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) a minimum 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 Megavoltage (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

will be missed using MVCT for delineation. The delineation power is good enough in delineating many of the tumours.

2018　　POSTER

Three-Dimensional Imaging for Radiotherapy Planning in Prostate Cancer

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Background: The preparation of external beam 3D Conformal Radiotherapy (3DRT) and Intensity Modulated Radiotherapy (IMRT) for prostate cancer entails carrying out a CT Scan and outlining the treatment volumes and organs at risk on each of the CT scan slices. Whilst this is explained in detail to patients before starting RT during the consenting process, quite often, patients find difficult to fully understand how RT is planned and delivered.

Material and Methods: The 3 dimension (3D) VERT imaging system (VERTUAL Ltd, U. K.) was used in this pilot study. Local ethical approval was obtained prior to starting this project and 50 patients were included. Patients were informed of the study and asked to sign an informed consent form. RT planning CT Scans were transferred into DICOM to the VERT system. Patients were shown their own CT Scan planning images in 3D and taken through the different stages of RT planning and delivery. Patients were then asked to fill in a questionnaire in order to obtain their feed-back and how the whole exercise could be improved.

Results: Patients welcomed this exercise as they not only better understood how RT is planned and given but also, why they might get some side effects from the RT. Furthermore, this extra knowledge helped them to better accept side effects and to better cooperate with bladder and bowel preparation during their treatment.

Conclusions: The use of the 3D VERTUAL system to explain patients how RT is given and delivered is not only highly welcomed by patients but also, it helps to reduce the fear factor many of them have before starting RT.

2019　　POSTER

Influence of High Density Inhomogeneity of Dental Prostheses in Radiation Therapy

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Background: Dental prostheses made of high density material contribute to modify dose distribution in head and neck cancer treatment. The study objective is to quantify dose perturbation due to high density inhomogeneity with experimental measurements and Monte Carlo simulations.

Material and Methods: Firstly, measurements in a phantom representing human jaw with thermoluminescent detectors (GR200A, 5 mm of diameter and 0.9 mm thickness) and EBT2 Gafchromic films in the vicinity of three samples: a healthy tooth, a tooth with amalgam and a Ni-Cr crown, irradiated in clinical configuration (6 MV photons, DSP = 94 cm, sample depth = 3 cm, 5 cm $\times$ 5 cm beam size). Secondly, Monte Carlo simulations (BEAMnrc code) are assessed in an identical configuration.

Results: Experimental measurements and simulation results confirm the two well-known phenomena: the passage of a low density medium to high density medium induced backscattered electrons causing a dose increase at the interface. Instead, the passage of a high density medium to a low density medium create a dose decrease near the interface. So, the results show a rise backscatter dose and a decrease after sample (only for crown) compared to the healthy tooth (see table).

	Before sample		After sample	
	TLD	Monte Carlo	TLD	Monte Carlo
Tooth with amalgam	−2.6%	−0.5%	−4%	+0.7%
Crown	+7.4%	+25.9%	−17.5%	−17.7%

Conclusion: Although teeth with amalgam have a density of about 12−13, the changes generated are not significant. However, the results for crowns (density of 8) are very significant and the discordance observed may be due to thickness difference, 0.9 mm and 0.25 mm respectively for TLD and Monte Carlo. Now, the next step will be to evaluate algorithms implemented in clinical treatment planning system.

2020　　POSTER

Dual Phosphoinositide 3-Kinase/Mammalian Target of Rapamycin Inhibitor is an Effective Radiosensitizer for the Treatment of Colorectal Cancer

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Background: The phosphatidylinositol 3-kinase (PI3K), protein kinase B (AKT) and mammalian target of rapamycin (mTOR) (PI3K/AKT/mTOR) signalling pathway are reported to play a crucial role in the pathogenesis of colorectal cancer (CRC). Since radiotherapy became an important treatment strategy for locally advanced rectal cancer, we sought to investigate whether the use of dual PI3K/mTOR inhibitor, BEZ-235, can improve the radiation-related antitumour effects of CRC cells.

Materials and Methods: CRC cell, the KRAS mutant, HCT116 was irradiated with different dose of radiation (0−6 Gy). Determination of the therapeutic effect and cell cycle distribution of radiation alone, dual PI3K/mTOR inhibitor (BEZ-235) alone, and combining BEZ-235 with irradiation were analyzed by cell survival assay, and flow cytometry, respectively. Phospho-Akt (p-Akt), p-mTOR, p-4EBP, p-p70S6K, and p-eIF4E protein expression were assessed by immunoblotting. The treatment effect of radiation alone, BEZ-235 alone, and the combination of BEZ-235 and irradiation was further evaluated in the *in vivo* study of xenograft experiments using HCT116 CRC cells were done by subcutaneous inoculation of cells into 5−6 weeks old female C.B-17/Icr-scid-bg mice.

Results: The synergistic effects of combining radiation with different concentration of BEZ-235 were demonstrated in the cell survival assay. Cell cycle distributions showed that there was a significant increase in the percentage of cells exposing to the combination of BEZ-235 and radiation in the sub-G1 cells when comparing with cells with no treatment or treating with irradiation alone. Furthermore, the combination of BEZ-235 and radiation resulted in a caspase-dependent apoptosis in association with activation of caspase-9. In the *in vivo* effect of BEZ-235 in CRC xenograft tumour, we found that treatment with the combination of BEZ-235 and radiation had a significant inhibitory effect on tumour size ($P < 0.01$) after 4 weeks of treatment than treatment with radiation alone or BEZ-235 alone. In addition, we found that irradiation alone up-regulated the expression of p-Akt, p-mTOR, p-4EBP, p-p70S6K, and p-eIF4E, however, the up-regulation of AKT/mTOR signalling pathway was attenuated by BEZ-235.

Conclusions: These findings indicate that the dual PI3K/mTOR inhibitor, BEZ-235, down-regulates radiation-induced Akt/mTOR signalling pathway and enhances therapeutic effects of radiation in CRC cells. The major mechanism of the synergistic effect of the combination of BEZ235 and irradiation-induced inhibition of cell growth of CRC is at least through the down-regulation of PI3K/Akt/mTOR pathway. This encouraging result provides a new approach for the combination of BEZ235 and radiotherapy in the treatment of CRC.

2021　　POSTER

"The Machine Fear"− Cancer Patients Undergoing Radiotherapy Treatment, an Observational Study

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Background: Cancer patients are often worried about both the disease and its treatments. The aim of our study is to evaluate patients' worries of the radiotherapy machine and the effects of the treatment on their mood.

Material and Methods: 46 patients in radiotherapy (58% male, 42% female; mean age: 65.5 years old, range: 46−75) were asked to undergo Profile of Mood States (McNair, Lorr, 1992) for monitoring fluctuating active mood states, Mini Mac (Watson, 1994) to value coping style and to a specific psychological interview concerning the feelings linked to the machine, the treatments and the socio-economical variables.

Results: The majority of patients is not afraid of the machine (91%), the rays (92%) and the noises (90%), only 7% complains about bad smells during treatments.

11% is worried about possible damages of machine and 13% about negative effects of the rays.

POMS analysis shows low levels of the factor depression dejection (98%), anger-hostility (93%), confusion-bewilderment (91%) and fatigue-inertia (97%).