

Contouring Differences Between Imaging Modalities Utilized for High Dose Rate Brachytherapy of the Prostate

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ABSTRACT

Purpose: High dose rate (HDR) brachytherapy is a well-established modality for treating prostate cancer. Imaging used for treatment planning is typically transrectal ultrasound (TRUS) or CT. This study aims to compare the volumetric accuracy of, and differences between, TRUS and CT-based prostate contours for HDR brachytherapy using MRI as a baseline.

Methods: The prostate was contoured by a resident physician and reviewed by an attending physician in Eclipse (V16.1) for 10 patients on four different image types (when available); 1) HDR TRUS pre-needle insertion (N=5), 2) HDR TRUS post-needle insertion (N=8), 3) HDR CT post-needle insertion (N=10), and 4) post-HDR treatment MRI (N=9). The difference in prostate volume between pre- and post-needle insertion HDR TRUS, both TRUS versus MRI, and CT versus MRI were analyzed. Differences were averaged and compared to determine agreement with MRI volumes.

Results: The average prostate volumes were 23.2±14.0cc (range: 8.1-36.7), 22.0±10.9cc (range: 5.3-39.0), 44.2±18.1cc (range: 18.9-71.5), and 27.7±11.2cc (range: 16.0-47.6) for (1), (2), (3), and (4), respectively. Post-HDR needle insertion TRUS contours were, on average, 51±12% (range: 32-72%) smaller than their CT counterparts. Post-HDR needle insertion TRUS contours were, on average, 14±14% (range: 1-35%) smaller than pre-needle insertion. Compared to MRI, pre- and post-needle insertion HDR TRUS contours were 20±19% (range: 2-47%) and 23±21% (range: 1-65%) smaller on average respectively, whereas CT volumes were 50±18% (range: 24-84%) larger on average.

Conclusion: The larger deviation from MRI volumes that CT contouring produced suggests that TRUS provides a more accurate volume for prostate contouring in HDR brachytherapy. Future research will utilize image fusion to calculate Dice-Sørensen coefficients and adjust for modality-specific differences in institutional contouring protocols to evaluate spatial agreement and dosimetric impact. Other future studies will investigate differences in perceived target coverage depending on which imaging modality is used for planning given the same needle insertion.

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PURPOSE

- High dose rate (HDR) brachytherapy is a well-established modality for treating prostate cancer.
- MRI is considered the gold standard for prostate delineation, but depending on an institution's capabilities, HDR planning typically relies on CT or transrectal ultrasound (TRUS).
- We believe that this work is impactful as it provides useful information about how perceived dosimetry and target volumes may change if an institution transitions from one HDR planning methodology to another.
- Our goal is to investigate the differences between physician prostate contours across various modalities and evaluate the impact it may have on planning and dosimetry.

