The differences in dose distribution caused by uncorrected rotations.

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PURPOSE

For postprostatectomy patients at higher risk of nodal involvement the target includes prostate bed - $PTV_{prostate}$ and pelvic lymph nodes - PTV_{nodes} (Fig.1). The irradiation of this target leads to an increase of doses delivered to the pelvic bones. The aim of this study was to determine the impact of rotational set-up errors on the dose distribution in this group of patients treated with whole-pelvic radiation therapy.

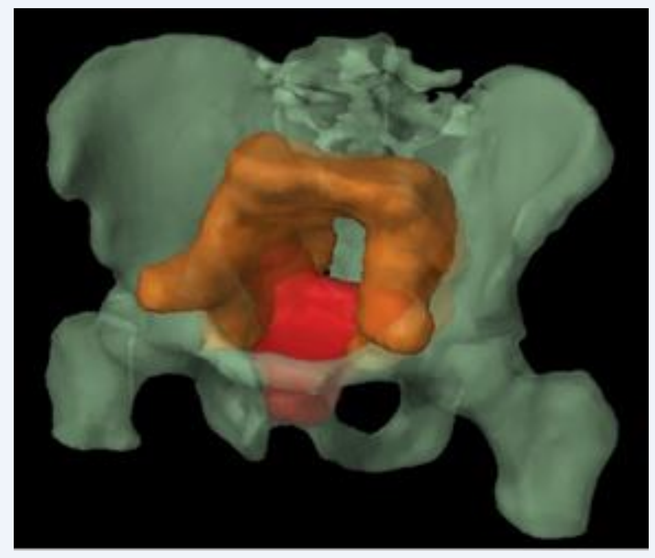

Fig. 1 The pelvic bones (gray) and the planning target volumes: prostate bed - $PTV_{prostate}$ (red) and pelvic lymph nodes - PTV_{nodes} (orange).

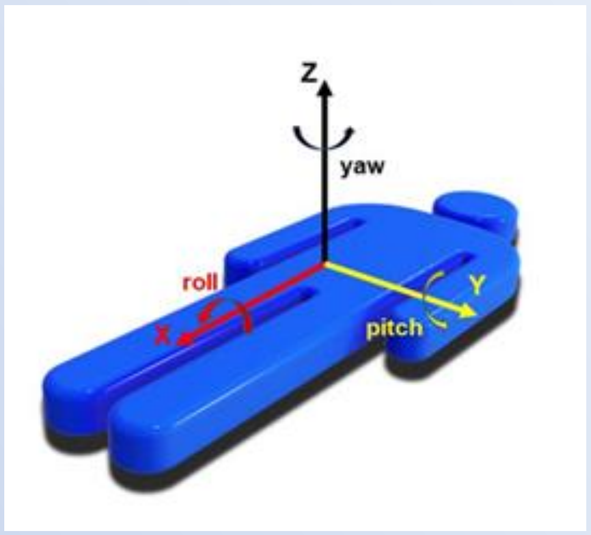

Fig. 2 The axis orientation.

MATERIAL AND METHODS

This study included 15 patients with prostate cancer treated with VMAT technique. All patients had daily CBCT scans (420 CBCTs in total) prior to the treatment delivery. Uncorrected pitch and roll rotations (Fig.2) were calculated during retrospective offline registration of each patient. Dose distributions were calculated for maximal value of rotation. The dose coverage of planning target volume – PTV (D95 - dose to 95% of the volume) and the dose delivered to the pelvic bones (V40 – pelvic bones volume that receives 40 Gy) were analysed.

RESULTS

The measured pitch and roll rotation for the evaluated patient achieved maximal value 4.5 degrees and 1.5 degrees, respectively. The mean and maximum values of pitch and roll are presented in Table 1.

D95 for PTV_{nodes} achieved required value of 98% for all patients. Table 2 presents values D95 for $PTV_{prostate}$ and pelvic bones V40 calculated on the basis of the reference CT and the rotated CT. For six patients D95 for $PTV_{prostate}$ were lower than 98% in case of rotated CT. The differences between pelvic bones V40 for reference CT and rotated CT ranged from -27 cc to 16 cc.

#	Mean value		Maximum value	
	pitch [^{0}]	roll [^{0}]	pitch [^{0}]	roll [^{0}]
1	-1,5	0,5	-4,2	0,6
2	-0,9	-0,4	-2,8	0
3	1,9	1,2	2,7	2
4	-0,2	-0,1	-1,9	-0,2
5	0	0,5	1,5	1,3
6	-1,3	0	-2,3	1,5
7	1,7	-0,4	3,6	-0,7
8	0,3	-0,1	1,3	0
9	-1	0,2	-2,1	0,8
10	-2,1	0,9	-3,8	0,8
11	2	-0,2	4,5	-1,4
12	0,2	-0,1	1,3	0,5
13	0	0,1	-1,6	0,1
14	0,1	-0,1	-1,5	0,3
15	0,1	0,5	1,3	0,1

Table 1. The mean and maximum values of pitch and roll in degrees for the 15 patients (“-“ clockwise direction).

#	Maximum value		D95 [%]		Pelvic Bones V40 [cc]		
	pitch [^{0}]	roll [^{0}]	reference CT	rotated CT	reference CT	rotated CT	difference
1	-4,2	0,6	99,5	97,1	261	254	7
2	-2,8	0	100	99,8	328	334	-6
3	2,7	2	100	99,8	313	313	0
4	-1,9	-0,2	99,9	96,6	334	328	6
5	1,5	1,3	99,5	99,4	321	325	-4
6	-2,3	1,5	98,6	97,6	297	297	0
7	3,6	-0,7	99,8	97,2	377	377	0
8	1,3	0	98,5	98,5	350	350	0
9	-2,1	0,8	99,6	99,2	435	435	0
10	-3,8	0,8	99,1	90,8	356	340	16
11	4,5	-1,4	99,5	96,4	439	466	-27
12	1,3	0,5	100	100	366	378	-12
13	-1,6	0,1	99,5	99,7	289	304	-15
14	-1,5	0,3	99,4	98	376	398	-22
15	1,3	0,1	99,5	99,2	249	265	-16

Table 2. The maximum value of pitch and roll; D95 and pelvic bones V40 calculated on the basis of the reference CT and the rotated CT.

CONCLUSION

The mean values of pitch and roll rotations demonstrate systematic errors that were not corrected during treatment. The differences in D95 for $PTV_{prostate}$ and pelvic bones V40 were caused by uncorrected rotations. However, the number of patients was too limited to make a definitive assessment of the correlation between the rotations and the differences obtained. The lower than the required value of D95 for prostate bed should be taken into consideration when defining the planning target volume.