

for Conventional, 7.5 hours for Conformal therapy, and 9 hours for IMRT, with 3 hours, 5 hours and 14 hours for planning time respectively.

Conclusion: Conformal therapy and IMRT are significantly superior to conventional technique to allow for normal tissues sparing. IMRT achieves better dose conformation but with higher integral dose than conformal therapy; the later is, however, best to achieve skin sparing. Finally, the overall workload is higher with IMRT than conformal therapy.

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POSTER

Performance reproducibility of intra-operative radiotherapy equipment – photon radiosurgery system

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Background: Intraoperative Radiotherapy (IORT) can deliver a critical dose to the tumour bed. It is being investigated whether a single high dose of radiation will impart the same clinical benefit as a standard course of external beam therapy. Our centre has four Photon Radiosurgery Systems (PRS) currently used to treat breast and neurological sites. The PRS comprises an x-ray generator, control console, QA tools and a mobile gantry. We investigated the dosimetric characteristics of each source and its performance stability over a period of time.

Methods: We investigated half value layer, output decay factor, internal rate monitor (IRM) reproducibility and depth-doses in water. The half value layer was determined by the broad beam method, using high purity aluminium attenuators. To quantify beam hardening at clinical depths, solid water attenuators of 5 and 10 mm were placed between the x-ray probe and attenuators. The ion chamber current was monitored over 30 minutes to deduce an output decay factor. IRM reproducibility was investigated under various exposures. Depth-dose curves in water were obtained at distances up to 35 mm from the probe.

Results: The mean energies for the beam attenuated by 5 and 10 mm of solid water were derived from ICRU Report 17 and found to be 12 and 24 keV. The average output level over a period of 30 minutes was found to be 98.9%. The average difference between the preset IRM limit and the total IRM count was less than 0.5%. For breast IORT, the average difference between the calculated and actual treatment times was found to be 0.30% (0.47% for neurological IORT). The beam attenuation in water varied by approximately $1/r^3$.

Conclusions: The x-ray sources are stable over time. Most measurements were found to lie within the manufacturer's tolerances and an intercomparison of these checks suggests that the four x-ray sources have similar performance characteristics.

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POSTER

Radiotherapy of the skin carcinoma of the inner canthus of the eye

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As 80% of all skin carcinomas develop on the face, the functional and aesthetic sequelae of the treatment are of paramount importance for the patient. Inner canthus of the eye is an anatomically complex region, offering slim chances for a radical excision of tumour with no undesired functional or aesthetic sequelae. Among several treatment options, surgery and radiotherapy are considered as treatment of choice. The main treatment aim is optimal cure with least possible functional and aesthetic damage. The cure rates after radiotherapy and surgery are similar, except that functional and aesthetic sequelae of radiotherapy are less mutilating. From 1991 to 2004, we treated 61 pts (29 females, 33 males) with non-melanoma skin cancer of the inner canthus of the eye. Biopsy showed that 53 were basal-cell carcinomas, 5 squamous cell and 3 basosquamous cell carcinomas. Mean age of pts was 72, range from 43 to 88 years. All pts were treated by irradiation; 6 of them were primary treated by surgery (two of them 3 times each) and one by electrocoagulation. The follow-up ranged from at least one year to more than 10 years.

From 55 patients treated by irradiation as first treatment there was only one recurrence. In that patient tumor recurred 5 years after irradiation and was salvaged by operation. Of 6 pts who had surgery as first treatment in 4 pts recurrence was cured by irradiation. Of remaining two, one was cured by second course of postoperative irradiation. Last patient was treated by operation 3 times, then by irradiation and was eventually salvaged by extensive operation with the removal of the eye.

