

# Masking Enhances Accuracy of Bladder Deformation in Multi-fraction Adaptive Brachytherapy as a First Step toward Composite Dose Estimation

Jennifer Barclay, Arnold Pompoš PhD, Xuejun Gu PhD, Kevin Albuquerque MD  
Department of Radiation Oncology, UT Southwestern Medical Center, Dallas, TX

## Introduction

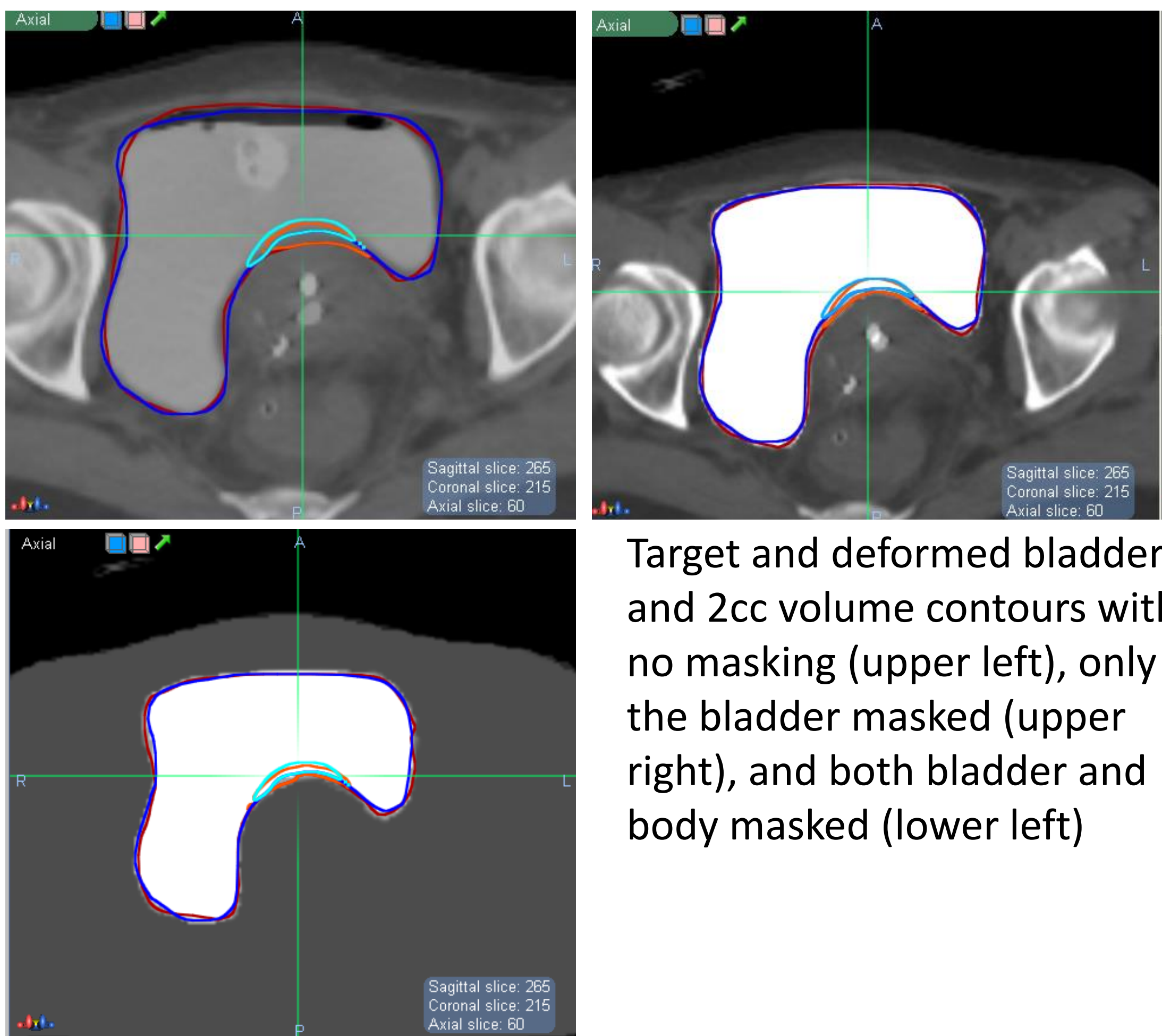
- GEC-ESTRO guidelines for cervix HDR brachytherapy advocate measurement of the 2cc dose received by organs at risk (OAR) and its summation across multiple treatment fractions to give a worst-case-scenario total cumulative dose estimate.
- If the OAR from different fractions could be accurately co-registered using deformation, then a more accurate composite dose could be obtained.

