783 POSTER

## Intensity-modulated radiosurgery (IMRS) using the Nomos tomotherapy system: technique and analysis of treatment parameters

M. Fuss, B.J. Salter, J.M. Hevezi, T.S. Herman. *UTHSC at San Antonio, Radiation Oncology, San Antonio, TX, USA*

**Purpose:** Presentation of the capability of a tomotherapeutic IMRT system to deliver intensity-modulated radiosurgery (IMRS). Evaluation of core parameters that characterize dose conformity, steepness of dose gradient and dose inhomogeneity for IMRS treatment plans using an increasing number of couch angles and two pencil beam sizes.

**Material/Methods:** Treatment plans of patients, treated by IMRS for solitary and multiple brain lesions (AVMs and brain metastases)between 6/1998 and 2/2001, were recalculated using 1, 2, 4, 6 or 9 couch angles and two pencil beam sizes (0.4 and 0.8 cm). For the purpose of this analysis the prescription isodose was standardized to encompass 99% of the target volume. We calculated conformity and homogeneity indices and analyzed the impact of an increasing number of couch angles and smaller pencil beams on these parameters.

**Results:** An increasing number of couch angles resulted in more homogeneous dose distributions. The degree of conformity improved with increasing number of couch angles; more than four couch angles resulted in only minor further improvements. Choice of smaller pencil beams had major impact on dose homogeneity and low dose conformality; an advantage in high dose conformality was detected in complex shaped target volumes.

**Conclusion:** Tomotherapeutic IMRS using four couch angles and the 0.8 cm pencil beam width resulted in the majority of computed cases in an excellent dose distribution and has been chosen for most IMRS treatments in our institution. In selected cases a higher number of couch angles or choice of smaller pencil beams might provide better treatment plans.

784 POSTER

## The advantage of 3D conformal treatment planning in elective nodal irradiation for laryngopharyngeal carcinoma

D. Mileusnic, M. Dekic, V. Glavicic, M. Karabasevic, B. Pantic, G. Nisevic, D. Lalic. *Military Medical Academy, Department of Radiotherapy, Beograd, Yugoslavia*

**Purpose:** To investigate the potential of 3D conformal radiotherapy planning to achieve adequate dose delivery and sparing of noninvolved healthy tissue structures in elective nodal irradiation (ENI) for laryngopharyngeal carcinoma.

**Patients and Methods:** CT scans of twelve patients with T3-4, N0, M0 laryngopharyngeal carcinoma were acquired and transfered to treatment planning system. A conventional 2D treatment plan with two lateral parallel opposed fields with abuted low anterior radiation field and 3D five fields conformal radiotherapy plans were compared for each patient. The target volumes and uninvolved dose limiting structures were contured on axial CT slices throughout the volume of interest. Delineation of various neck node levels (I-V) was performed according to proposed guidelines. Dose of 65-70 Gy to the primary tumor (PTV-1) and 50 Gy to the elective subclinical regions (PTV-2) was delivered. The planning parameters for these volumes and the degree of parotid gland and spinal cord protection were evaluatwed for both treatment techniques. A comparision of plans and treatment techniques was assesessed using isodose distributions, dose statistics and dose volume hystograms (DVH).

**Results:** Comparing DVH and dose statistics for PTV-I, no significant differences were found between 2D and 3D planning techniques (maximum dose, minimum dose, the dose that 5% of the volume receives and the dose that 95% of the volume receives). The apparent size of PTV-2 was underestimated with conventional 2D planning method relative to the 3D method.The dose conformity observed with 3D techniques was increased compared with that observed with 2D techniques which delivers unecessary radiation doses to the uninvolved structures. Dose volume analysis and statistics of 3D techniques showed that this approach provide significant reduction in the irradiated volume of parotid and spinal cord tissue as compared with 2D techniques.

**Conclusion:** Using 3D conformal radiotherapy techniques, satisfactory dose delivery to involved tissue (PTV) and efficient protection of normal tissue can be achieved with improve dose volume characteristics over conventional 2D treatment designs.