In my opinion radiotherapy is the treatment of choice for skin carcinoma of the inner canthus of the eye, which is evident from the patients photographs taken before and after the treatment

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POSTER

Low acute and late toxicity with preoperative intensity modulated radiotherapy (IMRT) for rectal cancer

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Purpose: to report the acute and late side effects in a group of patients with rectal cancer treated with pre-operative intensity modulated radiotherapy (IMRT)

Methods and materials: Forty three patients with rectal cancer with an amount of small or large bowel inside the small pelvis were treated with preoperative IMRT. Twenty six patients had a primary locally advanced rectum cancer and 17 a local recurrence. To the pelvis, a total dose of 50 Gy (2 Gy/fraction) was given to 14 patients and 44.65 Gy (2.35 Gy/fraction) to 29 patients. Five patients received a boost of 10–20 Gy because they were inoperable.

Inverse planning was performed using the module Helios of the treatment planning system Cadplan. The constraints were set to encompass the PTV within the 95% isodose line while delivering at least 100% to the isocenter. An overdose of maximum 15% was allowed. The dose to small bowel, colon and bladder was minimized. Each IMRT plan with 5 non-equispaced beams was compared with a conventional 3-field plan in order to evaluate the dose reductions of the organs at risk. The acute toxicity was scored for all patients. Twenty six patients had a follow up >6 months (median: 14; range: 6 – 32 months). Late toxicity was scored in this group.

Results: A median volume of 71 cm³ (3–239 cm³) and 11 cm³ (0–99 cm³) small bowel were irradiated to the 90% and 100% isodose line, resp. Conventional planning would have increased the median small bowel volumes to respectively 155 and 95 cm³. For large bowel, the volume irradiated to the 90% and 100% with IMRT was 24 cm³ (0–178 cm³) and 8 cm³ (0–55 cm³). The median bowel volume (small + large) to the 90% isodose line was 214 cm³ (24–513 cm³), IMRT reduced it to 119 cm³ (15–283 cm³). Overall, no acute grade 3 or 4 toxicity was reported. Twenty eight percent of the patients had a RTOG grade 1 diarrhea and 16% a grade 2. Acute side effects related to the bladder and skin were also low. Only 3 patients had late toxicity: 1 patient had RTOG grade 1 bowel toxicity, and 2 patients had RTOG grade 2 bladder toxicity.

Three of the 33 (9%) operated patients had a pathological complete response. Pathological downstaging was found in 19 of the 33 patients (57%).

Conclusion: With a median and maximum volume of 71 and 239 cm³ small bowel to the 90% isodose line, no grade 3–4 acute and late toxicity was reported. IMRT resulted in a significant reduction of the irradiated volume of bowel and bladder. Good pathological downstaging was also found.

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POSTER

Radiotherapy for bone metastases from Hepatocellular Carcinoma: dose-response relationship between the regression of extra and intra osseous masses.

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Purpose: The aim of this study was to evaluate retrospectively the palliative effect of radiotherapy (RT) for painful bone metastases and the dose-response relationship between the regression of extra soft-tissue and intra destructive osseous masses from Hepatocellular carcinoma (HCC).

Methods and Material: From January 2001 to June 2004, 26 patients (38 sites) with painful bone metastasis from HCC were analyzed. The patients received 8 Gy/1fr (single fraction group) in 10 sites, 20 Gy/5Ffr–30 Gy/10fr (Moderate dose group) in 16 sites or 40 Gy/20f – 50 Gy/25fr (High dose group) in 12 sites. Irradiated sites were cervical spine (5), thoracic spine (6), lumbo-sacral (10), pelvis(8), long bones(5), others (4) respectively. The volume of extra-osseous soft tissue and intra-osseous masses respectively were measured both before and after radiotherapy periodically on the CT scan. Percent regression = ((pre-RT tumor volume – post-RT tumor volume) / pre-RT tumor volume)*100. Pain control was measured with self assessment questionnaire. Criteria for subjective response were as follows: CR was defined as complete disappearance of pain; PR was defined as 50% improvement in pain. NC meant that pain relief was minimal(≤50%) or absent. All patients were planning with 3D-RT planning system and were treated with 6MV-X or 10MV-X linear accelerator.

