been performed by 3D RTS software (Plato, Nucletron). The prescription dose (PD) is referred to the minimum isodose that encompasses almost 99% of the PTV.

For each plan the dose-volume histogram (DVH, 100000 points) has been calculated for the PTV and the brain VOI. Conformity Index (CI) has been evaluated on basis of the definition contained in ICRU 62; over (>107%PD, Vo), under (<95%PD, Vu) dosage volume in PTV and maximum dose in PTV divided by prescription dose (MDPD) have been evaluated. Non-target volumes brain tissue encompassed in the 50%PD isodose have been evaluated (V50).

Results: The average CI is 1.8, 2.9 and 2.3 respectively. The MDPD is 1.26, 1.18 and 1.19 respectively. None of the PTV has been underdosed (Vu=0). The average Vo is 96%, 89% and 92% respectively. For the non-target brain the average volumes V50 are 2%, 5% and 8% for meningioma and metastasi cases respectively; for GBL case V50 are 27%, 48% and 32% respectively.

Conclusion: DCRT allows a better dose conformity than conventional arc technique and static conformal for all types of tumor. The overdosage at the PTV is compatible with small volumes of the PTV (6 cm3) except for the GBL case. Non target brain is less involved with DCRT in all cases.

From this preliminar analysis, DCRT is particularly indicated for intracranical small size tumor where the dose fall-down outside the PTV is important and dose inhomogeneities on the PTV are not very relevant because of the small size of the volume.

772 POSTER

Systematic and random set-up errors in patients having postoperative radiotherapy for breast cancer

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Purpose: We have previously shown that using different patient positioning for adjuvant breast radiotherapy has a significant effect on cardiac doses and consequently the risk of cariac radiation damage. Reproducibility of patient positioning and patient movement, including respiratory movement, may dilute this benefit as small variations in physical dose translate to large differences in predicted biological effect. We have investigated the reproducibility of radiotherapy set-up for the best patient positioning (Tgrip method), compared to a standard arm-rest immobilisation technique.

Methods: Digital port images were obtained on days 1,2,3 and on the 1st day of each subsequent week of treatment.. Medial and lateral images taken each time. The images were scaled and the images were then enhanced to give a clear outline of the treated area. Measurements from skin surface to posterior field border were taken at 1/4, * and 3/4 intervals from superior to inferior borders at right angles to the posterior border. No adjustments were made during XRT based on these results

Results: To date 25 consecutive patients have been assessed 11 with the Tgrip and 14 treated with the armrest. A total of 984 measurments were analysed. The stability of the Tgrip and armrest were not statistically different, SD for set-up error being 0.26cm and 0.28cm respectively. There was a systematic error on day 1 of treatment which disappeared by day 2.

Conclusion: There are no difference between techniques in set-up accuracy so the biological benefits of the Tgrip method are not lost by poor reproducibility. The random error for both methods is within acceptable tolerances. Set-ups should not be altered based on day 1 portal images.

773 POSTER

Impact of intravenous contrast on target definition in radiotherapy of non small cell lung cancer

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Purpose: Accurate planning target volume(PTV) definition is critical to achieving local disease eradication in non small cell lung cancer (NSCLC). The impact of intravenous contrast (ivc) on target definition when using three dimensional conformal radiotherapy (3DCRT) was assessed in this study.

Methods: Patients with NSCLC (stages Ib -IIIb) underwent CT scanning before and after the administration of ivc. Gross tumour volumes(GTV) for each patient were outlined manually in both ivc and non-ivc scans. 3DCRT plans were generated for PTVivc and PTVnon-ivc. PTVivc was subsequently transferred to the non-ivc study to assess resulting dose distribution to the PTVivc from the non-ivc 3DCRT plan. The impact of ivc on CT based calculations in 3DCRT plans was also addressed by comparing the dose distribution to an identical test volume in corresponding non-contrast and contrast planning CT plans.

Results: When GTVnon-ivc were compared to GTVivc, contrast enhancement reduced the volumes by a range of 22-34%. When the non-ivc 3DCRT plans were used to cover the PTVivc, both the minimum dose in the PTVivc and the volume of the PTVivc receiving >95% of the prescribed dose(Vol.95) were significantly reduced. The minimum dose in PTVivc ranged from 85.1% to 43.1% and the Vol.95 of PTVivc ranged from 97.6% to 95.3%. When the contrast and non-contrast scans were assessed for the test volume, the difference in dose distribution to the test volume, spinal cord and lungs ranged from 0-1.6%, 0.7- 3% and 0- 1.2%, respectively.

Conclusions: Use of ivc when defining the GTV reduces the risk of underdosing the target in NSCLC, when using 3DCRT. An added benefit of using ivc is an increase in the potential for dose escalation through reduction in size of the GTV. If ivc scans are used directly for planning, and not just as reference images, the presence of contrast in the scans does not appear to have a major impact on the planning system calculations. However, this warrants further investigation before being used in planning calculations routinely.