785 POSTER

## New prototype of mechanical quality assurance sheet for clinical linear accelerator

K.C. Shin[1], K.H. Kim[2], Y.K. Oh[3], J.K. Kim[4], H.G. Yun[1]. [1] *Dankook University Hospital, Therapeutic Radiology, Cheonan, Korea;* [2] *Chungnam Nat. University Hospital, Therapeutic Radiology, Taejon, Korea;* [3] *Kyungpook Nat. University Hospital, Radiation Oncology, Tagku, Korea;* [4] *Chonbuk Nat. University Hospital, Therapeutic Radiology, Chonju, Korea*

**Purpose:** In recent years, radiotherapy equipment has become much more sophisticated, and with the sophistication comes an increased set of quality assurance (QA) responsibilities. More linear accelerators are computer controlled, requiring QA of not only radiation integrity, but also of the mechanical accuracy of the linear accelerator. The existing QA sheets are adequate for acceptance testing and commissioning but those sheets are somewhat descriptive form for routine QA. We are going to develop new prototype of mechanical QA sheet to visualize and to verify long-term stability of mechanical QA for clinical linear accelerator.

**Materials and Methods:** The items included in mechanical QA sheet were 1) gantry rotation, 2) collimator rotation, 3) couch rotation, 4) optical distance indicator(ODI), and 5) laser alignment. We compared new prototype sheet with conventional sheet for several hospitals in Korea for those items. The QA acceptance criterion in this study follows almost all published recommendations. The contents of test for mechanical QA are the following. 1) The confirmations with the digital and/or mechanical gantry angle readouts are correct. 2) Verification of the digital and/or mechanical readouts of collimator angle identifying the true angle, as determined with the spirit level. 3) Measurement of the light field using a graph paper and compare with the digital readouts. 4) Confirmation of digital readout accuracy. 5) Verification of the sagittal laser, the left and right lasers, and the ceiling laser intersect at the isocenter. In the design of new QA sheet, we emphasized the representation of the visualization of QA result and long-term stability of mechanical QA by using excel program.

**Results and conclusions:** In the mechanical QA process, we think establishing the visualized QA sheets with estimating the long-term stability for the result of QA for a facility are more efficient.

786 POSTER

## Electron beam chest wall irradiation after mastectomy due to breast cancer

E. Gez[1], N. Assaf[1], R. Bar Deroma[1], E. Rosenblat[1], M. Stien[1], A. Beny[1], G. Frid[1], J. Zidan[2], A. Kuten[1]. [1] *Rambam, Oncology, Haifa, Israel;* [2] *Sieff, Oncology, Safed, Israel*

**Aim:** to evaluate the efficacy and toxicity of electron chest wall irradiation after mastectomy due to breast cancer. Pts with the following criteria were included: tumor size > 4 cm, more than 3 lymph nodes involved or extracapsular extension, close or positive surgical margin and skin involvement.

**Patients and Treatment:** 1980-1993, 148 pts received local radiotherapy. 72% received adjuvant chemotherapy and 55% adjuvant hormonotherapy. Tumor size was T2 in 51% of pts, T3 in 30% and T4 in 10%. Axillary lymph nodes were metastatic in 80% and surgical margin was involved in 50% of pts. Radiation therapy included: chest wall and internal mammary irradiation by electron field and axilla and supraclavicular lymph nodes areas by photon field. The total dose to the chest wall and regional lymph nodes was 50Gy.43 pts received a median 16Gy boost to the scar.

**Results:** local-regional recurrence occurred in 15 of 144 evaluated pts (10%): 11 in chest wall and 4 in the axilla and supraclavicular areas. Median time to recurrence since surgery was 20 months. In 11 of the 15 pts there was late systemic relapse. Tumor size and lymph nodes status influenced the local recurrence. Local recurrence in T1 and T2 was 6% versus 18% in T3 and T4 (p=0.029). No local recurrence in 28 pts with N0. Systemic relapse occurred in 40% of pts with median time of 33 months since surgery (range 6-176). Sites of metastases were skeletal bones in 65% of pts, lungs in 3%, liver in 25% and brain in 9%. Only lymph nodes status affected the systemic relapse rate. 45% relapse rate in 104 pts with N1 versus 14% in 28 pts with N0 disease (p=0.002). Disease-free and overall survival were: 68% and 80% in 5 years, 58% and 67% in 10 years and 50% and 55% in 20 years. Treatment was well tolerated and late toxicity included lungs fibrosis in 20 pts (14%), but only 4 pts were symptomatic and required treatment.5 pts suffered from a cardiac event as follows: CHF 3 pts, IHD 1 and cardiomiopathy 1. Other side effects were: bone fraction 1 pt, lymphedema 10, brachyplexopathy 2, fibrosis/telengectasia and pigmentation in 21 pts.

**In conclusion:** electron chest walls irradiation after mastectomy due to breast cancer is an effective and tolerated treatment. The results are

comparable with photon chest wall irradiation. Electron chest wall irradiation is relatively simple and safe and therefore is recommended.

