aim of this study was to validate the CT–MRI image fusion method and compare delineation obtained by CT-MRI image fusion versus CT alone.
Materials and Methods: Image fusion software (XIO CMS 4.50.0), was applied to delineate 25 patients. Patients were scanned on CT and MRI in the treatment position within an immobilization device before the initial treatment. The gross tumour volume (GTV) and clinical target volume (CTV) were delineated on CT alone according to the institutional protocol, and on CT+MRI images consecutively and image fusion was obtained automatically. The visual verification of fusion result was done for each CT slice, and if necessary, manual correction was applied.
Results: Image fusion showed that CTV delineated on CT image study set is mainly inadequate for treatment planning, in comparison with CTV delineated on CT-MRI fused image study set. In our study CT imaging could not provide clear boundaries or CT image showed tumour with unclear edema with insufficient information for target delineation. The CT- MRI fused image provided clear boundaries visualized by MRI T2 sequence, or revealed tumour expansive tissue with perifocal edema with clear boundaries. Fusion of different modalities enables the most accurate target volume delineation.
Conclusion: The effectiveness of medical image fusion is illustrated in this paper. It proves that medical image fusion is a powerful technique used in medical imaging analysis. Image fusion allows better visualization for RT delineation and planning of target volumes. CT-MRI fusion provides even better estimation of target volumes that may permit treatment individualization, organ sparing or functional avoidance.

2015 POSTER

Rectal Volume Variations During Prostate and Pelvic Lymph Node Image Guided Radiation Therapy

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Background: Patients undergoing prostate radiotherapy, particularly when pelvic lymph nodes are irradiated, have been assumed to undergo a systematic decrease in rectal volume throughout radiation treatments due to radiation colitis, which can result in dosimetric variations due to deformation or geographic miss; this can be quantified with daily volumetric imaging.
Materials and Methods: 335 kilovoltage cone beam computed tomography (KV-CBCT) images from 12 consecutive patients undergoing image-guided pelvic radiation, with concurrent hormonal therapy, for intermediate or high risk prostate cancer were analyzed retrospectively. Treatments were planned using intensity modulated radiation therapy (IMRT, n = 7), 3D conformal radiation (n = 3), or a combination (n = 2), with planning treatment volume (PTV) margins of 4−6 mm at the posterior prostate and 7−10 mm elsewhere. Patients were instructed to have a full bladder and to use mild bulk laxative daily. Total pelvic doses ranged from 4320–5040 cGy (150–180 cGy per day), with a prostate boost via IGRT to 6840–7800 cGy (n = 9) or brachytherapy (n = 3). An average of 260 cc of bowel received greater than 40 Gy, and all patients experienced grade 1 (n = 3) or grade 2 (n = 9) GI toxicity. Daily shifts based on KV-CBCT images were approved by a board-certified radiation oncologist. Daily rectal volumes were drawn by a single observer, using planning superior and inferior borders and according to RTOG 0126 guidelines.
Results: Rectal volumes consistently decreased throughout the radiation course ($p < 0.005$). In spite of this, treatment rectal volumes were close to planning rectal volumes on average (mean, 101% of planning volume, st dev 38%), due to the fact that rectal volumes were larger than planning values in the first week of treatment (see Table). Rectal volumes on axial slices containing the prostate and rectal diameter at isocenter did not vary systematically during the treatment course ($p = 0.71$ and 0.66, respectively), indicating that the decrease in rectal volume occurred in the upper rectum. Among individual patients, average treatment rectal sizes varied two-fold (56–121 cc), with a mean average rectal size of 89 cc. A slight trend toward anterior corrective patient shifts, based on KV-CBCT images, with larger daily treatment rectal volumes was also seen ($p = 0.13$).

Week of treatment	n	Average rectal volume (treatment/planning)
1	51	117.4%
2	51	102.1%
3	48	102.6%
4	45	100.7%
5	41	98.0%
6	38	96.3%
7	37	93.0%
8	24	93.1%

Conclusions: Pelvic radiation therapy for prostate cancer induces systematic decreases in rectal volume throughout treatment in the age of IMRT and IGRT. Re-simulation at the time of prostate boost planning may help minimize dosimetric consequences of this change. Large daily variations in rectal volumes underscore the utility of IGRT for daily prostate localization.

