Evaluation and reporting of bladder dose is currently based on the total bladder volume with contouring of the outer wall. This study aims to investigate contouring and dose evaluation of several bladder sub-structures potentially responsible for urinary morbidity after radiochemotherapy and Image Guided Adaptive Brachytherapy (IGABT) in locally advanced cervical cancer (LACC).

Methods. The study hypothesis is that different bladder structures are related to different morbidity endpoints. Therefore, a methodology for contouring subvolumes (trigone, bladder neck, urethra) was established. Structures were contoured for all BT fraction extracting DVH parameters: outer bladder wall (D 2cm3, D 0 cm3), ICRU Bladder point, trigone (D 1cm3, D 1cm13), bladder neck (D 01cm3, D 0 cm3), and urethra (volume, D 01cm3, D 2cm3). A total of 40 LACC [FIGO Stage: Ib(3), IIb(30), III A(1), III B(1), IV B(5)] patients according to the EMBRACE protocol was selected.

Results. The reported values represent the cumulative EBRT+BT dose inEQD2. Median D 2cm3 Values were 71.7 [59.2–81.8] and 56.2 [47.8–69.3] Gy for bladder wall and trigone, respectively. Bladder wall dose was systematically higher, and hotspots often placed outside the trigone. Median ICRU point dose was 63.0 [49.8–80.5] Gy, Median D 01cm3 values for bladder wall, trigone, bladder neck and urethra were 85.6 [58.2–109.8], 70.9 [48.3–105.6], 61.7 [46.5–76.9], and 50.6 [45.6–64.7] Gy, respectively. Median urethra volume and D 2cm3 dose were 3.2 [1.4–6.5] cm3 and 47.9 [44.8–58.7] Gy, respectively. Median D 0 cm3, D 1cm3 Values were 85.6 [58.2–109.8], 70.9 [48.3–105.6], 61.7 [46.5–76.9], and 50.6 [45.6–64.7] Gy, respectively. Median urethra volume and D 2cm3 dose were 3.2 [1.4–6.5] cm3 and 47.9 [44.8–58.7] Gy, respectively.

Conclusion. The study showed that the parameters currently used for IGABT bladder dose reporting (D 2cm3, ICRU point) do not fully and accurately describe the dose distribution in the lower urinary tract sub-structures. D2cm3 for the outer bladder wall is often higher than trigone dose and in many cases the ICRU bladder point is not a good indicator. It is interesting to note that urethra volume may be relevant for endpoints such as incontinence varied across patients. Further understanding of dose-effect relationships for the bladder may be gained by future systematic delineation of bladder sub-structures.

Reference


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[OA040] Quantifying the effect of increased tissue definition on inter-observer variation in organ at risk for lung cancer patients using motion-compensated imaging

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Purpose. The development of 4DCT imaging allows clinicians to account for movement of both the target tumour and organs at risk, although the choice of method of image reconstruction can impact how accurately observers can contour nearby organs. Motion-compensated (MC) image reconstruction is a technique that reduces blurring compared to standard averaged reconstruction. This study aims to quantify the presence of sharper boundaries by taking the value of the image gradient at contour lines, and link this increase in tissue definition to lower inter-observer variation.

Methods. Eight patients with early stage non-small lung cancer were imaged with 4DCT, and these scans were reconstructed using both motion-compensated and averaged techniques. These two sets of scans were then each delineated by five clinicians, who contoured nearby organs at risk. The mean distance between observers’ contours was calculated and compared to the image gradient value at each point on the delineation.

Results. Drawing on results by McWilliam et al. [1], the use of motion-compensated CT image reconstruction results in a reduction in inter-observer variation across all sites delineated. The use of MC increases definition of boundaries between organs, represented by an increase in the image gradient at the delineation boundary. This result was particularly pronounced around the trachea, where preliminary results show the use of motion-compensated reconstruction reduced delineation separation by 50%; across all patients, the heart saw very little improvement between imaging techniques.

Conclusions. The use of motion-compensated CT reconstruction produces images with more well-defined boundaries between tissue, and higher values of image gradient. When delineating organs at risk, the presence of large gradients is a statistically significant (p < 1E-4) predictor of inter-observer agreement. Regions where this effect was not seen—specifically the heart—is thought to be due to additional organ motion not accounted for when reconstructing the scan.

Reference


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[1041] Spatial distortions in MRI

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Purpose. MR images inherently suffer from spatial distortions. Spatial distortions play an important role particularly in quantitative MRI, where MRI parameters are employed as quantitative biomarkers, and in MRI-based treatment planning for advanced radiotherapy applications, which require high spatial accuracy in target localization and definition.