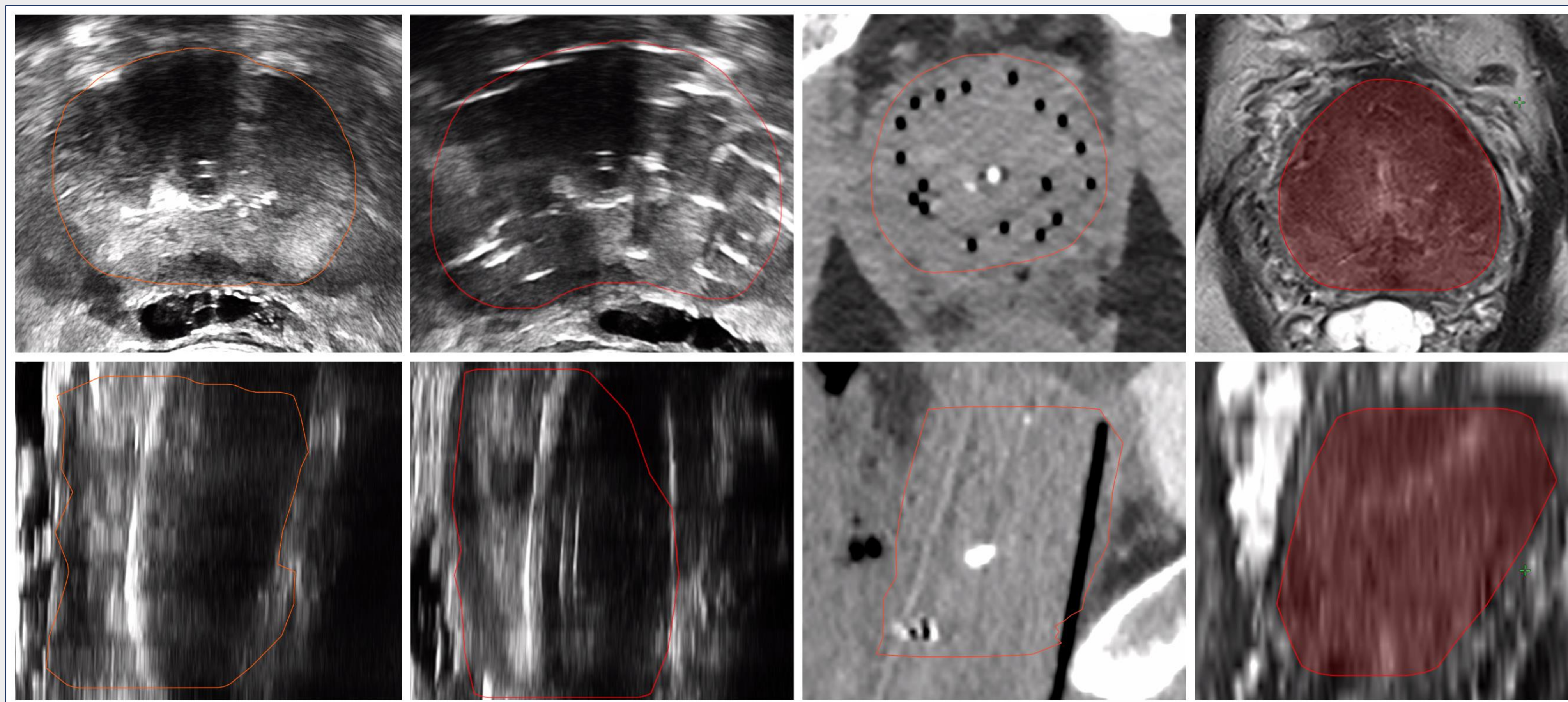


Figure 1: An example of all image types included in this study for Patient 10. From left to right: pre-needle insertion US, post-needle insertion US, post-needle insertion CT, post-HDR MRI with axial images on the top and sagittal images on the bottom.

RESULTS

- The average prostate volumes for each image type were:
 - 23.2±14.0cc (range: 8.1-36.7), (1)
 - 22.0±10.9cc (range: 5.3-39.0), (2)
 - 44.2±18.1cc (range: 18.9-71.5), (3)
 - 27.7±11.2cc (range: 16.0-47.6) (4)
- Post-HDR needle insertion TRUS contours were, on average, 51±12% (range: 32-72%) smaller than their CT counterparts.
- Post-HDR needle insertion TRUS contours were, on average, 14±14% (range: 1-35%) smaller than pre-needle insertion.
- Compared to MRI, pre- and post-needle insertion HDR TRUS contours were 20±19% (range: 2-47%) and 23±21% (range: 1-65%) smaller on average respectively, whereas CT volumes were 50±18% (range: 24-84%) larger on average.

CONCLUSIONS

- The larger deviation from MRI volumes that CT contouring produced suggests that TRUS provides a more accurate volume for prostate contouring in HDR brachytherapy.
- Future research will utilize image fusion to calculate Dice-Sørensen coefficients and adjust for modality-specific differences in institutional contouring protocols to evaluate spatial agreement and dosimetric impact.
- Other future studies will investigate differences in perceived target coverage depending on which imaging modality is used for planning given the same needle insertion.

METHODS AND MATERIALS

- Prostate contours for 10 patients across four different image types were evaluated.
- Prostates were contoured by a resident physician and reviewed by an attending physician in Eclipse (V16.1).
- Four different image types were contoured:
 - HDR TRUS pre-needle insertion (N=5)
 - HDR TRUS post-needle insertion (N=8)
 - HDR CT post-needle insertion (N=10)
 - Post HDR treatment (MRI) (N=9)

	Pre-Insertion US [cc]	Post-Insertion US [cc]	Post-Insertion CT [cc]	Post-HDR MRI [cc]
Max	39.5	39.0	71.5	47.6
Min	8.1	5.3	18.9	15.2
Mean	23.2	22.0	44.2	27.7
SD	14.0	10.9	18.1	11.2

Table 1: Average descriptive statistics of prostate contour volumes [cc] across available imaging modalities for all patients. Values include maximum, minimum, mean, and standard deviation. Modalities include pre-insertion US, post-insertion US, post-insertion CT, and post-HDR MRI.

