

USE OF THE INTRA-PROSTATIC CALCIFICATIONS FOR CORRECTION OF THE ORGAN MOTION



G.Mantello1, G.Pierfederici1, M.Valenti2, S. Costantini1, F. Cucciarelli1, M. Di Benedetto1, L. Fabbietti1, F. Fenu1, A. Maucieri1, M. Montisci1, L. Vicenzi1, A. B. Galosi3, S. Maggi2, and M. Cardinali1

¹ Dept of Radiotherapy, ² Dept of Physics, ³ Dept of Urology, AOU Ospedali Riuniti Ancona, Italy

Aim The treatment of the prostate can foresee the use of Fiducial gold Markers (FMs) which are opportunely inserted by the urologist into the gland and act as a surrogate for the position of the prostate itself.

As an alternative to the use of gold markers some authors have studied the use of natural markers such intra-prostatic calcifications (ICs), present in 90% of prostatectomies and visible in the images obtained in bunkers in at least 35% of the patients as Cone Beam Computed Tomography (CBCT)

The visibility of the ICs is dependent on the density and size of the calcifications and can have several advantages: they are natural, they do not create artifacts on images, and they cannot migrate because they are integrated into soft tissues.

The aim of this work was to study the possibility of using the ICs, identified in the Simulation CT (CTsim) and in CBCT, as natural markers to correct the organ motion inter fraction of the prostate during the entire course of radiotherapy.

Figure 1: Main steps of the study: step1) selecting patients with intraprostatic calcifications on the CT sim images; step2) checking their optimal visibility on the CBCT images; step3) checking optimal match CBTCs/ CT sim images on the calcification; step 4) checking the adequacy of the 5mm CTV-PTV margin.



Table 1: visibility of intraprostatic calcifications on acquired Cone Beam Computed Tomography (CBCT), per each patient.

Patients ID	Acquired CBTCs (patient)	Intraprostatic calcifications visibility		
		Clearly visible	Barely visible	Scarcely visible
1	19	18 /19	1/19	-
2	18	17/18	1/18	-
3	16	16/16	-	-
4	14	13/14	1/14	-
5	16	16/16	-	-
6	16	15/16	1/16	-
7	18	16/18	2/18	-
8	10	7/10	1/10	2/10
9	11	9/11	2/11	-
10	11	10/11	1/11	-
11	11	10/11	1/11	-
12	8	-	8/8	-

Materials and Methods: A total of 135 patients treated for prostate cancer were included. The study consisted of four steps:

- 1) selecting patients with intraprostatic calcifications on the CT sim images;
- 2) checking their optimal visibility on the CBCT images;
- 3) checking optimal match CBTCs/ CT sim images on the calcification;
- 4) checking the adequacy of the 5mm Clinical Target Volume and Planning Target Volume (CTV-PTV) margin (Figure 1).

The 5 mm margin was chosen based on the experience gained in the last 12 years in the image-guided RT of the prostate with implantation of gold markers at our radiotherapy department. The study of the stability of the gold markers and the calculation of the residual error after correction of the target position, led radiotherapists and physicists to consider a 5 mm CTV-PTV margin suitable to compensate for the uncertainty of positioning the target.

Results: Out of 135 studied patients, 32 (23.7%) showed calcifications, 20 (14.8%) periprostatic and 12 (8.9%) intra-prostatic. 87.5% of cases had clearly visible ICs on CBCT (147 / 168 images), 11.3% barely visible (19 /168 images) and finally 1.2% scarcely visible / not visible (2 images). (Table 1) In 89.2% of the images (106/ 118), the ICs allowed a good match and an optimal compensation of residual organ motion (OM) within 5 mm. In 10.2% cases (12 /118), gas in the rectum conditioned the correct use of ICs.

Conclusion:

The ICs when clearly visible (> 2 mm) and are at least 3, can be used as very reliable natural fiducial markers.

This method potentially reduces the risks and costs associated with the implementation of conventional fiducial markers. Given the fairly high prevalence of these calcifications in the population of patients with prostate cancer, this non-invasive method could be more widely applied.

To date, there are no indications on the margin to be adopted in a protocol that provides for the use of calcifications to compensate for the motion.

In this study, we have shown, in agreement also with the studies reported in the literature, that in a high percentage of cases it is possible to make a good correction of the interfraction organ motion co-recording on the undertaken calcifications, if any, and that a 5 mm margin can compensate for the residual error after co-registration.