Evaluation and validation of the use of Orthopedic Metal Artifact Reduction algorithm (O-MAR) for dose calculation in radiotherapy

C. Noblet1, G. Delpon1, C. Dupuy1, S. Josset1, C. LLagostera1, A. Lisbona1, M. Voyeau1 and S. Chiavassa1

1 Institut de Cancérologie de l’Ouest – René Gauducheau, Service de physique médicale, Boulevard Jacques Monod, 44805 Saint-Herblain

**Introduction:** O-MAR algorithm mitigates artifacts caused by metal objects in CT images. Initially developed for diagnostic CT images, O-MAR may also prove useful to address CT images used for dose calculation in radiotherapy. Indeed, metal artifacts severely degrade dose calculation accuracy and are usually manually corrected by assigning electron density to 1 g.cm-3. Nevertheless, this process is long, inaccurate and operator-dependent. Moreover, it only applies to soft tissue area. The aim of this study is to evaluate and validate the use of O-MAR on dosimetric CT images for patients with metallic implants (orthopedic and dental). **Method:** The capability of O-MAR to restore real Hounsfield Units (HU) was evaluated on cylindrical phantom considering various inserts (solid water, lung and cortical bone). CT images (Philips BigBore®) were acquired without metal (reference) and with 2 artificial hip joints, with and without O-MAR correction. Same experiment was made with dental implants. The impact of O-MAR on dose calculation was evaluated on previous images using the treatment planning system (TPS) CMS XIO for a 6MV photon beam and for various clinical ballistics on 3 TPS (CMS XIO, IplanRT et Tomotherapy®). Results obtained with O-MAR correction were also compared with those obtained on CT images manually corrected, which are the standard of practice in our institution. For each case, 3D distribution of local percent difference dose was analyzed excluding doses lower than 10% of the prescribed dose. Finally, O-MAR was applied to patients CT images.

**Results:** HU measurements show that artefacts have limited impact on lung insert but significant impact on solid water and cortical bone inserts with a difference of 100HU and 250HU respectively. O-MAR effectively reduces these differences to 40HU in solid water and 90HU in cortical bone. Moreover, O-MAR is more effective than manual correction to reduce impact of artefacts on dose calculation. In the phantom with 2 artificial hip joints, for a single 6MV photon beam, the percentage of pixels with a local percent difference dose >+/-1% (PLPD1%) is 5.2% without correction, 2.3% with manual correction and 1.2% with O-MAR. Similar analysis considering 7 IMRT beams (XIO) gives a PLPD1% of 9.5%, 5.7% and 4.4% respectively. O-MAR effectively corrects patients CT images with artificial hip joints. However, for dental implants, some manual re-working remains necessary after O-MAR correction.

**Conclusion:** For orthopedic implants, O-MAR is effective to correct metallic artefacts. Comparing with manual correction, O-MAR results in a considerable saving in time and increases accuracy of dose calculation. For dental implants, although manual correction is still required, time saving remains substantial.