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Intelligent real time 3D ultrasound diagnostic imaging technology with automated diagnostic capabilities

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Approximately 90% of trauma deaths occur in an accident or combat zone prior to medical or surgical intervention. In most cases of an accident, paramedics, who are the first to arrive on the scene, or medical personnel in trauma management situations, such as combat field hospitals, and/or mass casualty incidents, are not always sufficiently equipped to quickly and reliably determine internal bleeding or non-visible abdominal trauma. To this day, commercial diagnostic mobile systems that provide intelligent automated software tools that could detect life threatening injuries within the so-called golden hour of trauma diagnosis do not exist. To address this technological gap, the Defence Research and Development Canada (DRDC) has developed an innovative real time 3D (4D) ultrasound medical diagnostic imaging system that aims to address the Canadian Armed Forces Health Services combat casualty care requirements in far forward operations. This technology development consists of a fully digital 3D ultrasound adaptive beam former based on a fully coherent processing of a (32x32)1024-transducers matrix array ultrasound probe. Based on the Focused Assessment with Sonography in Trauma (FAST) protocol and by emulating the radiologist's tasks, DRDC's field-deployable compact 4D ultrasound imaging system integrates automated diagnostic capabilities to detect non-visible abdominal bleeding, hematothorax and effusion, with the aim to minimize training requirements by emulating a radiologist's tasks in order to support triage for trauma care by medics in remote and/or hostile environments. The present paper will discuss the technological challenges associated with this development and will introduce the main components of DRDC's technology that consist of: a 2D (32x32) matrix transducer array probe; volumetric image reconstruction processing based on a 3D adaptive beam former; a back-end 4D software visualization tools as an open architecture for third parties to easily integrate additional functionality and; software modules with automated diagnostic capabilities to detect non-visible abdominal bleeding.

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Quantification of the impact of electrons transport model on DVH metrics and radiobiological indices for lung radiotherapy plans

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The purpose of this work is to evaluate and quantify the impact of calculation of electrons transport on dose distribution and radiobiological predictions for lung radiotherapy. The dose was calculated using Modified Batho (PB-MB) method and Anisotropic Analytical Algorithm (AAA). Dose parameters derived from DVH for target and lung were compared. To compare dose distribution, 2D gamma (γ) index was applied. The radiobiological indices, TCP and NTCP, were also compared using EUD model. Spearman's rank test was used to explore the best correlation coefficient (r) predicting the dose difference. The bootstrap method was used to estimate the 95% confidence intervals. Wilcoxon paired test was used to calculate p-values. For the same prescribed dose to the PTV, the plans generated with AAA predicted less dose in the target and a more heterogeneous dose distribution inside the target with $p<0.05$. However, MB predicted a better coverage of the target. The γ analysis showed that the difference between MB and AAA could reach up to ±10%. The MB overestimated the TCP while underestimating the NTCP with $p<0.05$. The data showed a good correlation between TCP and D95%, as well as NTCP with mean dose, V20 and V30 with $r>0.7$. The electrons' transport taken into account by calculation algorithm as AAA showed a significant impact on delivered dose, dose distribution and TCP/NTCP. Readjusting the prescribed dose and a better optimization to protect the organs at risks should be considered in order to obtain the best clinical outcome when using AAA.

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