

Treatment verification in prostate brachytherapy patients using electromagnetic tracking integrated in an HDR/BT afterloader

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OBJECTIVES

To analyze prospectively the feasibility of treatment verification using a prototype of a combined EMT/BT system (Flexitron afterloader with an integrated EMT sensor; Elekta)¹ in prostate HDR brachytherapy (BT). In particular the impact of motion correction using reference sensors is quantified.

METHOD

After phantom measurements showed that the effect of EM field interference due to medical equipment is limited in BT clinical settings² when using the combined EMT/BT system, we embarked on a prospective clinical study for HDR-BT prostate patients.

EMT measurements, in which the EMT sensor was automatically moved by the afterloader through the implant, were performed after CT imaging and after dose delivery.

We analyzed 21 data sets in which the positions of 3 external and 1 internal reference sensor were measured concurrently to correct for patient motion.

Therefore, the measurements of the integrated EMT sensor were corrected at each point in time with the deviation of the three external reference sensors from their overall mean position or with the deviation of the internal reference sensor from its overall mean position.

Next, the (corrected) EMT-measured dwell positions were registered to its planned dwell positions (as reconstructed from the CT images). The residual error, i.e. the Euclidean distance between (corrected) EMT-measured and planned dwell positions, was calculated.

RESULTS

All results are summarized in table 1.

For one individual case (data set 19) with a relatively large mean residual error, correction using an internal reference sensor significantly decreased the mean residual error (fig.1).

	Mean residual error (mm)	Range of max. residual errors per data set (mm)
Without motion correction	1.8 (range 1.1 – 4.4)	2.5 – 9.5
Correction with external reference sensors	1.9 (range 1.4 – 3.0)	3.6 – 8.6
Correction with internal reference sensor	1.7 (range 1.1 – 2.2)	2.2 – 7.7

Table 1: Mean and maximum residual errors for the 21 data sets.

REFERENCES

¹ Kallis et al. 2018 Phys Med Biol. 63(9) 095008.

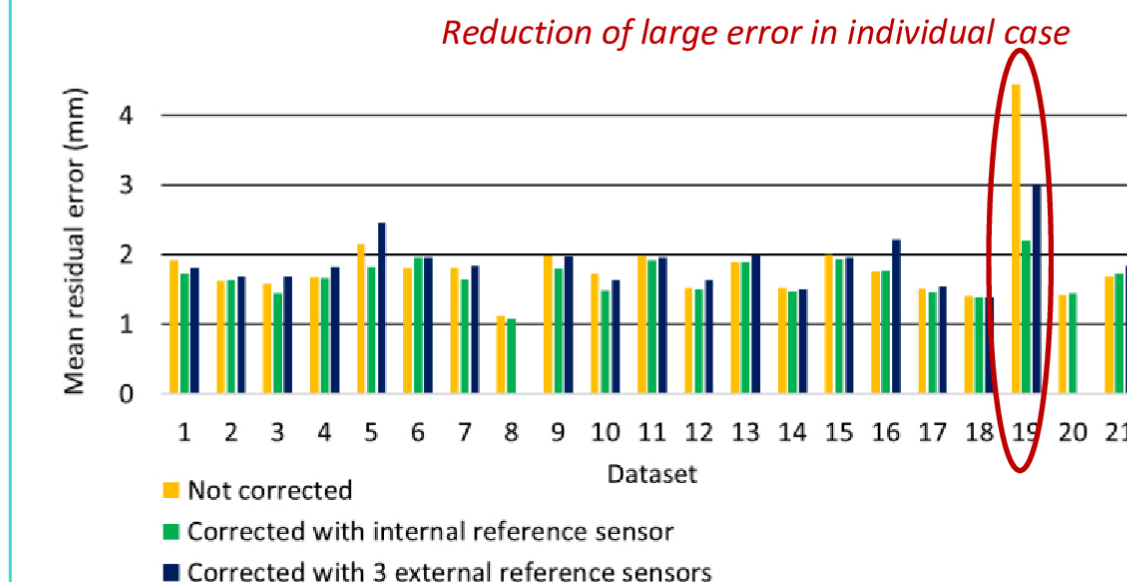
² Heerden van et al. 2019 Radiother Oncol 133: S34-S35.

³ Kallis et al. 2019 Radiother Oncol 141:p312-320.

CONCLUSIONS

- The mean residual errors (below 3.0 mm when using reference sensors) indicate the clinical feasibility of EMT for treatment verification in HDR-BT prostate patients using the prototype combined EMT/BT system.
- Reference sensors may reduce large errors in individual cases.
- These results are comparable to previous results for HDR-BT breast verification³.

RESULTS



*Data set 8 and 20 incomplete due to external reference sensors failure

Figure 1: Mean residual errors for the 21 data sets.