## Objectives

- Assess bladder deformation quality using statistical methods
- Determine whether a technique called masking, which involves resetting the pixel values within a contour, can be used to improve bladder deformation

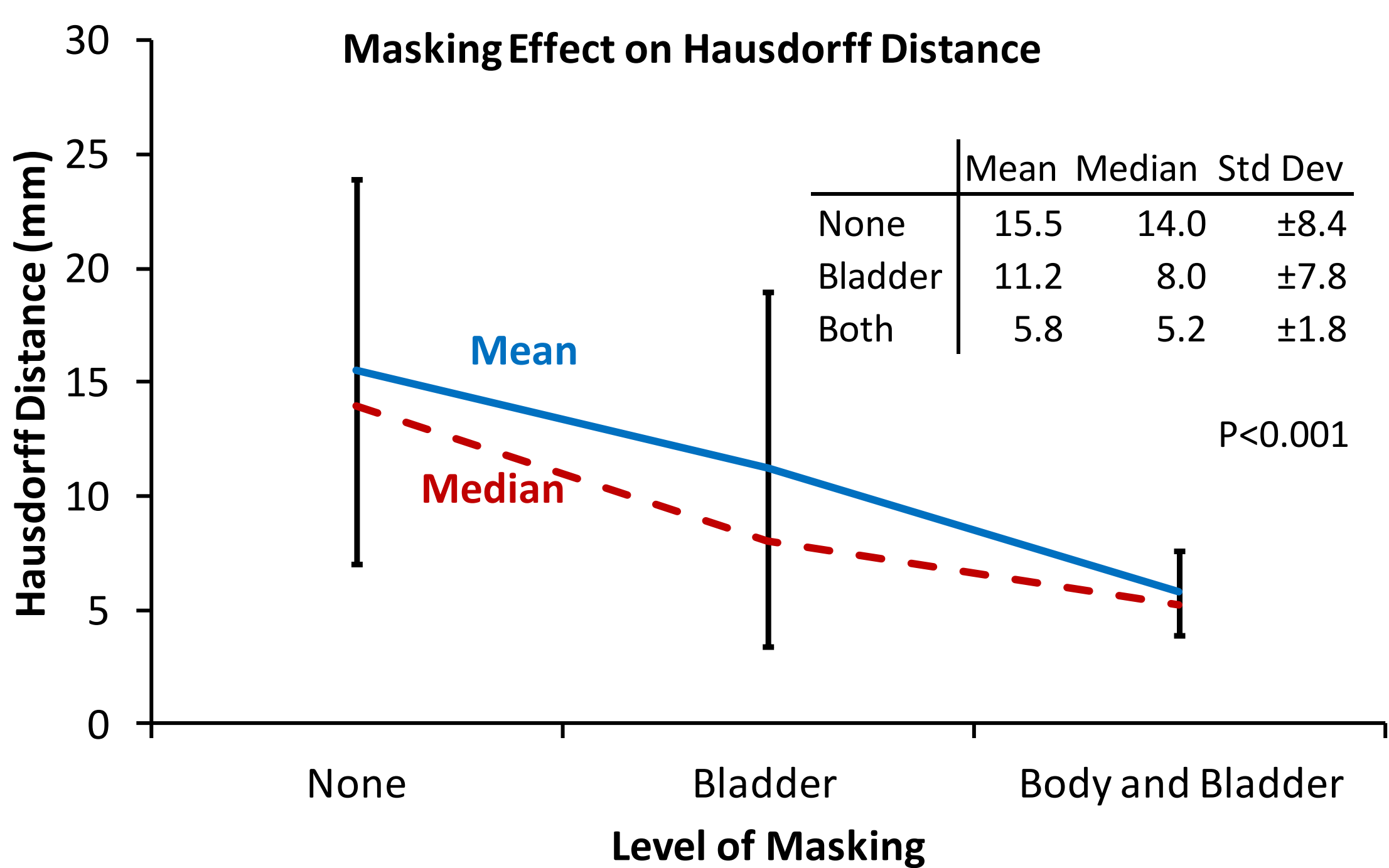
