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Three-dimensional calculation against mutually changed isodoses in brachytherapy due to inhomogeneity-based dose calculations

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Question: With the introduction of inhomogeneous algorithms in brachytherapy, comparison plans with respect to the different algorithms can be safely generated. Often, however, the plans of both algorithms (TG-43 / ACE), especially in the abdominal region or in body regions with large surrounding scattering regions, differ very little in their respective DVH representation. Nevertheless, local shifts in specific isodoses are often caused by local small inhomogeneities and / or altered scattering regions. A three-dimensional absolute calculation of local differences with a vectorial representation allows a rapid evaluation and estimation of these differences, in plans that are almost identical in their DVH representation.
Methodology: By means of a proprietary C ++ tool programmed in the house, all the concrete structures of a brachytherapy plan can be easily extracted. Since isodoses can be deposited as an ROI structure, it is now possible to evaluate the isodose-based structures of plans computed with different algorithms. After the initial application of a Hull function to the extracted point clouds of an isodose starch, absolute concrete isodose distances can be calculated and displayed three-dimensionally by successive analysis of the deflection beams emanating from the inner center of gravity of an ROI structure in all directions. In order to solve the distance calculation of triangulated planes, vector-stretched equation systems are solved.
Result: The mathematical method allows the calculation of concrete absolute distances of two opposing isodose surfaces. It is possible with the proposed method to find and detect small local changes very quickly, despite the hardly visible differences in DVH.
Conclusion: For the scrolling and the elaborate search for possible differences of two plans, which are hardly different in DVH values, now a tool is available, in order to automatically search for isodose differences. This also provides an absolutely determining tool for analyzing the three-dimensional effects of changing isodoses.

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Impact of heterogeneity-corrected dose calculation using a grid-based Boltzmann solver on breast and cervix cancer brachytherapy

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Purpose: To analyse the impact of heterogeneity-corrected dose calculation on dosimetric quality parameters in gynecological and breast brachytherapy using Acuros, a grid-based Boltzmann equation solver (GBBS), and to evaluate the shielding effects of different cervix brachytherapy applicators.
Material and methods: Calculations with TG-43 and Acuros were based on computed tomography (CT) retrospectively, for 10 cases of accelerated partial breast irradiation and 9 cervix cancer cases treated with tandem-ring applicators. Phantom CT-scans of different applicators (plastic and titanium) were acquired. For breast the $V_{20Gy\alpha\beta3}$ to lung, the $D_{0.1cm^3}$, D_{1cm^3}, D_{2cm^3} to rib, the $D_{0.1cm^3}$, D_{1cm^3}, D_{10cm^3} to skin, and D_{max} for all structures were reported. For cervix cases, the $D_{0.1cm^3}$, D_{2cm^3} to bladder, rectum and sigmoid, and the D_{50}, D_{90}, D_{98}, V_{100} for the CTV_{HR} were reported. For the phantom study, surrogates for target and organ at risk were created for a similar dose volume histogram (DVH) analysis.
Results: Calculations with TG-43 overestimated dose for all dosimetric indices investigated. For breast, a decrease of ~8% was found for D_{10cm^3} to the skin and 5% for D_{2cm^3} to rib, resulting in a difference of –1.5 Gy EQD2 (equivalent dose to 2 Gy fractionation) for overall treatment. Smaller effects were found for cervix cases with the plastic applicator, with up to –2% (–0.2 Gy EQD2) per fraction for organs at risk and –0.5% (–0.3 Gy EQD2) per fraction for CTV_{HR}. The shielding effect of the titanium applicator resulted in a decrease of 2% for D_{2cm^3} to the organ at risk versus 0.7% for plastic.
Conclusions: Lower doses were reported when calculating with Acuros compared to TG-43. Differences in dose parameters were found larger in breast cases. A lower impact on clinical dose parameters was found in cervix cases. Applicator material causes systematic shielding effects that can be taken into account.

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Phantom study to compare dose calculation in Oncentra Brachy TG-43 and ACE for skin treatments with superficial mould (Freiburg-Flab)

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Since few years dose calculation algorithms are available, which are taking inhomogeneity of density into account. These new algorithms follow the recommendation of TG-186. Since 2008 in Augsburg patients with non-melanoma skin-cancer are treated with 3-D planned HDR-Brachytherapy by means of Ir-192 source and Freiburg-Flab. We are investigating the difference of dose calculated according TG-43 and TG-186 to points on the skin surface retrospectively in clinical cases with Oncentra Brachy (Elekta). For a better understanding of the results when running a dose comparison study for clinical cases with bended catheters a phantom study under clear geometric conditions is performed and will be presented here. A Flab 9cmx11cm was positioned on 7cm RW3, scanned and a 3D-planning performed in TG-43 and TG-186. To compare the data to published papers, which are comparing TG-43 to Monte Carlo calculation and to examine recommendation to cover the Flab with scatter material, RW3 from 0cm-5cm was positioned onto the Flab giving different scatter-conditions. The dose is calculated in TG-43 and in TG-186, by use of the f-factor, the dwell times in the TG-186 are adjusted to be the same as in TG-43. The dose is compared for points in -/+ 0.5cm and for several other distances, too. In the planning process the body is contoured but neither the target volume nor the Flab. In the clinical workflow one cannot contour the Flab precisely. We investigate the influence on dose calculation when the flab material is neglected, partial contoured by applying automated contouring and a rough contouring taking the air gaps as water equivalent. Oncentra Brachy gives two options in calculation accuracy the influence is investigated as well.