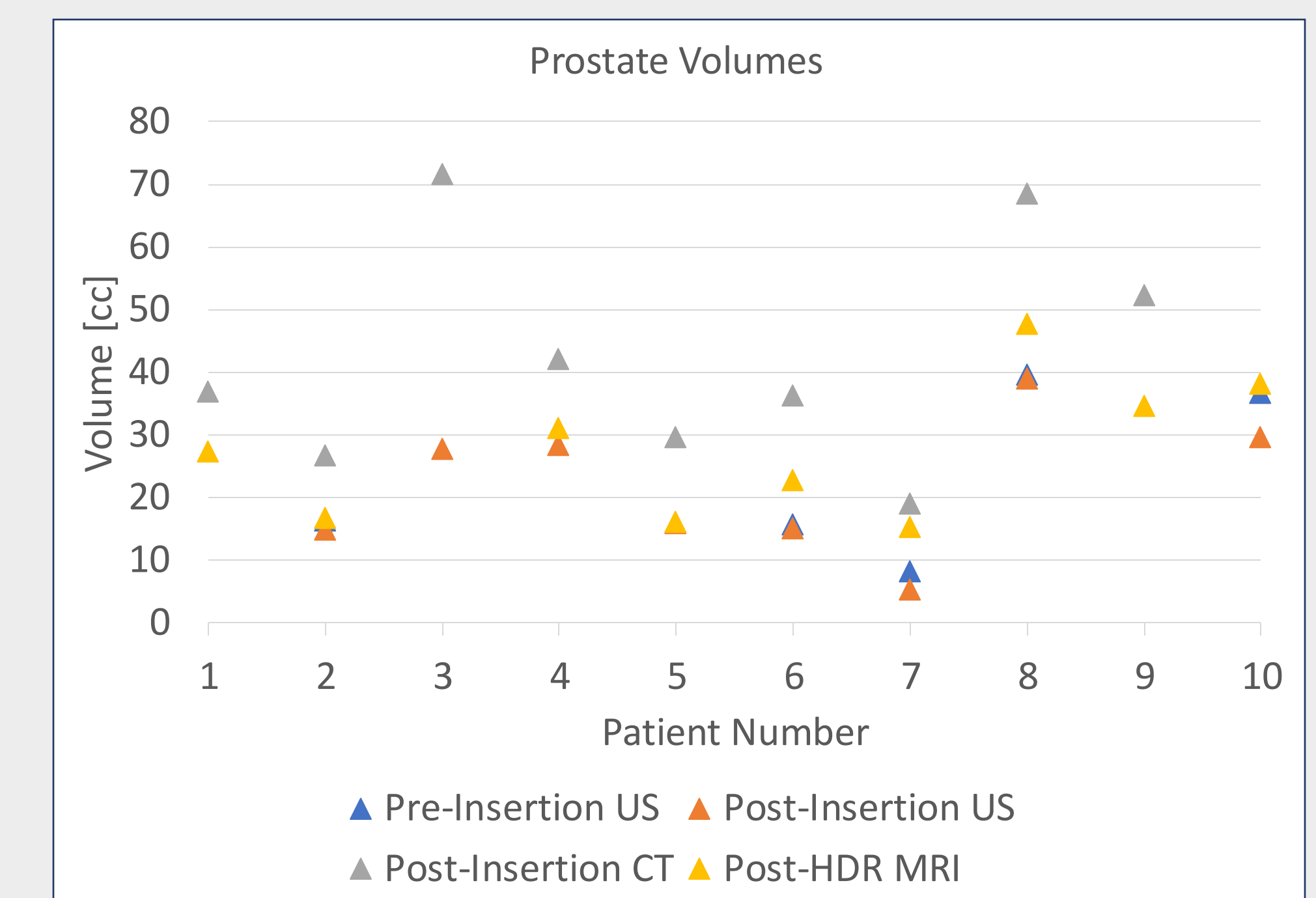


Figure 2: Prostate contour volume [cc] for each patient for all available modalities. Note that not all images are available for all patients, which is indicated by a missing data point.