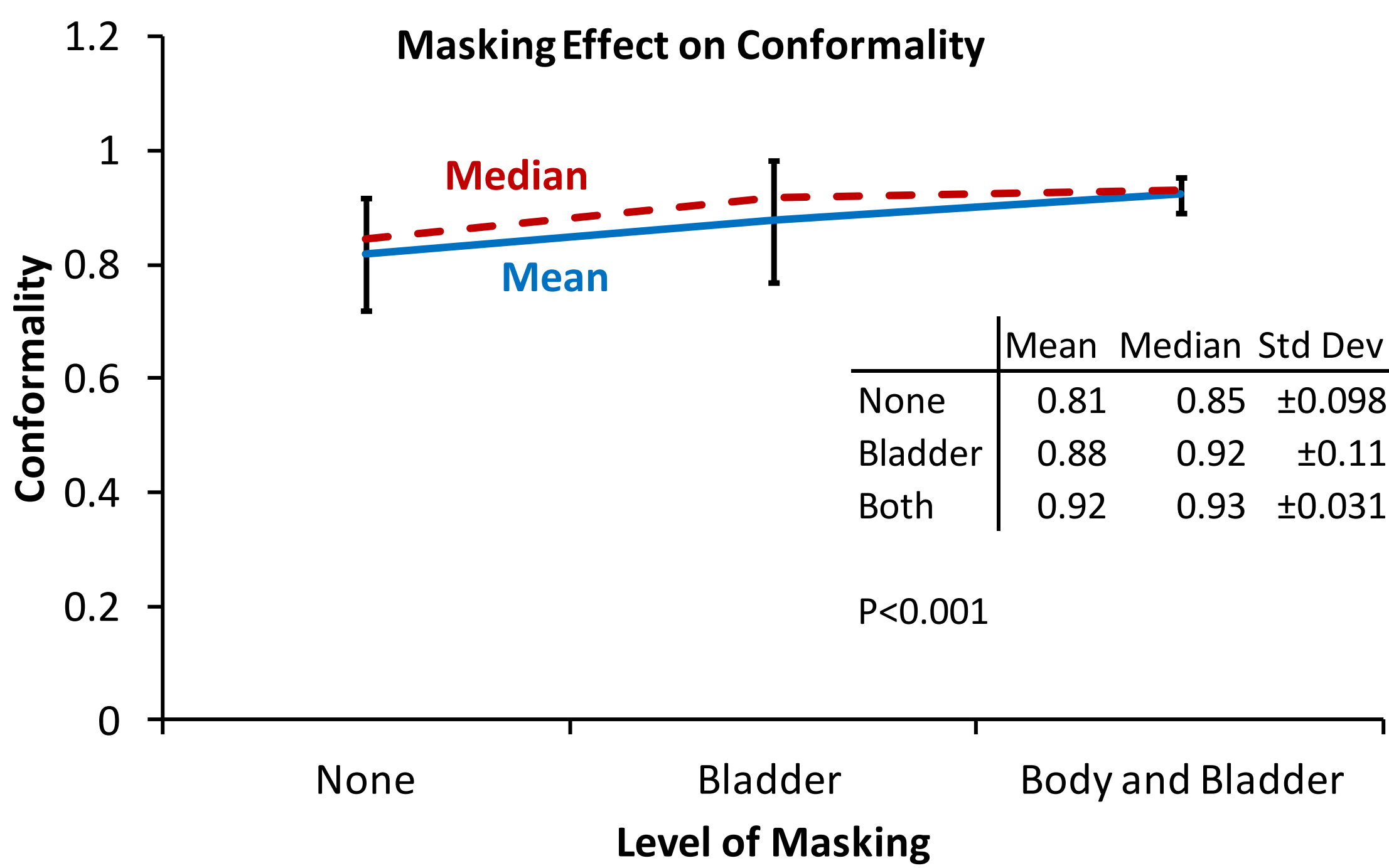
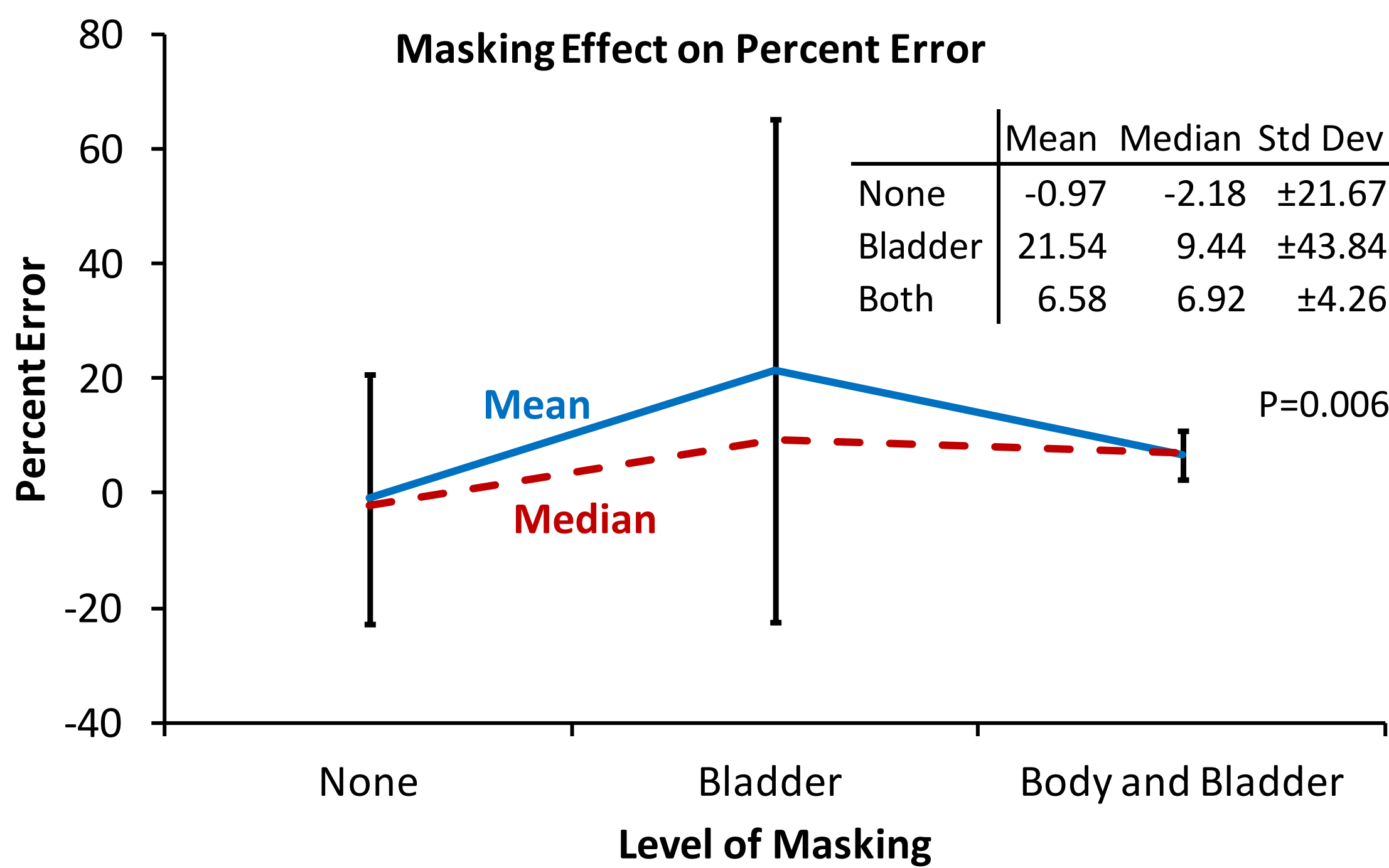
## Materials and Methods

