Comparison of monitor units and dose calculation between two independent second-check verification software

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Background

The independent calculation software is designed to verify the calculations of monitor units (MU) and doses computed in a treatment planning system (TPS). The independent calculation is important within the quality assurance process of the treatment plans that will be delivered to the patients, since the configuration data may be incorrect in the TPS, leading to incorrect MU and dose calculations. It is recommended that this process be carried out before starting the first treatment session, together with other quality control procedures, such as: dose measurements with ionization chamber, dose distribution with detector arrays, in vivo dosimetry, etc.; thus guaranteeing that the delivered dose is within the recommended range of ±5% [1,2].

Methods

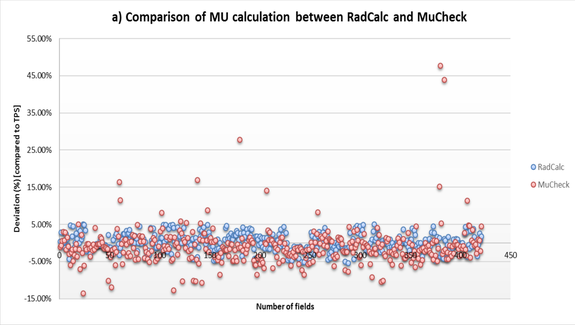
In this work, two commercial software for independent calculation of MU and dose are compared, MuCheck v.8.4.0 (Oncology Data Systems) and RadCalc v.7.1 (LifeLine Software), using 3D conformal and IMRT treatment plans calculated in Eclipse v.11.0 (Varian Medical Systems) treatment planning system (TPS) with AAA algorithm, which were delivered with an Oncor Impression Plus linear accelerator (Siemens Healthineers). IMRT plans were isocentric with 6MV photons and step&shoot mode. Conformal plans were isocentric, except in some breast plans that were non-isocentric and which a calculation point to evaluate MU and dose were created, using 6 and 18MV photons and virtual wedge of multiple angles. Seventy treatment plans of different anatomical locations were compared, pelvis (whole pelvis, cervix, prostate and rectum): 12, lung: 6, head & neck: 6, whole brain: 3, mediastinum: 3, esophagus: 2, spine metastases: 1, IMRT plans and breast: 21, spine metastases: 9, whole pelvis: 3, soft tissue: 2, breastbone: 1, eye orbit: 1, 3D conformal plans. Two hundred fifty-two IMRT fields and one hundred sixty-eight 3D conformal fields were analyzed. To perform the dose and MU calculation, both software require a calculation point that is located in the isocenter for isocentric plans, and for non-isocentric plans, it coincides with the calculation or normalization point.

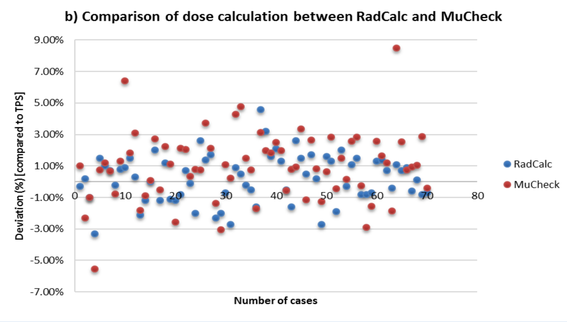
Results and Discussion

Figure 1a shows the percentage deviations of the MU calculation performed by both software with respect to that calculated by TPS for all fields analyzed. For the MU independent calculation performed with RadCalc software: 33% of the calculated fields are within ±1% of deviation, around 80% between ±3%, 99% between ±5% and 1% greater than ±5% when compared with the calculation made by TPS. For the MU calculation with MuCheck software: 25% of the calculated fields are between ±1% deviation, around 60% between ±3%, 85% between ± 5% and almost 15% greater than ±5% when compared with the calculation made by TPS. Figure 1b shows the percentage deviations of the dose calculation performed by both software with respect to that calculated by TPS for all plans analyzed. For the independent dose calculation performed with RadCalc software: 45% of the calculated plans are within ±1% of deviation, around 95% between ±3% and the total of the analyzed plans between ±5% when compared with the calculation performed by TPS. For the dose calculation with MuCheck software: 33% of the calculated plans are between ±1% deviation, around 85% between ±3%, 95% between ±5% and 4% greater than ±5 % when compared with the calculation made by TPS.

The anatomical locations that present the most differences greater than ± 5% in MU calculation are pelvis and head & neck for IMRT plans, and breast for conformal 3D plans calculated with both software using a single normalization point. However, the fields calculated with RadCalc software that do not meet this uncertainty limit only achieve ± 6% deviation in the UM calculation, while MU calculation deviation in the performed with MuCheck software for some fields reaches up to 40%. In the case of doses calculation, only MuCheck software presents differences greater than ± 5% in three treatment plans. Some issues to be aware of related to incorrect independent calculation are: to use single verification point, intrinsic configuration of the software algorithms to perform the calculation, inaccuracy treatment beams and machine modeling, lack of precision by determination of the treated area for each field, the lack of tissue compensation (e.g. tangential fields for breast treatment), calculation failure for non-isocentric beams, incorrect calculation for fields that use high-angulation virtual wedges and poor precision for use of effective depth.

Figure 1. Comparison of a) MU and b) dose calculation between RadCalc and MuCheck with respect to TPS.





Conclusions

- It is important to know how software works, whether commercial or in-house, calculate UM and doses and what is the uncertainty regarding the TPS, in addition, its necessary to complement it with other quality controls, such as those mentioned above, according to the expected deviations.

Acknowledgments

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References

[1] **Stern, R.L., et al.**, Verification of monitor unit calculations for non-IMRT clinical radiotherapy: Report of AAPM Task Group 114, Med Phys 2011, 38, 504-530.
[2] **International Atomic Energy Agency**, Lessons learnt from Accidental Exposures in Radiotherapy, Safety Reports Series 2000, 17.