774 POSTER

Stereotactic radiotherapy for lung cancer using gold grain radiomarker and/or active breathing control system

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Purpose: A stereotactic radiotherapy (SRT) for lung cancer is not easy due to its internal motion. To overcome this problem, we developed disposable gold grain radiomarker and active breathing control system. The purpose of this study is to investigate the usefulness of newly developed gold grain radiomarker for fluoroscopically invisible lesion and active breathing control(ABC) system.

Patients and Methods: Thirty-five patients with metastatic lung cancer (46 lesions) and 19 patients with primary lung cancer (21 lesions) have been treated with SRT since July 1997. To be sure to include the tumor movement due to respiration to planning target volume (PTV), every patients were examined by fluoroscopy and radio-opaque catheters of the same length of tumor movement were attached on the anterior and lateral chest wall before CT simulation. In the case of the tumor which was invisible by fluoroscopy, a gold grain was implanted into the tumor as a radiomarker. This is a very small gold grain with a size of 0.8 x 3mm which is charged in the tip of a sterile disposable long needle with mandril. In the present study, this gold grain radiomarker was used for seven patients. We mainly used a protocol of 60 Gy/8 fractions/2 weeks for the tumors near the mediastinum and pleura(19 lesions), and a protocol of 45 Gy/3 fractions/3-6days for the tumors in the central region of the lung(32 lesions). Respiration was held at a desired phase at which the tumor was irradiated, by the newly developed ABC system. Six patients were treated using this ABC system.

Results: Among 46 lesions of metastatic lung cancer, complete response (CR) was achieved in 37 lesions while 5 lesions had a partial response (PR) so far (1 NC and 3 unknown). All patients developed mild pneumonitis or lung fibrosis about 3 to 6 months after SRT just in the treatment volume. A gold grain was recognized by even linacgram. Internal organ motion was sufficiently suppressed by the ABC system, and the motion was ±1-1.5mm.

Conclusion: SRT to primary or metastatic lung cancer provided excellent local control without severe normal tissue damage so far. A gold grain was useful for fluoroscopically invisible lesion for radiotherapy planning and verification of actual irradiation field by finacgraphy. ABC system was also very useful for a tumor with large internal motion by respiration.

775 POSTER

Interstitial brachytherapy and external beam radiation in patients with locally advanced carcinomas of the head and neck

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Purpose: To evaluate the effect of interstitial high-dose-rate (HDR) brachytherapy followed by external beam radiation (Co 60 unit) for locally advanced as well as unresectable tumors of the head and neck.

Patients and Methods: Between 1989 and 1996, a total of 68 patients (13 females, 55 males) with squamous cell carcinomas of the head and neck were referred to our Department and consecutively irradiated with

a combination of a removeable Iridium 192 interstitial implant (15 Gy/5 Gy single dose/3x week) and external beam irradiation (77 Gy, range 60-85 Gy). Seventeen out of 68 (25%) patients underwent resection prior to radiation, however, surgery was microscopically complete only in 7 of them. Distribution according to UICC T1, T2 and T3+T4 showed 6 (9%), 13 (19%) and 49 (72%) patients. The mean age was 59 years (range, 39-88). Fifty-four (79%) patients presented with lymph node involvement. Afterloading technique was applied in 55 patients for the primary tumor, in case of unknown primary interstitial brachytherapy of the enlarged lymph nodes was performed. No patient showed up with distant metastases at time of first diagnosis.

Results: Only 16 (24%) patients had a locoregional recurrence after treatment. Combined radiation was successful in 52 (76%) cases. The overall 2-year survival was 32%, the disease free survival 45%, respectively. The mean follow-up time was 10.3 months, respectively, with a range of 1-96 months. We only observed acute side effects grade 1+2, but for delayed toxicity, 3 patients showed up with a fistula.

Conclusion: Interstitial HDR brachytherapy followed by external beam radiation is a safe and efficacious treatment combination and carries a small risk for complications.

776 POSTER

The interfractional three-dimensional reproducibility of a frameless stereotactic radiotherapy system

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Purpose: Fractionated stereotactic radiotherapy (FSRT) has two advantages: mechanical accuracy resulting from stereotaxy and a radiobiological advantage resulting from fractionation. The development of a relocatable frame and frameless system made FSRT possible and increased its popularity. However, there is debate over whether the setup accuracy of FSRT systems is comparable to that of stereotactic radiosurgery (SRS) systems. We evaluated the interfractional three-dimensional reproducibility of a frameless FSRT.

Materials and Methods: Between April 1999 and March 2001, we performed FSRT on 14 patients with various intracranial tumors using the pReference SRS system (NMPE, USA). Treatment was determined by the shape and volume of the tumor, and the location of critical organs. We chose multiple arc FSRT when the tumor was spherical or less than 3 cm in size, and conformal FSRT when the tumor was very irregular or larger than 4 cm. Using the program ISOLOC, we obtained three pieces of information: 1) the couch translations required to bring the target point to the isocenter, 2) the distance between stereotaxy markers in the CT study and the distance between the markers as determined from orthogonal beam films taken in the anterior-posterior and lateral directions, and 3) the rotational movement of the head position between the CT study and treatment. We evaluated two kinds of error: 1) the reproducibility of the isocenter in the interfraction, and 2) patient displacement in the a) translational and b) rotational components, using orthogonal films between the target coordinates and isocenter coordinates in the interfraction.

