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Evaluation of Beam Delivery Accuracy of a ZAP-X Gyroscopic Radiosurgery System

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Abstract
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Abstract

Objectives:

The purpose of this work is to evaluate the beam delivery accuracy of a ZAP-X gyroscopic frameless radiosurgery systems (GRS) by analyzing the results of the daily Winston-Lutz tests performed over the course of a year.

Methods:

A Prime RT Safe Phantom with a 4 mm diameter steel ball placed in its interior is used to simulate a patients head. After an auto-aligment using kV and DRR images the steel ball is placed at the kV imaging isocenter. The Steel ball test is performed taking six MV images with the MV imager detector from different gantry angles: patient left (axial=0, oblique=90), home (axial=180, oblique=180), antero-posterior (axial=270, oblique=90), patient right (axial=180, oblique=90), postero-anterior (axial=90, oblique=90) and left flip (axial=180, oblique=270). The MV imager is a scintillator detector used to measure beam attenuation through a patient during treatment. For each beam, it generates a 1000x1000 pixel image in TIF format with a pixel size of 0.0376 mm/pixel at isocenter. All images were analised using the built-in ZAP software to get the offset between the steel ball and the beam center.

Results:

Over the course of a year we have analised 227 steel ball test. The mean/maximum deviation, in absolute value in mm, has been: 0.08/0.38 (patient left x), 0.35/0.62 (patient left y), 0.19/0.69 (home x), 0.33/0.65 (home y), 0.38/0.62 (antero-posterior x), 0.16/0.42 (antero-posterior y), 0.05/0.52 (patient right x), 0.12/0.41 (patient right y), 0.19/0.39 (postero-anterior x), 0.02/0.27 (postero-anterior y), 0.02/0.49 (left flip x) and 0.04/0.33 (left flip y).

Conclusion(s):

The implementation of GRS showed that submillimeter accuracy is possible for single collimator targets with a mean deviation of less than 0.38 mm and a maximum punctual deviation of 0.69 mm. As a next step, it is necessary to evaluate beam accuracy on targets with more than one collimator to check table movements.