- CT scans from ten cervical cancer patients had bladders contoured by treating radiation oncologists and the urethra contoured using the catheter as a fixed reference point.
- Three copies of each CT were made: nothing masked, only the bladder masked, and both bladder and body masked.
- Using VelocityAI 2.8.1, the bladder was deformed onto the target (Fraction 1) planning CT from subsequent planning CT.
- To assess deformation accuracy:
  - The percent error of the deformed bladder volume
  - The conformity, the overlap of two volumes
  - The Hausdorff distance, the distance between two surfaces
  - The distance from the target to the deformed urethra

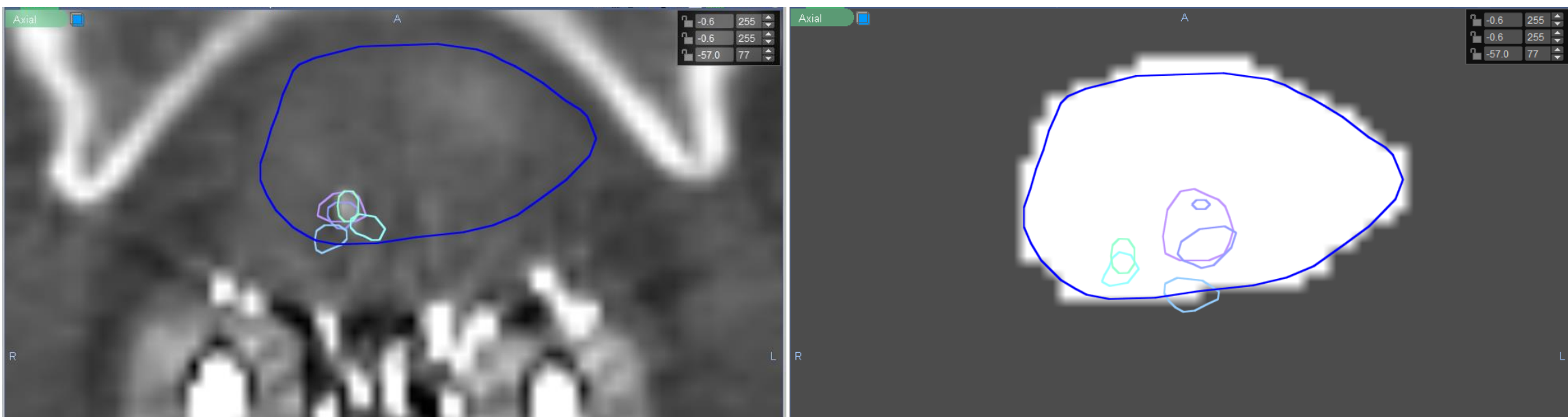
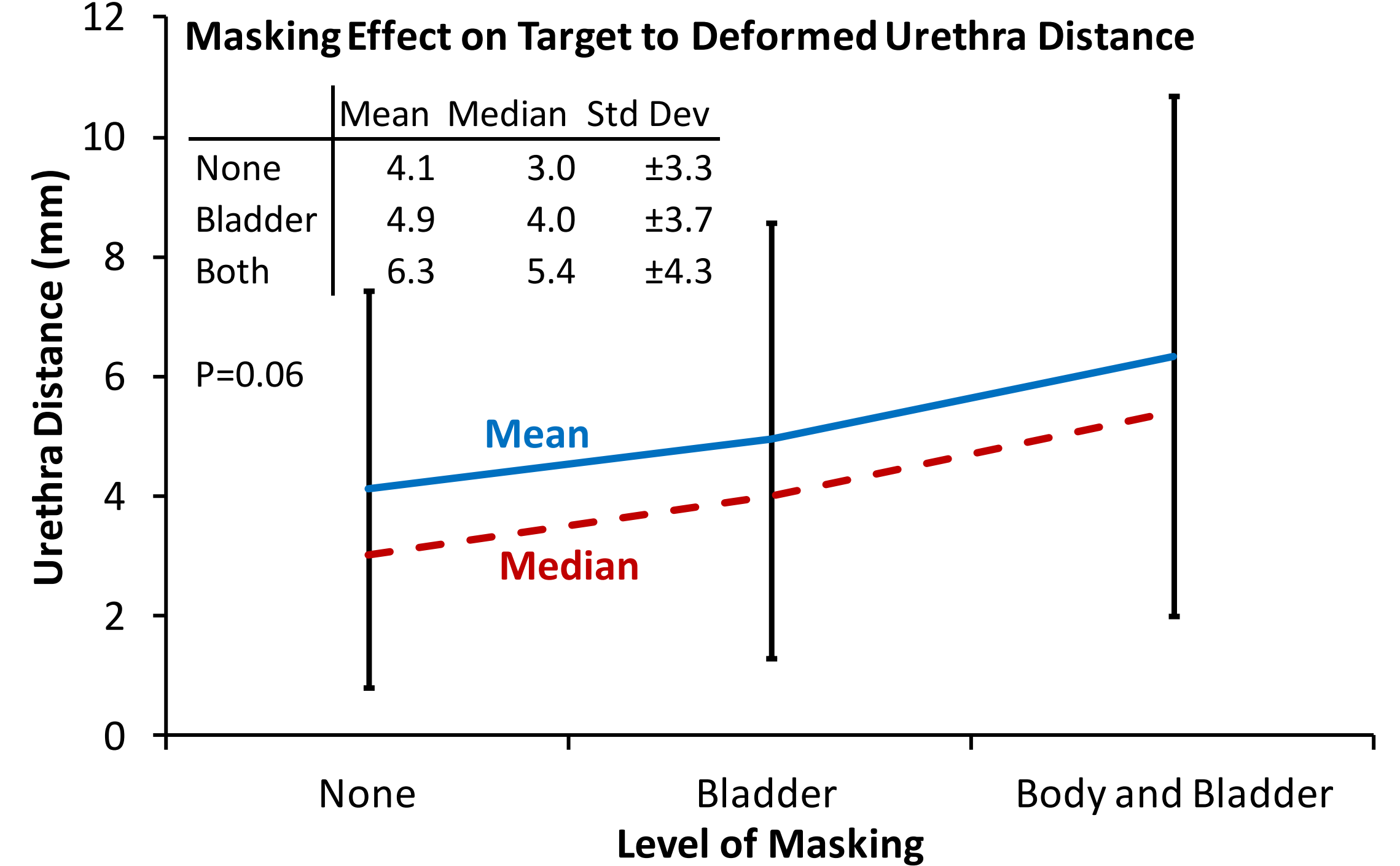