Methods and results. Spatial distortions stem from sources which either relate (sequence dependent distortions) or do not relate (non-sequence dependent distortions) to the measurement conditions (field strength, pulse sequence, scanning parameters, etc.). Non-sequence dependent distortions arise from gradient field non-linearity and, thus, are related to the MRI system. Although MRI scanners utilize post-imaging correction algorithms which reduce gradient field non-linearity distortions, residual distortions may still be considerable at areas distant from the isocenter. These can be estimated and corrected with the aid of specially designed phantoms. Sequence dependent distortions arise from static magnetic field inhomogeneity (ABo), magnetic susceptibility (ABx) and chemical shift (ABCs) phenomena, collectively referred to as field inhomogeneities, which may be machine-related (ABo), or patient-induced ([ABx] and [ABCs]). Sequence dependent spatial distortions scale linearly with B0 and can be partly controlled through the optimization of the scanning parameters and conditions that affect them. How-
ever, patient-induced relevant phenomena cannot be predicted and may not be constant in time (e.g., susceptibility effects related to the presence of gadolinium-based contrast agents). Therefore, patient-specific distortion characterization and/or correction has drawn considerable attention. Relevant studies rely on either the field mapping technique or the read gradient polarity reversal method. Both methodologies not only account for susceptibility and chemical shift distortions but also for B0 related distortion. It is worth noting that the total distortion magnitude measured is mostly affected by the location dependent relative signs of distortion components stemming from different sources, such as B0 inhomogeneity and susceptibility effects. Spatial distortions also result in signal intensity distortions, since the signal intensity of a homogeneous voxel is either compressed or extended in a voxel of different size, shape and position.

Conclusions. Overall, it is essential to characterize, reduce and correct spatial distortions, so as not to adversely affect MRI quantitative size, shape and position.

Purpose. The method of Magnetic Resonance Spectroscopy (MRS) imprints with a fast and a non-destructive manner series of brain metabolites as well as their concentration within brain parenchyma. Furthermore, it illustrates the infiltrative character of brain tumors. These MRS indicators correspond to biochemical products of the carcinogenesis procedure, such as cell proliferation, cell metabolism, cells’ destruction, necrosis, hemorrhagic and cystic elements. The combination of the macroscopic translated information of MRS along with the microscopic findings of Patholогоanatomy can differentiate in a reliable manner between the various types of cancer and assess therapies.

Methods. MRS technique has the potential to diagnose brain tumors in vivo, in a non-invasive manner, without using ionizing radiation, with good spatial and temporal resolution. A number of patients with brain glioma were imaged with Magnetic Resonance Imaging (MRI). Magnetic Resonance Spectroscopy followed, as well as Perfusion measurements and post injection MRI. All examinations were performed in a 1.5 Tesla Signa HDxt General Electric system. The MRI protocol involved T2 Flair, T2, gradient-echo T2*, T1, Diffusion, Diffusion Tensor Imaging (DTI), Tractography, Perfusion and post injected contrast medium MRI. MRS protocol involved both single voxel as well as 3-D Chemical Shift Imaging (CSI).

Results. This study illustrates the correlation between MRI and MRS macroscopic findings with the microscopic patholогоanatomical ones: Diffusion with cellularity, DTI with neuronal axons’ destruction. Perfusion with neovascularization, MRS with brain metabolism, cell proliferation, necrosis, hemorrhage, anaerobic glycolysis, etc. MRS can also demonstrate infiltration of tumor cells within brain parenchyma even in cases where MRI fails to do so, due to the fact that the local cell biochemical background is at an initial stage.

Conclusions. MRS is a non-invasive technique that provides useful and conclusive information regarding differential diagnosis of brain tumors.

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[OA042] Correlation of magnetic resonance spectroscopy and histological findings in brain tumors

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Purpose. The method of Magnetic Resonance Spectroscopy (MRS) based on low-pass filtering for magnetic resonance imaging (MRI) quality control (QC) purposes

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Purposes. Signal-to-noise ratio (SNR) is a prominent metric to assess scanners performances. SNR measurement in MRI is challenging because of the difficulty to quantify noise level from images. A gold-standard consist in pixel-by-pixel variance calculation on several images (>100) scanned in identical conditions. This method is accurate but cannot be practically implemented because of time constraints. Another gold-standard consists in scanning images without radiofrequency excitation hence collecting noise-only. This latter is also unpractical because it requires a specific and generally not-granted access to the hardware. Consequently, there is a need for designing alternative methods for accurate and precise noise quantification. This work aims to introduce a new noise level quantification method for SNR measurement.

Methods. Our method (NoiseFilt) quantifies noise level by combining these operations: (1) subtraction of two images subsequently scanned in identical conditions, (2) Low-pass filtering to extract and suppress low-frequency remaining information, (3) \(\text{SNR}_{\text{filt}} = \text{standard deviation of pixels. Using a dataset of 30 exam} \)

images. A gold-standard consist in pixel-by-pixel variance calculation on several images (>100) scanned in identical conditions. By means of Bland–Altman analysis, we assessed the agreement between all these methods and the noise-only standard method (NoiseDiff). We also assessed their correlation with NoiseDiff (Pearson’s correlation coefficient \(r < 0.05\)).

Results. Bland–Altman analysis showed that NoiseFilt agrees more with the standard than the three other methods. Correlation of our NoiseFilt method with the gold-standard \(r = 0.80\), \(p < 0.05\) was higher than the three others’ \(r = 0.37, \text{NoiseDiff} = 0.61, \text{Diff} = -0.04\).

Conclusion. We demonstrated that our method produces accurate measurement, is simple to implement, and is usable for instance for quality control (QC) purposes. This new metric is being tested with additional scans in QC monitoring of different MR scanners.