The Dependence of Tissue Inhomogeneity Correction Factors on Photon Beam Quality Index Variations

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INTRODUCTION

- Nowadays, mostly Varian and Elekta accelerators are used.
- One may expect that the quality index of photon energies of accelerators from the same vendor with the same nominal energy differ a little only.
- Therefore, inhomogeneity correction factors (ICFs) for the same nominal energy generated with the same vendor's accelerator should not differ very much.
- If such a conclusion is true, it enables to use the results of other users for testing the TPS.

AIM

The purpose of this study was to investigate the dependence of ICFs on tissue phantom ratio ($TPR_{20,10}$), the so-called quality index (QI) for 6 MV & 15 MV photon energy.

METHOD

- Water phantom containing regions of the lung (0.26 g/cm³), adipose tissue (0.92 g/cm³) and bone (1.85 g/cm³) were constructed in Eclipse TPS.
- ICFs calculations were performed AAA for several field sizes and for points lying at several depths inside of and below different thicknesses and densities of the inhomogeneities.
- The range of QI as $TPR_{20,10}$ (6 MV)= 0.67±k*0.01 and $TPR_{20,10}$ (15 MV)= 0.76±k*0.01, where k = -3, -2, -1, 0, 1, 2, 3.
- ICFs were also measured in a CIRS thorax phantom for a 10x10 cm² field size, for 6 MV and 6 MV FFF generated in a TrueBeam accelerator.

RESULTS

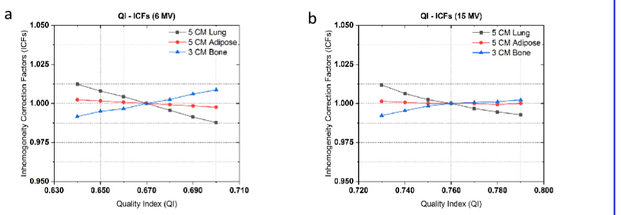

Figure 1 ICFs as a function of QI at P_{below} = 5 cm for 5 cm lung (0.26 g/cc) and adipose (0.92 g/cc), and 3 cm bone (1.85 g/cc) for 10x10 cm² field size for 6 MV (a) and 15 MV (b) photon energy. The absolute ICFs for the QI of 0.670 were 1.136, 1.024 and 0.923 for Lung, Adipose and Bone respectively. The absolute ICFs for the QI of 0.760 were 1.103, 1.015 and 0.941 for Lung, Adipose and Bone respectively.

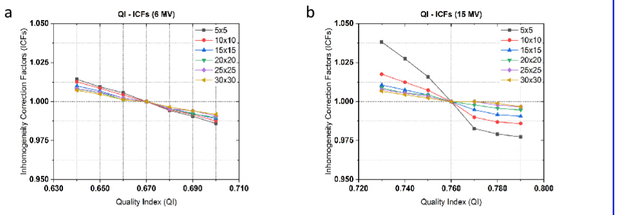

Figure 2: ICFs as a function of QI at P_{below} = 1 cm for 5 cm lung (0.26 g/cc) for 5x5, 10x10, 15x15, 20x20, 25x25 and 30x30 cm² field size for 6 MV (a) and 15 MV (b) photon beams. The absolute ICFs for the QI of 0.670 were 1.158, 1.136, 1.118, 1.108, 1.101 and 1.097 for 5x5, 10x10, 15x15, 20x20, 25x25 and 30x30 cm² field size respectively. The absolute ICFs for the QI of 0.760 were 1.052, 1.073, 1.071, 1.066, 1.062 and 1.059 for 5x5, 10x10, 15x15, 20x20, 25x25 and 30x30 cm² field size respectively.