Result: Eighty one percent (31/38) showed some type of pain relief (CR, {PR}). There were no significant differences in pain relief among the groups (Single fraction 80%, Moderate dose 82% and High dose 83%). The median duration of pain relief was 3.5 months, 5 months and 6 months for Single fraction, Moderate and High dose group. High dose group had longer duration of pain relief than single fraction. (p<0.05) In the median

regression of the extra osseous masses, High dose group only had tumor regression (19.5–55%). All sites treated with single fraction had growth of the extra masses after RT and had re-growth of intra masses after 4 months. Seven sites had re-calcification of bone metastases after 4 months, which were all treated with high dose. The median overall survival time was 5.5 months.

Conclusion: RT is an effective for pain relief of bone metastases from HCC, but correlation was not found between the total dose and pain relief. High dose group had longer duration of pain relief. Single fraction could not be controlled growth of intra destructive osseous masses after four months. Therefore, high dose RT seemed to be necessary to control osseous masses.

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POSTER

Effect of respiration on kidney in radiotherapy

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Introduction: Conformal radiotherapy and Intensity modulated radiotherapy allows improvement in the treatment outcome due to increased targeting accuracy through advanced beam shaping techniques to precisely conform radiation dose to the geometry of the tumor. Organ motion and treatment set-up uncertainties are unavoidable factors that are limiting the accuracy in treatment delivery and have to be accounted during treatment planning. Radiotherapy treatment planning needs optimum definition of the target volume in its relative position to normal tissue. The limited radiation tolerance of the kidneys is an important consideration in radiotherapy to estimate the movement of kidney during respiration. In this study, an effort has been made to quantify the variation of kidney movement during deep inspiration and deep expiration.

Materials and Methods: Twenty radiotherapy patients for whom abdominal imaging is required were selected for this study. Siemens Volume Zoom CT (Spiral CT) was used for this study. The CT imaging of the abdomen was done with both deep inspiration and deep expiration. After imaging the two CT datasets for deep inspiration and deep expiration were then pushed to the Eclipse Treatment Planning System through the Dicom network. The difference between the positions of the kidney during deep inspiration and deep expiration was then estimated based on the CT table position.

Results: In four patients the right kidney was found to be displaced slightly more than the left kidney. No difference was found between the right and left kidney for the rest of the patients during the deep inspiration and deep expiration. The maximal vertical motion of the superior and the inferior pole from its end-expiratory to its end-inspiratory position was found to be 1.7 ± 0.6 cm for both right and left kidney, maximum 4 cms. The lateral movement for both the kidneys was found to be 0.3 ± 0.1 cm.

Conclusion: The shift in the kidney during deep inspiration and deep expiration clearly dictates the need for accounting the kidney motion during radiotherapy treatment planning. For tumors close to the kidney care should be taken while giving the margin to the Clinical Target Volume.

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POSTER

Radiation therapy in patients with cardiac pacemakers and implantable cardio-defibrillators: a survey of patterns of practice among radiation oncology in Japan

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Backgrounds: Patients with cardiac pacemakers (PM) and implantable cardio-defibrillators (ICD) were increasing, and radiation therapy department should expect to face the prospect of treating a patient with these devices. Although the risk of potentially life-threatening malfunction secondary to electromagnetic interference or ionizing radiation is recognized, there are no practical clinical guidelines for radiation therapy with PM and ICD in Japan. Our objective was to determine the current patterns of practice of radiation oncologist in Japan.

Materials and methods: A survey was sent to 174 main radiation departments in Japan. Questionnaires were consists of experience of radiation therapy for patients with PM or ICD, and policies of management of patients with PM or ICD during radiation therapy.

Results: Total 108 questionnaires were returned (61%). Ninety-one departments had experience of radiation therapy for patients with PM or ICD (84%), and of these, two departments had experiences of malfunction of PM during or after radiation therapy. Policies of management of PM and ICD during radiation therapy were as follows; Keep PM and ICD device outside of the direct radiation beam in 65 departments (60%).

