale Blanche, CHRU Brest, Brest, France / [9] Department of Urology, Città della Salute e della Scienza di Torino, University of Turin, Turin, Italy / [10] Department of Urology, Clinique Saint-Augustin, Bordeaux, France / [11] Department of Urology, La Croix du Sud Hospital, Quint Fonsegrives, France / [12] Department of Urology, Grenoble Alpes University Hospital, Université Grenoble Alpes, CNRS, Grenoble INP, TIMC, Grenoble, France / [13] Department of Urology, University Hospital Ostrava, Ostrava, Czech Republic / [14] Department of Urology, Centre Hospitalier Universitaire de Reims, Reims, France / [15] Department of Urology, Hôpitaux Universitaires de Genève, Geneva, Switzerland / [16] Department of Urology, Cliniques de l'Europe-Saint Elisabeth, Brussels, Belgium

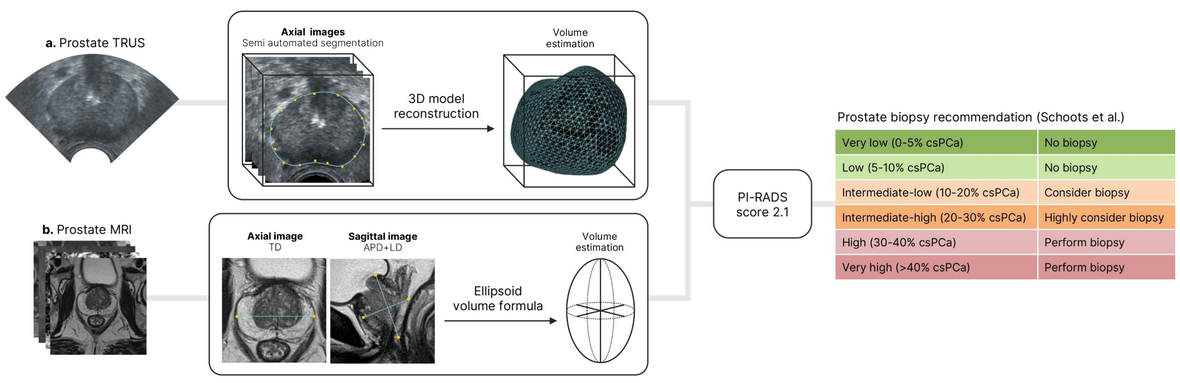
Introduction

Prostate-specific antigen (PSA) testing remains a crucial screening tool for early detection. However, a more precise assessment of PCa risk is needed to guide therapeutic decisions and avoid unnecessary biopsies. PSA density (PSAd) has emerged as a promising criterion, in particular among smaller prostates and/or low serum PSA value. Currently, there are no recommendations concerning the most appropriate imaging modality, or the optimal volume calculation method to determine the PSAd. In the present study we aimed to evaluate the risk distribution of patients with csPCa depending on the imaging modality used for prostate volume estimation.

Methods

Design, Setting, and Participants: Overall, 4841 patients who underwent MRI-targeted and systematic biopsies were identified from a prospectively maintained database between January 2016 to April 2023 at fifteen European referral-centers. A total of 971 patients met inclusion criteria and were included in the analysis.

Outcome Measurements and Statistical Analysis: Correlation of prostate volume estimation was assessed by Kendall's correlation coefficient and graphically represented by scatter and Bland-Altman plots. Distribution of csPCa was presented using the Schoots risk-adapted table based on PSAd and PI-RADS score. The model was evaluated using discrimination, calibration plots and decision curve analysis(DCA).

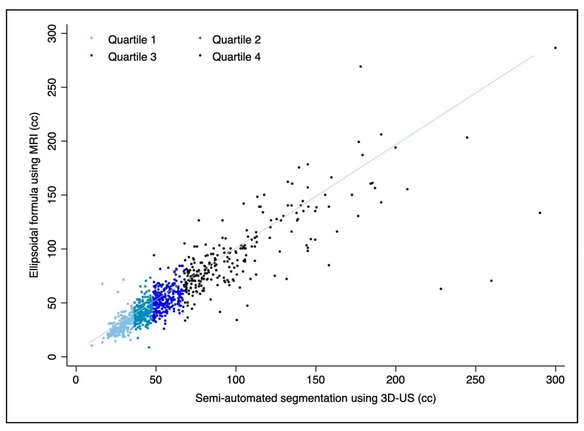


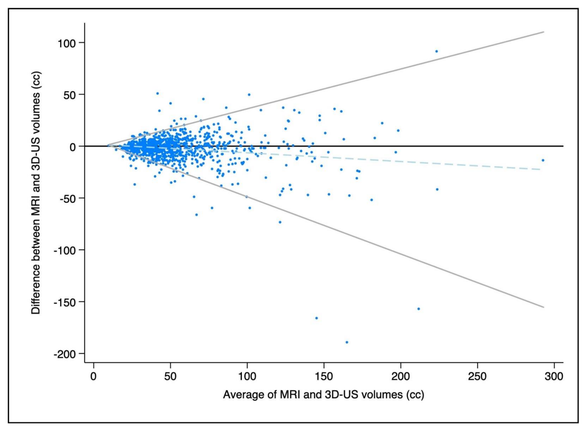
Prostate biopsy recommendation (Schoots et al.)