	Post-HDR MRI : Pre- Insertion US	Post-HDR MRI : Post- Insertion US	Post-HDR MRI : Post- Insertion CT	Post- Insertion CT : Post- Insertion US
Max	47%	65%	-24%	72%
Min	2%	1%	-84%	32%
Mean	20%	23%	-50%	51%
SD	19%	21%	18%	12%

Table 2: Average descriptive statistics of prostate contour volume percent differences compared to MRI as well as post-insertion CT compared to post-insertion US for all available patient images. Values include maximum, minimum, mean, and standard deviation.

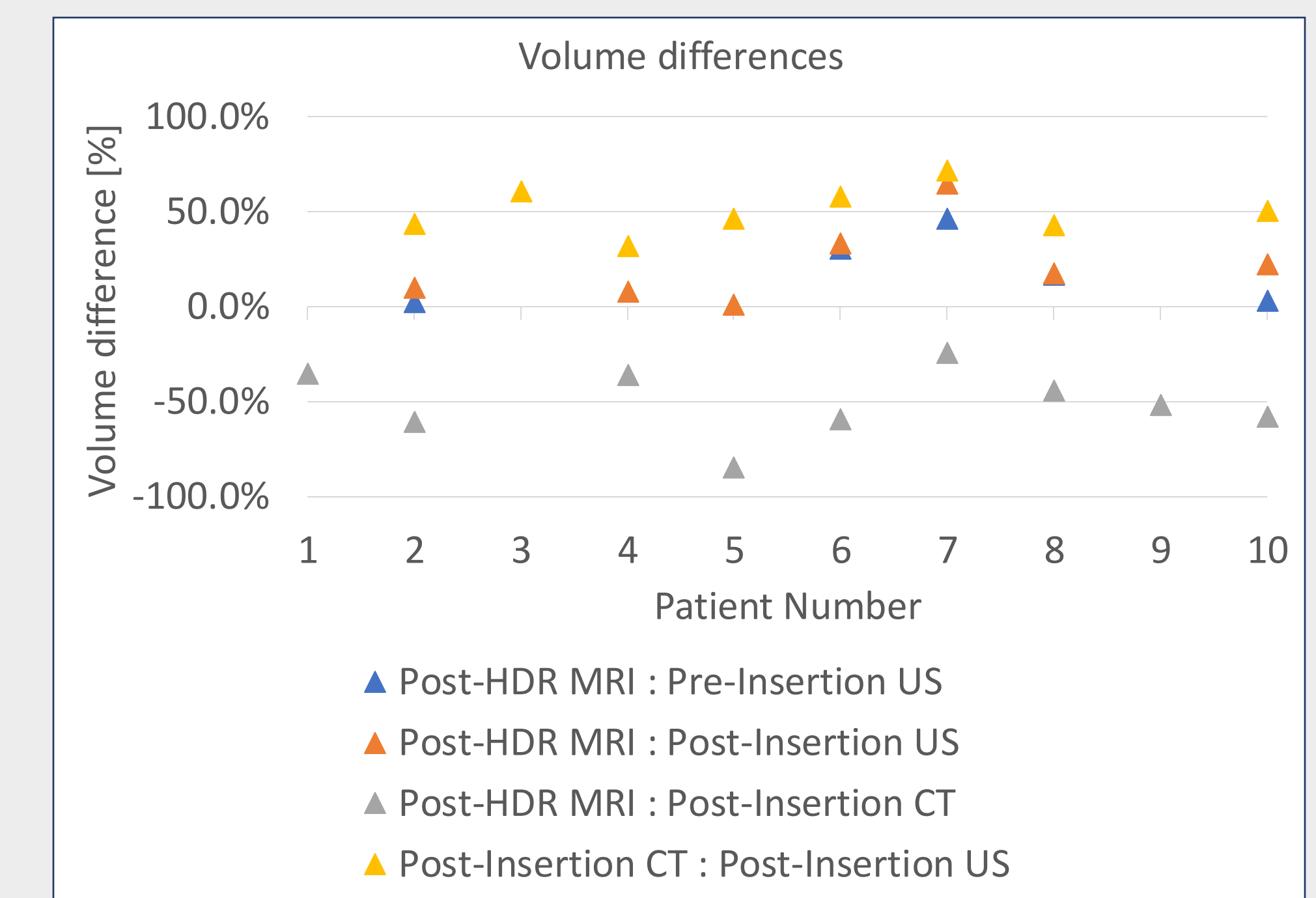


Figure 3: Percent differences of prostate contour volume compared to MRI as well as post-insertion CT compared to post-insertion US. Positive values indicate that contour "X" is larger than contour "Y" given "X:Y" in the legend.