Target and deformed bladder and 2cc volume contours with no masking (upper left), only the bladder masked (upper right), and both bladder and body masked (lower left)

## Results



## Results



Junction of bladder and urethra with no masking (left) and both body and bladder masked (right). The target bladder and deformed urethra contours from all five fractions are shown.

## Conclusion

- Results of the statistical assessment show that the accuracy of bladder deformation can be significantly improved by masking.
- With masking, deformed bladder volume and location more closely approached those of the target bladder than without masking.
- Masking has the potential to improve the accuracy of dose deformation and composite dose calculation in adaptive brachytherapy.

## References

Georg P, Lang S, Dimopoulos JCA, *et al.* Dose-volume histogram parameters and late side effects in magnetic resonance image-guided adaptive cervical cancer brachytherapy. *Int J Radiat Oncol Biol Phys* 2011; 79(2): 356-362.

Lebesque JV, Bruce AM, Kroes APG, *et al.* Variation in volumes, dose-volume histograms, and estimated normal tissue complication probabilities of rectum and bladder during conformal radiotherapy of T3 prostate cancer. *Int J Radiat Oncol Biol Phys* 1995; 33(5): 1109-1119.

Saarnak AE, Boersma M, van Bunningen BNFM, Wolterink R, Steggerda MJ. Inter-observer variation in delineation of bladder and rectum contours for brachytherapy of cervical cancer. *Radiother Oncol* 2000; 56:37-42.

Potter R, Haie-Meder C, Limbergen EV, *et al.* Recommendations from gynaecological (GYN) GEC ESTRO working group (II): Concepts and terms in 3D image-based treatment planning in cervix cancer brachytherapy—3D dose volume parameters and aspects of 3D image-based anatomy, radiation physics, radiobiology. *Radiother Oncol* 2006;78:67-77.