Very low (0-5% csPCa)	No biopsy
Low (5-10% csPCa)	No biopsy
Intermediate-low (10-20% csPCa)	Consider biopsy
Intermediate-high (20-30% csPCa)	Highly consider biopsy
High (30-40% csPCa)	Perform biopsy
Very high (>40% csPCa)	Perform biopsy

Results

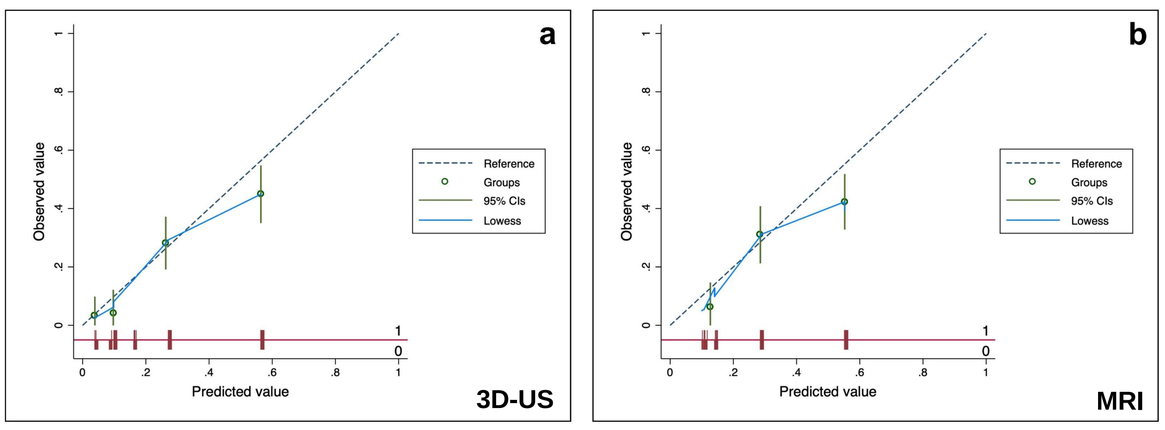
Overall, median prostate volume estimation using 3D-US was higher compared to MRI (49cc[IQR 37-68] and 47cc[IQR 35-66], p<0.001). A significant correlation between imaging modalities was observed (τ=0.73[CI 0.7-0.75], p<0.001). Bland-Altman plot emphasizes the differences in prostate volume estimation, especially for larger prostates. Using the Schoots risk-adapted table, a high-risk of csPCa was observed in PI-RADS score 2 combined with high PSAd, and in all PI-RADS score 4-5.

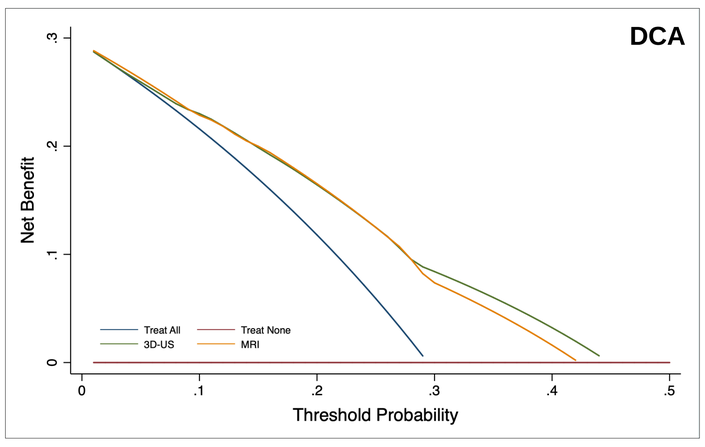




		low < 0.10	intermediate - low 0.1 - 0.15	intermediate - high 0.15 - 0.20	high ≥0.20
PI-RADS 2	3D-US	0% (0/3)	10% (1/10)	0% (0/2)	33% (2/6)
2% (21/971)	MRI	0% (0/6)	14% (1/7)	0% (0/3)	40% (2/5)
PI-RADS 3	3D-US	4% (2/49)	7% (4/55)	16% (5/31)	23% (6/26)
17% (161/971)	MRI	0% (0/45)	12% (6/52)	11% (3/28)	22% (8/36)
PI-RADS 4-5	3D-US	28% (49/177)	40% (77/194)	41% (76/153)	72% (192/265)
81% (789/971)	MRI	30% (49/164)	40% (70/174)	45% (72/159)	70% (203/292)

The risk of csPCa was proportional to the PSAd for patients with PI-RADS score 3. The model achieved good accuracy (AUC of 0.69 and 0.68 using 3D-US and MRI, respectively), adequate calibration and a higher net benefit when using 3D-US for probability thresholds above 25% on DCA. Limitations included the absence of comparison with surgical pathology specimens.





Conclusions

The present study suggests that prostate volume estimation using semi-automated segmentation should be preferred over ellipsoidal formula when estimating PSAd with an improvement of risk-stratification for csPCa prediction.

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