Results: The interfractional reproducibility of the isocenter relative to the planned treatment was $x = 0.0 \pm 0.3$ (mm), $y = 0.1 \pm 0.4$ (mm), and $z = 0.0 \pm 0.3$ (mm). The magnitude of patient displacement in interfractionation was less than 0.5 (mm) for the translational component and less than 1° for the rotational component.

Conclusions: The reproducibility of the interfraction on patient-displacement-induced translational and rotational error was in the acceptable range for FSRT. We believe that the setup accuracy of our FSRT system is comparable to that of a SRS system.

777 POSTER

CT-MR-SPECT fusion based on a vacuum-dental frame and its application in RT planning, -treatment and -follow-up

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Purpose: CT, MR and SPECT/PET data can offer important information in diagnosis, treatment and follow-up of tumors. While various methods of fusing CT and MRI have been developed and offer satisfactory results, the possibility of assigning functional information of SPECT/PET images to precisely defined anatomical structures remains a challenge. We present the relevance for radiotherapy of a simple, reliable, precise and non-invasive method of combining functional and anatomical modalities on a case report of a 52 year old woman with optic nerve meningeoma.

Materials and Method: 3D dataset acquisition is performed with a reference frame (SIPLab Innsbruck Frame) with 11 modality-specific markers in precisely defined positions. This frame is reproducibly connected to the Vogele Bale Hohner (VBH) vacuum- mouthpiece, which allows objectively identical repositioning of the frame with respect to the head. The desired 3D imaging modalities can then be manually (SPECT-CT/MR:paired-point matching) or automatically (CT/MR:voxel based) fused using commercially available planning software. The same vacuum MP can be used for reproducible head fixation during treatment.

Results: 21 patients have been treated and followed using the above method.

As an indicator of registration accuracy, the RMSE (root mean square error) of all 117 datsets registered via the external landmarks was 0.9 mm for CT-MR and 1.4 mm for SPECT-CT fusion. No measurable deviations occurred in automatically merged CT/MR datasets unless head position in the respective scanners differed greatly, requiring use of external markers for registration. Fusion per data-pair requires <5 minutes.

A representative pictorial case report of a 56 year old female with optic meningeoma, whose loss of functional activity (SPECT) of the tumor after 50 Gy corresponded with an impressive recovery of eyesight, is presented. Activity in the parasagittal frontal region with no CT/MRI correlate remains in observance during follow-up.

Conclusion: This method is a simple and accurate tool to combine 3D diagnosis, treatment planning, treatment and follow-up (as fourth dimension),all via a vacuum mouthpiece. In the scope of a unified approach in the treatment of cranial tumors at this institution, the same vacuum-MP and frame are used for frameless stereotactic biopsy and neurosurgery in select cases.

778 POSTER

Development of a new linac system combined with a self-moving CT and a single common couch

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Purpose: To evaluate the performance of our new linac system combined with a self moving gantry CT with a single common couch.

Materials and Methods: To carry out CT-guided frameless stereotactic irradiation(STI) precisely, we have developed a new linac system. We used a single common couch, and placed the linac on the opposite side of the CT which has a self moving gantry. When we turn the couch 180 degrees, the zero position of the CT corresponds to the isocenter of the linac. For CT, we used HiSpeed DX/i (GE Yokogawa Medical Systems, Tokyo,Japan). The diameter of gantry mouth is 70cm. Scan range is 180cm. To obtain CT images, the gantry moves along the rails instead of the couch moving into the gantry as in conventional CT. We can obtain information about the gantry position from the magnetic linear scale, which is parallel to the rails on which the gantry moves. The couch itself is made of carbon. It is 40cm wide, 210cm long, and has a maximum thickness of 10cm. It can be moved 320mm in the vertical direction, and 110mm in the lateral direction in the gantry mouth of the CT. We use this couch for both CT scanning and irradiation. For linac, we used EXL-15DP(Mitsubishi Electric, Tokyo, Japan). In daily treatment, we adjust the patient(couch) position by CT images, and can make set up error minimum. To assess the performance of this system, we evaluated the accuracy of the scanning position of the CT, the accuracy of the rotation of the couch. The accuracy of the scanning position of the CT is evaluated by obtaining the CT images of crosswire phantom. The accuracy of the rotation of the couch is evaluated with CCD camera and small acrylic ball.

Results: The error in the scanning position of the CT was within 0.3mm for each perpendicular directions. The difference between the CT origin and the linac isocenter according to the 180 degree turn of the couch was within 0.2mm for lateral and vertical directions.

Conclusion: The accuracy of this system is sufficient to carry out CT-guided frameless STI. We suggest that we can carry out frameless STI accurately and non-invasively with this system. And with this system, we can perform not only single fraction STI but also fractionated STI for any lesions in body. And this system is useful for quality assurance and adjusting of isocenter for intensity modurated radiation therapy and three dimensional conformal radiation therapy.