

Technical description of the next generation electromagnetic positioning device for 4DRT.



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Introduction

Electromagnetic positioning was first described by Lennernäs & Nilsson 1995. In this technical note we describe the latest development of the Micropos 4DRT RayPilot system. It is an electromagnetic positioning system being developed to provide accurate, precise, objective, and continuous target localization throughout the course of clinical radiotherapy (Fig.1). It is not X-ray dependent and can be used with or without IGRT techniques. The system uses a non-permanent implant and can be used on existing treatment table tops.



Figure 1. Illustration of the Micropos 4DRT system on a linear accelerator table.

Materials & Methods

The Micropos Medical RayPilot 4D localization system generation 1 has earlier been used in a pilot *in vivo* technical feasibility study (ref. 2, poster P-1077 ESTRO 2008). In this study an electromagnetic positioning marker was temporarily inserted in urethra, and the transponder position was determined with a 3D resolution of 1.7 ± 1.0 mm (as compared to 2 orthogonal 2-D radiographic positioning). The system has now been developed with a reduced transmitting implant diameter, a significantly improved positioning algorithm, an optimized antennae system with e.g. 33% increase of the number of receiving antennae. The system has been evaluated *in vitro* using an automatic 3D-moving device in order to test a large number of random positions (Fig.2).



Figure 2. Automatic 3D-moving device for testing random positions.

Results

The system precision for 5000 random positions in generation 2 was 0.37mm, 0.19mm, and 3.1 mm for 3D error, SD and max error. The submillimeter precision is demonstrated in Figure 3. Generation 1 system (used in clinical study) showed a corresponding resolution of 0.77mm, 0.58mm, 6.6 mm.

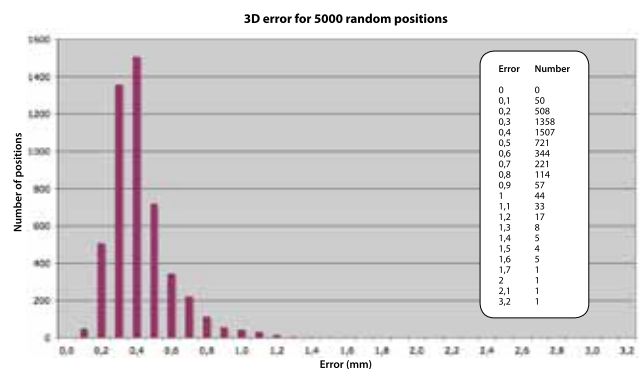


Figure 3. Histogram showing the distribution of *in vitro* errors in generation 2.

The 3D *in vivo* study of generation 1 showed a resolution of 1.7mm (compared to 0.77mm *in vitro*). With all technical upgrades the precision has increased significantly *in vitro* indicating that generation 2 will give a submillimeter precision *in vivo*.

Conclusions

- 4DRT electromagnetic positioning systems demonstrates high precision both *in vivo* and *in vitro*.
- Generation 2 shows submillimeter precision *in vitro* and indicates use *in vivo* with high precision.
- The system shows promising results for use in positioning and continuous supervision of organ movement during radiotherapy.

References: 1. A new patient positioning system using magnetic implants and magnetic field sensors Lennernäs b, Nilsson S, Radiother Oncol. 1995 Dec;37(3):249-50

References: 2. High precision transponder localization using a novel electromagnetic positioning system in patients with localized prostate cancer. Kindblom J. et al. Accepted for publication, Radiotherapy & Oncology August 17 2008