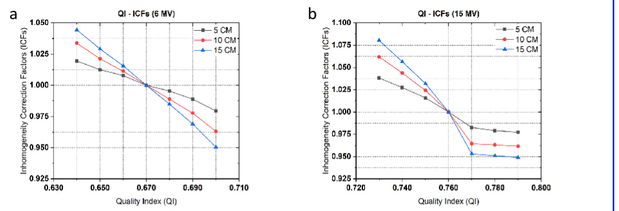

Figure 3: ICFs as a function of QI P_{below} = 1 cm for 5, 10 & 15 cm lung (0.26 g/cm³) for 5x5 cm² field size for 6 MV (a) and 15 MV (b) photon beams. The absolute ICFs for the QI of 0.670 were 1.144, 1.327 and 1.544 for 5, 10, and 15 cm thicknesses of lung inhomogeneity respectively. The absolute ICFs for the QI of 0.760 were 1.052, 1.160 and 1.292 for 5, 10, and 15 cm thicknesses of lung inhomogeneity respectively.

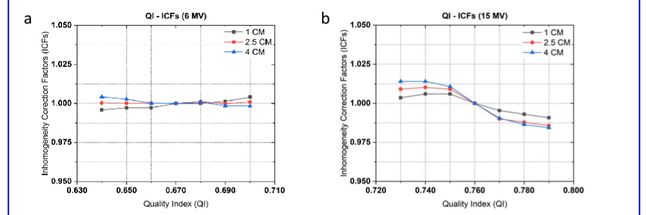

Figure 4: ICFs as a function of QI at P_{inh} = 1 cm, P_{inh} = 2.5 cm (middle of 5 cm lung) in lung (0.26 g/cc) and P_{inh} = 1 cm above lung-water interface for 10x10 cm² field size for 6 MV (a) and 15 MV (b) photon beams. The absolute ICFs for the QI of 0.670 were 1.000, 1.022 and 1.049 for 1, 2.5, and 4 cm depth of lung inhomogeneity respectively. The absolute ICFs for the QI of 0.760 were 0.993, 1.000 and 1.014 for 1, 2.5, and 4 cm depth of lung inhomogeneity respectively.

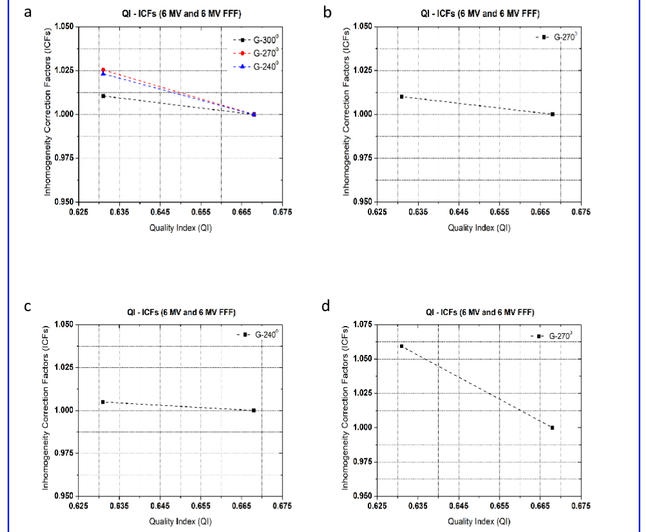

Figure 5: ICFs difference as a function of beam quality 0.632 (6 MV FFF) and 0.668 (6 MV) measured with CIRS phantom. (a) measurement at point 5 (default point) at gantry angle 300°, 270° and 240°; (b) at point 6 at gantry angle 270°; (c) at point 7 at gantry angle 240°; (d) at point 8 at gantry angle 270°.

CONCLUSIONS

- A negligible dependence of the ICFs on energy was found for adipose and bone tissue.
- For lung tissue, in the CPE region, the dependence of ICFs on different beam quality indexes with the same nominal energy may not be neglected, however, this dependence was linear.
- Where there is no CPE, the dependence of the ICFs on energy was more complicated.
- Measurements result carried out with the CIRS phantom were consistent with calculations.

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