High Precision Patient Tracking of Intracranial and Head and Neck Targets

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The ability to perform high precision repeat location for fractionated radiotherapy treatment has been an ongoing struggle for oncologist, physicist, and therapist. Combination reference and immobilization systems has made repeat localization a major area of clinical research. As radiation therapy formulates more complex dose delivery systems, such as electronic compensation, intensity modulation and expanded use of non-coplanar beams, the ability to solve the repeat localization problem becomes more important

It was not uncommon for the radiosurgical procedure to be abandoned because of an insufficient margin between the high does region and a critical structure. There were other occasions when single dose therapy was not a consideration but increased accuracy, in order to achieve significant volume reduction, was desired. For these reasons a method of repeat stereotactic fixation, applicable to stereotactic radiotherapy, was developed.

The initial design was restricted to intracranial targets. There were two primary design criteria. The first was to be able to detect and adjust the target's alignment in 6 degrees of freedom, 3 translational and 3 rotational. The system has to be able to adjust the vector alignment of the target center to the unit's isocenter to within +/- 0.5-mm. The second was to be able to setup and treat the patient, consisting of 4 to 5 non-coplanar beams or arcs in the same time frame that routine non-stereotactic patients are treated, approximately 15 minutes.

To achieve this goal a system that separated the functions of immobilization and localization was developed. This system is based upon a bite plate and infrared technology. The basic infrared camera system is linked to a PC that sits in the radiation vault and produces a set of alignment vectors that the therapist uses for daily setup. Attention was paid to the refresh rate of the system so that smooth manual adjustment of the patient was possible. Standard vacuum head holders and thermal plastic masks systems are used for immobilization. The immobilization system is totally separate from the biteplate irled system.

The design goal contained a level of accuracy that could not be validated using port films. A system was therefore developed that allowed the new bite plate system to be tested against the commonly employed rigid stereotactic ring. 200 patients underwent testing. Each test consisted of repeated insertions and reading of the absolute location of the biteplate irled array. The average relocation of the system has been 0.13mm +/- 0.1 mm. The system is now being expanded to head and neck use

The University of Florida Research Institute has licensed the patents and rights derived from this work. Frank Bova is a paid consultant to Sofamor Danek.

Learning objectives:

The pervious methods of combination immobilization and localization have limited accuracy.

In order to prove submillimeter accuracy new experimental systems must be utilized and if one is sub millimeter precision is possible.