Keep the device from 1 cm to 10 cm outside of the radiation fields edge in 34 departments (31%). Keep the device outside the collimated radiation beam during portal filming in 18 departments (17%). Only 18 departments estimated the absorbed dose received by the device before treatment (17%). ECG monitoring during radiation therapy in 19 department (18%). Consult cardiologists in 18 departments (17%), and check the functions of the device before radiation therapy in 21 departments (19%).

Conclusion: Malfunction of PM and ICD during radiation therapy was not recognized enough and practical clinical policies were deferent between departments in Japan.

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POSTER

Four-dimensional radiation therapy for lung cancer using the second model 256-detector row CT-scanner

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We developed the second model 256-detecotor row CT was based on the design of the first one, which can obtain approximate 100 mm length in 1 s rotation. Our group previously reported its promise for the amount of diagnostic information and overcomes some of the limitations of present helical CT methods such as shorter scan time in wide cranio-caudal direction, contrast enhancement, cardiovascular circulation, perfusion, and kinematics. The second model 256-detector row CT can solve problems of the first model, especially in temporal resolution. Therefore, we believe the 256-detector row CT is enough to adopt to the four-dimensional (4D) radiation therapy. Here, we describe a preliminary investigation of 4D radiation therapy using the 256-detector row CT and adapted to non-small cell lung cancer (NSCL). The patients in this study were five male patients in our hospital, who were eligible patients having NSCL and American Joint Committee on Cancer Stage II. They had given their informed consent to be included in the study and approved by the Institutional Review Board (IRB) of NIRS. All were inpatients of the institute hospital and receiving radiation therapy. The 256-detector row CT used a cine scan mode (continuous axial scan with the table remaining stationary) to acquire one respiratory cycle. Scan conditions were 120 kV, 240 mA, 256* 0.5 mm beam collimation, 6 s acquisition time with cine scan mode. The effective dose was estimated as 14.5 mSv (=2.41 mSv/s * 6 s). Eight volumetric cine data (divided one cycle respiratory phase to eight) were transferred to the photon treatment planning system, XIO (CMS, Computerized Medical Systems, Inc. St. Louis, MO) and we planned the photon treatment using commercially available superposition algorithm. The planning target volume (PTV) included the gross target volume (GTV) with a 3 mm setup margin and 5 mm allocated for the penumbra with the MLC, which features a full 40×40 mm² field and is that offers 5 mm resolution for high precision treatment of small and irregular fields. MLC was used to define the field boundary and changed MLC position by varying the target shape with respiration. The 256-detector row CT showed the potential for 4D therapy and improve accuracy in planning because the 256-detector row CT allows for reconstructions in 0.5 mm isotropic resolution with a high temporal resolution. Although we reached this conclusion using the photon beam, it may be applied to carbon ion beam therapy as well.

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POSTER

The utility of multimodality imaging with MRI to determine treatment volumes for chemoradiation in rectal cancer

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Purpose: To compare the gross target volume (GTV) derived from CT simulation alone (CT-GTV) to multi-modality GTV (M-GTV) derived from co-registered CT & MRI simulation and diagnostic MRI images

Methods: 15 patients (10 males, 5 females) with locally advanced rectal cancer (T3 and/or N1 disease) undergoing pre-operative chemo-radiation had co-registered CT and MRI simulation images. All had a diagnostic MRI with pre & post-contrast axial, coronal and sagittal T1 & T2 scans and sagittal STIR images. A diagnostic radiologist with a radiation oncologist defined the GTVs. The CT-GTV was defined from CT simulation images whilst blinded to the MRI. The M-GTV was then defined using co-registered CT & MRI simulation images whilst simultaneously reviewing the multiplanar diagnostic MRI. Assessment endpoints included an analysis of the volume and spatial relationship of the CT-GTV with respect to the M-GTV. The volume relationship was examined by calculating the ratio of the overall CT-GTV/M-GTV volume. In addition the volume ratio of the portion of the CT-GTV/M-GTV contained within the anatomically defined true rectum, the sigmoid and the anus was also calculated individually