

## Cyberknife Treatment of a Rectal Carcinoma Recurrence: Influence on the Dosimetry of a Rectal Prosthesis

Maria Cristina Frassanito, Palma Rita Altieri<sup>2</sup>, Pasquale Tarantino<sup>3</sup>, Mario Brandi<sup>4</sup>, Anna Maria Grazia Pastore<sup>4</sup>

1. 2. Physics, Italian National Institute of Nuclear Physics (INFN), Bari, ITA 3. Surgery, Mater Dei Hospital, Bari, ITA 4. Radiotherapy Cyberknife, Mater Dei Hospital, Bari, ITA

✉ **Corresponding author:** Maria Cristina Frassanito, cristinafrassanito@hotmail.com

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## Abstract

**Objective(s):** We report the case of a Cyberknife treatment on a recurrence of a rectal adenocarcinoma. The tumor enveloped the rectum, involving both the internal and the external lumen and, in order to avoid a total occlusion of the rectum, it was inserted a metallic stent in the lumen. The aim of the study was to evaluate the variation in the dosimetry of the treatment determined by the insertion of the prosthesis.

**Methods:** The radiosurgery apparatus Cyberknife (Accuray, Inc. Sunnyvale, CA, USA) is a system in which the linear accelerator is mounted on a robotic arm and can deliver hundreds of beams in any directions and angle, which hit with a sub-millimetric precision the lesion while sparing the surrounding normal tissue. Identification of the lesion by the robot was performed by means of gold fiducial markers inserted in proximity of the mass. Rectal prosthesis consisted in a Nitinol mesh which did not produce artifacts in the CT image thus allowing a proper contouring of the lesion. The dose prescribed was 25 Gy in 5 fractions at the 79% isodose level. Treatment planning (Multiplan software) was performed with Ray Tracing algorithm which has the limit not to allow an accurate calculation of the dose distribution for the case of the electronic density dishomogeneities determined by the metallic stent and the empty rectal lumen.

For a better understanding of any possible influence on the photon beam due to the presence of a metallic prosthesis in the treated patient, and for a detailed study of the dosimetric parameters (like depth dose and dose profiles), Monte Carlo (MC) simulation is the best approach that can be established. Indeed, for the accuracy of the computer simulation for all the physics processes involved, essential for such applications, Monte Carlo codes (FLUKA, GEANT4 and MCNPX for example) are considered as the gold standard for dosimetric calculations. Thanks to the FLUKA graphical interface, FLAIR, the CT DICOM image of the patient was translated into voxel-based computational phantom so, by using all the proper and real material densities, the stent behavior with respect to the photons was carefully evaluated in terms of absorbed dose and beam attenuation.

**Results:** The MC simulation study showed a slight perturbation of the dose in the proximity of the stent and the reduction of the target coverage. Both effects could be considered irrelevant for the outcome of the treatment.

### Open Access

#### Abstract

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From the clinical point of view, the patient presented as acute collateral effect an intense perineal pain which was treated with steroids and analgesic. After two weeks it occurred the spontaneous expulsion of the stent from the rectum which revealed the colligation of the tumorous mass.

Conclusion(s): This study shows that insertion of a metallic stent in the rectum when the tumor envelopes the organ and compromises the lumen aperture alters slightly the dose distribution without compromising the outcome of the treatment.