2016 POSTER

Impact of Choice of Algorithm and Clip Box Position on the Automatic Image Registration for Prostate Cancer

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Background: Image registration performance has been compared between bone matching and grey value matching algorithms for treatment of prostate cancer in terms of resulting couch shift values, failure rates and calculation times.
Materials and Methods: The X-ray volume imaging system (version 4.2.1 b47) used in this study is an onboard kilovoltage cone-beam CT (CBCT) imaging system integrated into the Elekta Synergy® (Elekta Oncology Systems, Crawley, UK).
Five to 10 CBCT scans of 20 prostate cancer patients were used with F0 filter, S20 collimator, 120 kV, 335 mAs. The images for this study were acquired through 200º (half-fan) rotations and all the projection images were sampled with 512×512 pixels, leading to a volume data having a voxel size of $0.518 \times 0.518 \times 0.518\,mm^3$. The slice thickness of reference fan-beam CT (FBCT) was 2 mm. To register the FBCT to the CBCT images, four clip box positions or regions of comparison were specified; (a) the entire CBCT images, (b) lumbosacral spine, (c) femoral head, (d) aminimum volume including prostate, bladder and rectum. The misalignment between FBCT and CBCT images, failure rate of registration, and calculation time were all measured for the bone matching, the grey value matching, and the bone matching with followed by the grey value matching.
Results: The difference of measured misalignment between the bone and the grey value matching algorithms along the lateral, longitudinal, and vertical axes on average was 0.4, 0.6, and 0.7 mm in (a); 0.4, 1.2, and 0.8 mm in (b); 0.2, 0.3, and 0.5 mm in (c); and 0.2, 0.7, and 0.6 mm in (d). Meanwhile, rotational misalignment around x, y, and z axes on average was 1.0, 0.3, and 0.2 degrees in (a), 0.9, 0.3, and 0.3 degrees in (b), 0.4, 0.2, and 0.1 degrees in (c), and 0.9, 0.3, and 0.3 degrees in (d). The failure rates were 8% for the bone matching with (b), 10% for the grey value matching with (d), and 0% for the bone matching with (a) followed by the grey value matching with (d). The average calculation times were 2.2 seconds (s) for the bone matching, 179.1 and 32.6 s for the grey value matching with (a) and (b)−(d) respectively, and 29.5 s for the combined bone matching with (a) and the grey value matching with (d).
Conclusions: It was suggested that the bone matching using the entire CBCT images followed by the grey value matching using a minimum volume including prostate, bladder and rectum would be the most preferable image registration technique for prostate cancer registration.

2017 POSTER

To Compare the Accuracy of Target Delineation Between Mega-voltage (MVCT) and Kilo-voltage Computed Tomography (KVCT) With Contrast Medium Using a Solid Water Phantom

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Background: In order to see whether the tumour target for radiotherapy could be delineated using contrast medium in MVCT, a solid water phantom to mimic a human body was used to compare the accuracy of target delineation between MVCT and KVCT with contrast medium.
Materials & Methods: A solid water rectangular phantom was penetrated by 88 parallel cylindrical canals with known diameters. 72 canals were filled with known concentration of contrast medium (Ultravist 370). The phantom was then scanned with GE LightSpeed® RT 16 CT scanner and TomoTherapy Hi-Art II unit for 5 times each. A well experienced radiation therapist contoured all the canals in all CTs' sets. One-tailed paired t-test was performed to test the percentage differences between contoured size and actual size in KVCT & MVCT respectively.
Results: Canals with 20% concentration could still be delineated down to 0.3 cm. The mean of differences in size between KVCT and MVCT differs very significantly as expected. Therefore KVCT is superior to MVCT in delineating the size of the canals.
Conclusion: Although KVCT is superior to MVCT in delineating target in this study, only target less than 0.3 cm with 20% contrast concentration