Enhancements on the GLAaS algorithm for portal dosimetry: testing on machine quality assurance procedures and RapidArc pre-treatment verifications.

G. Nicolini[1], E. Vanetti[1], A. Clivio[1], A. Fogliata[1], L. Cozzi[1,2]

[1] Oncology Institute of Southern Switzerland, Medical Physics, Bellinzona, Switzerland
[2] University of Lausanne, Faculty of Medicine, Lausanne, Switzerland
mail: antonella.fogliata-cozzi@eoc.ch

Introduction

To report about enhancements introduced in the dosimetric procedure, known as GLAaS and originally settled for IMRT pre-treatment verification, used to convert raw images acquired with the portal imager into dose matrices.

Material and Methods

Two characteristic effects limiting the general applicability of portal imaging based dosimetry are the over-flattening of images (eliminating the "horns" and "holes" in the beam profiles induced by the flattening filters) and the excess of backscattered radiation originated by the arm supports. These two effects were corrected for in the new version of GLAaS formalism and results are presented to prove the improvements for different beams, detectors and support arms. With the new corrections, it is possible to use GLAaS to perform standard tasks of linac quality assurance. Data were acquired to analyse open and wedged fields (mechanical and dynamic) in terms of output factors (OF), MU/Gy, wedge factors (WF), profile penumbrae, symmetry and homogeneity. GLAaS data were compared against calculations on the treatment planning system (the Varian Eclipse) and against ion chamber measurements (IC) as consolidated benchmark.
Given the versatility of the system, the use of GLAaS algorithm was also extended to pre-treatment verification of RapidArc™ fields, a novel planning and delivery method in the category of intensity modulated arc therapies aiming to deliver highly modulated plans with variable MLC shapes, dose rate and gantry speed during rotation. To perform quantitative analysis, the gamma index concept of Low and the Modulation Index concept of Webb were applied to a set of RapidArc fields, acquired at both low (6 MV) and high (18 MV) beam energies with a PV-aS1000 detector.

Results

With the new GLAaS version, minimum, maximum and average percentage difference between GLAaS and Eclipse (or IC) data in the flattened field region (80% of the field size) were: 0.1±1.0, 0.7±0.8, 0.1±0.4 (1.0±1.4, -0.3±0.2, -0.1±0.2) for open fields, 0.4±1.6, -1.5±1.8, -0.1±0.3 (-2.2±2.3, 2.3±1.2, 0.8±0.3) for dynamic wedges, -1.3±0.7, -0.7±0.7, -0.2±0.2 (-0.8±0.8, 0.7±1.1, 0.2±0.3 for mechanical wedges. All other analysed parameters were successfully tested.
Regarding GLAaS applied to RA fields, the Gamma Agreement Index computed for a Distance to Agreement of 3 mm and a Dose Difference (ΔD) of 3% was 96.7±1.2 % at 6 MV and 94.9±1.3 % at 18 MV, over the field area. The Modulation Index for calculations resulted 17.0±3.2 at 6 MV and 15.3±2.7 at 18 MV while the corresponding data for measurements were: 18.5±3.7 and 17.5±3.7.

Discussion

With the introduced enhancements, the GLAaS method can be considered as a valid Quality Assurance tool for both standard tasks of Linac quality procedures and pre-treatment patient oriented verifications as in case of RapidArc treatments.

References

[1] Nicolini G, Fogliata A, Vanetti E, Clivio A, Cozzi L. GLAaS: an absolute dose calibration algorithm for an amorphous silicon portal imager. Applications to IMRT verification. Med Phys 2006; 33: 2839-2851.
[2] Nicolini G, Vanetti E, Clivio A, Fogliata A, Boka G, Cozzi L. Testing the portal imager GLAaS algorithm for machine quality assurance. Radiat Oncol 2008; 3:14.
[3] Otto K. Volumetric Modulated Arc Therapy: IMRT in a single arc. Med. Phys. 2008;35: 310-317