Imaging dose computed in patient for kV-IGRT protocols used at three treatment facilities of the AH-HP group

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Résumé

Introduction:

The improvements in radiotherapy procedures have significantly enhanced patient survival rates. While benefits of kV-Image Guided Radiotherapy in local tumor control largely outweigh associated risks, imaging induced additional dose are often neglected when considering maximal allowed dose for organs at risk (OARs). The ELISA project (founded by Cancéropôle IDF) aimed at computing individualized doses for multiple kV-IGRT protocols on a 97-patient cohort and determine the excess dose at OARs.

Material and Methods:

The Commissariat à l'énergie atomique et aux énergies alternatives has been developing a Monte Carlo tool (using Penelope) aimed at estimating patient doses for kV-IGRT, facilitated by projects such as AID-IGRT(1) (French ANR), HARMONIC(2) (Euratom H202). This tool has been employed in the ELISA project on a cohort of 97 patients, 60 were treated at the Hôpital Européen Georges Pompidou, 22 at the Hôpital Tenon, and 15 at the Hôpital Henri-Mondor.

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This cohort was divided into four groups based on tumor location: Head and Neck (H&N), Breast, Lung, and Prostate. For each group, multiple kV-imaging protocols were selected to represent three common hospital practices-five for the H&N group, two for breast, four for lung, and six for prostate.

Each patient's planning CT image was used at a reference geometry for all protocols of its corresponding group, regardless of the actual protocol used during treatment. Dose metrics (D50% and D10%) were extracted based on treatment contours.

Results:

All five H&N protocols (using either Varian's OBI or Elekta's XVI) resulted in cumulative imaging doses to OARs below 0.4Gy. The highest doses were consistently observed in the larynx, parotid glands, and thyroid.

For the Lung group, protocols relying primarily on 2D-kV imaging displayed cumulative doses below 0.2Gy (OBI). Protocols using daily CBCT did not exceed 0.6Gy. Additionally, the Cyberknife ceiling mounting system delivered higher imaging doses, reaching up to 0.8Gy on the thyroid, which was identified as a consistent hot spot across all tested imaging procedures.

For both breast protocols (both based on OBI), similar doses were observed, with total doses below 0.2Gy. Notably, the number of fractions varied from 30 to 8 due to one protocol incorporating CBCT in addition to 2D-kV imaging.

In the Prostate group, imaging doses were the highest, for the four OBI-based protocols doses typically fell between 1 and 2Gy and D10% for both femoral heads and sacrum nearly reached 4Gy and 3.5Gy respectively. The Halcyon protocol showed slightly lower doses, while the Cyberknife system was able to deliver doses below 0.5Gy.

Conclusions:

While doses are relatively low for the H&N, Lung, and Breast groups, the study highlights the high dose level received at femoral heads and sacrum for the Prostate group, especially when using OBI-based protocols. It was also demonstrated that for all groups but H&N, doses decrease by up to 30% due to patient morphology. This underscores the importance of considering individualized imaging protocols, especially for patients with slimmer or more slender anatomy, in order to help reduce doses for those at risk of higher dose intakes.

References

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Mots-Clés: Imaging dosimetry, IGRT, Monte Carlo