

Displacement of implanted gold fiducials due to rectal marker placed for delineating the luminal surface of rectum

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Purpose

■ For prostate cancer patients, the use of a rectal marker may be helpful to identify the anterior luminal surface of the rectum on CT images accurately. However, it could result in the deformation of the prostate.

■ The purpose of this study was to evaluate the possibility of potential displacement of implanted gold fiducials due to the rectal marker (Intermark Inc., UK) placed for delineating the luminal surface of rectum.

■ In this study, we evaluated the displacement of implanted gold fiducials secondary to the placement of a rectal marker placed in order to delineate the luminal surface of rectum.



Fig. 1. Rectal marker (Intermark Inc., UK) placed for delineating the luminal surface of rectum.

■ The gold fiducials were contoured for evaluating the displacement due to the rectal. Displacements of gold fiducials with and without the rectal marker were computed. Also, displacements of gold fiducials against the isocenter as well as femoral head were computed for comparison.

Results

■ Table 1 shows the displacement of gold markers implanted into prostate with and without rectal marker. Mean displacement of gold fiducials was less than 2.5 mm in all directions (lateral: 0.12 ± 0.15 cm, vertical: 0.21 ± 0.29 cm, longitudinal: 0.14 ± 0.27 cm). However, the maximum displacement of fiducials in the anterior-posterior and superior-inferior directions was approximately 3.5 mm and all cases were skewed toward the anterior direction, demonstrating that the movement of gold fiducials due to rectal marker was strongly related.

Table 1. Displacement of gold markers implanted into prostate with and without rectal marker.

	Displacement of gold marker (cm) with/without rectal marker		
	Lateral	Vertical	Longitudinal
Case 1	0.05 ± 0.04	0.19 ± 0.01	0.14 ± 0.01
Case 2	0.16 ± 0.06	0.35 ± 0.08	
Case 3	0.08 ± 0.04	0.07 ± 0.05	0.04 ± 0.02
Case 4	0.18 ± 0.10	0.17 ± 0.20	0.05 ± 0.09
Case 5	0.16 ± 0.04	0.27 ± 0.03	0.35 ± 0.09
Average	0.12 ± 0.15	0.21 ± 0.29	0.14 ± 0.27

Results (cont'd)

■ Table 2 shows the difference of distance in between gold fiducials implanted into the prostate with and without rectal marker. The maximum displacement between the gold fiducials with and without rectal marker was 0.12 ± 0.13 cm. It showed that the rectal marker resulted in the deformation of prostate as well as rectum and the relative positions for the gold fiducials implanted posteriorly close to rectum were shifted up to 1.2 ± 1.3 mm.

Table 2. Difference of distance in between gold fiducials implanted into the prostate with and without rectal marker.

	Difference of distance (cm) in between gold fiducial with/without rectal marker		
	1&2	2&3	1&3
Case 1	0.07	0.08	0.10
Case 2	0.08	0.04	0.08
Case 3	0.08		
Case 4	0.15	0.31	0.21
Case 5	0.01	0.05	0.04
Average	0.08	0.12	0.11
SD	0.05	0.13	0.08

■ Table 3 shows the difference of distance between isocenter and gold fiducials implanted into prostate with and without rectal marker. The maximum displacement between the gold fiducials with and without rectal marker was 0.17 ± 0.09 cm. In addition, it showed that the movement of gold fiducial due to rectal marker was strongly patient-specific.

Table 3. Difference of distance between isocenter and gold fiducials implanted into prostate with and without rectal marker.

	Difference of distance (cm) between isocenter and gold fiducial with/without rectal marker		
	fiducial 1	fiducial 2	fiducial 3
Case 1	0.14	0.13	0.07
Case 2	0.04	0.31	0.29
Case 3	0.04	0.02	
Case 4	0.07	0.08	0.13
Case 5	0.03	0.04	0.17
Average	0.06	0.11	0.17
SD	0.05	0.12	0.09

■ Table 4 shows the difference of distance between femoral head and gold fiducials implanted into the prostate with and without the rectal marker. Maximum displacement between the gold fiducials with and without the rectal marker was 0.15 ± 0.08 cm. This result showed that the treatment margin of 5 mm was adequate to cover the deformation of prostate as well as rectum caused by rectal marker, especially in anterior-posterior direction. Overall, the relative positions of gold fiducials were minimally changed with and without rectal marker. However, rectal marker pushed the rectal wall and prostate in anterior direction of 0.21 ± 0.29 cm with maximum displacement of 3.5 mm.

Table 4. Difference of distance between isocenter and gold fiducials implanted into prostate with and without rectal marker.

	Difference of distance (cm) between femoral head and gold fiducial		
	fiducial 1	fiducial 2	fiducial 3
Case 1	0.07	0.02	0.06
Case 2	0.21	0.08	0.10
Case 3	0.05	0.08	
Case 4	0.18	0.24	0.03
Case 5	0.22	0.11	0.15
Average	0.15	0.11	0.09
SD	0.08	0.08	0.05

Methods and Materials

Development of Moving Phantom System

■ Five prostate-cancer patients were scanned by using a CT scanner (Brilliance Big Bore, Philips) for planning purposes. CT images were acquired with a rectal marker (Intermark Inc., UK) and then followed by images without the marker.

■ For all of the patients, two or three gold fiducials were implanted into the prostate for image-guided radiation treatment. Both CT images were imported into the AcQSim station (Pinnacle 8.0d, Phillips) and then image-fused and registered based on the bony structure.

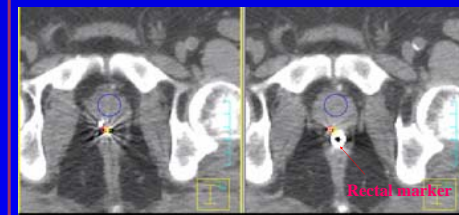


Fig. 2. Axial images showing the displacement of gold fiducials implanted into prostate with and without rectal marker.

Conclusions

■ Overall, the relative positions of gold fiducials were minimally changed with and without rectal marker. However, the rectal marker forced up the rectal wall and prostate anteriorly (mean: 0.21 ± 0.29 cm) with maximum displacement of 3.5 mm.