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Point Dose Verification in Delivery Quality Assurance for Gyroscopic Radiosurgery System

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Yagiz Yedekci [1], Huseyin Kivanc [2], Fatih Biltekin [3], Demet Yildiz [4], Gozde Yazici [5], Gokhan Ozyigit [5]

1. Radiation Oncology, Hacettepe University Medical School, Ankara, Turkey, Ankara , TUR 2. Hacettepe University, Ankara, Turkey, Ankara , TUR 3. Radiation Oncology, Hacettepe University Medical School, Ankara, Turkey, ankara, TUR 4. Radiation Oncology, Hacettepe University, Ankara, TUR 5. Radiation Oncology, Hacettepe University Medical School, Ankara, TUR

Corresponding author: Yagiz Yedekci, yagiz.yedekci@hacettepe.edu.tr

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Abstract

Objectives:

This study aimed to evaluate the feasibility and accuracy of patient-specific delivery quality assurance (PS-DQA) using the Semiflex®3D ionization chamber within the ZAP-X gyroscopic radiosurgery system.

Methods:

PS-DQA measurements were performed on 110 patients with 184 lesions treated using the ZAP-X system. Target volumes ranged from 11 mm^3 to 63,044 mm^3, with a mean of 4,321 mm^3. Treatment plans were developed using the ZAP-X Treatment Planning System (TPS), which utilizes a ray-tracing algorithm for dose calculation. PS-DQA was conducted using a water-equivalent spherical phantom and the Semiflex®3D ionization chamber. The phantom was scanned with 0.625 mm CT slice thickness, and treatment plans were recalculated on the phantom's CT dataset. The percentage differences between measured and planned doses were analyzed, focusing on different target volume categories and the use of small collimators (4 mm and 5 mm). Statistical analysis assessed the significance of observed differences.

Results:

Most PS-DQA measurements (84%) showed discrepancies between -5% and +5% compared to planned doses. However, smaller target volumes (0-500 mm^3) exhibited significantly higher percentage differences, highlighting challenges in dose measurement accuracy for these fields. Greater dose discrepancies were also observed when small collimators were extensively used, particularly when their usage exceeded 75% of total isocenters. Tukey HSD tests confirmed statistically significant differences between groups based on target volume and collimator size.

Conclusion(s):

The study confirms the feasibility of PS-DQA with the Semiflex®3D ionization chamber in the ZAP-X system while highlighting challenges with small target volumes and extensive use of small collimators.