787 POSTER

## An effectiveness evaluation of simplified hemibody irradiation

L. Miszczyk[1], W. Sasiadek[2]. [1] *Centre of Oncology, M. Sklodowska-Curie memorial Institute, Radiotherapy Department, Gliwice, Poland;* [2] *Centre of Oncology, M. Sklodowska-Curie memorial Institute, Radiotherapy Department, Gliwice, Poland*

**Aim of the study:** Assessing of simplified hemibody irradiation (HBI) technique as a palliative treatment of patient with multiple, painful bone metastases.

**Material and method:** The material comprised 23 patients with multiple painful bone metastases (25 cases of HBI). In no one case bone metastases in skull and distal part of limbs were found, so these parts of the body were excluded from irradiated field. All patients were irradiated using 6 MV photons from two opposite AP_PA fields. The dose of 6 Gy was delivered for UHBI and 8 Gy for LHBI. No tissue density corrections were considered and no shields were used. The degree of pain relief and performance status improvement was assessed one and two months after treatment, depending on clinical and histopathological diagnosis and type of bone metastases. The dependencies between degree of pain relief, performance status and different biological and technical factors were checked.

**Results:** The biggest mean degree of pain relief (100%) was obtained in the cases of multiple myelomas, prostate cancers (78%) and lung cancers (88%). Taking into account histopathological diagnosis, the best answer has been found in multiple myeloma and squamous cell cancer (88%). The difference between degrees of pain relief for types of metastases also was found (65% for osteolitic vs. 50% for osteoclerotic metastases). No difference between UHBI and LHBI was found. The statistically significant correlation between pain relief, performance status improvement and decrease of analgetics use was found.

**Conclusion:** The obtained results suggest that presented simplified HBI is an effective treatment modality for patients with multiple painful bone metastases, giving an in

788 POSTER

## Nonoperative treatment for locally advanced esophageal carcinoma

O. Bondarouk. *Institute of Oncology, Kiev, Ukraine*

**Introduction:** Radiotherapy is one of the most widespread methods for treatment of locally advanced esophageal carcinoma. The purpose of this study was the comparison of different radiotherapy regimens.

**Materials and Methods:** 152 cases of squamous cell carcinoma arising from the cervical and thoracic esophagus (stage II–IV) were treated by radiation therapy at the institute. All patients were divided into 4 subgroups according to the treatment policy. 1st group of 46 patients was treated by external beam radiotherapy (EBRT) to a dose 30 Gy/15 fractions/3 weeks. After 2 weeks rest they continued to receive treatment with $^{60}$Co-HDR intracavity brachytherapy (IBT) to a dose 15–20 Gy delivered in 3–4 sessions of 5 Gy each week apart. Simultaneously these patients got EBRT to a dose 20 Gy/10 fractions/2.5 weeks. 2nd group of 41 patients was treated by EBRT to a dose 30 Gy/5 Gy per fraction/6 fractions per week. IBT was provided in 2–3 days after EBRT. The average dose delivered by IBT (Selectron, source $^{137}$Cs, pellets LDR-MDR) was 15 Gy; the dose per fraction was 5 Gy twice per week. The dose was calculated at 0.5 cm below esophageal mucosa at both groups. In the 3rd group (29) the $^{137}$Cs-IBT to dose 15 Gy/3 fractions was provided in two weeks after EBRT dose 40–45 Gy/19–21 fractions/4–4.5 weeks. For 36 patients of 4th group EBRT alone was done to a dose of 51–54 Gy/17–18 fractions/3.5 weeks.

**Results:** There was remarkable increase to the end of the 1st year in relief of dysphagia and local control in groups with IBT. The level of benign radiation-induced esophageal ulceration's and strictures was maximum in 2nd group. The survival rate from all groups is represented in the table.

| | EBRT + IBT1 ($^{60}$Co) 46 | EBRT + IBT2 ($^{137}$Cs) 41 | EBRT + IBT3 ($^{137}$Cs) 19 | EBRT 36 |
|---|---|---|---|---|
| 1-y | 72.73 ± 6.2% | 69.23 ± 5.1% | 57.89 ± 5.3% | 36.11 ± 5.1% |
| 3-y | 27.23 ± 5.7% | 11.54 ± 5.8% | 15.79 ± 4.3% | 8.33 ± 4.1% |
| 5-y | 19.57 ± 4.2% | 7.32 ± 4.4% | 5.26 ± 3.6% | 4.11 ± 2.7% |

**Conclusion:** Use of HDR-brachytherapy combined with traditional fractionated is the most preferable from investigated regimens.

789 POSTER

## The virtual simulation process

L. Fariselli[1], M. Fumagalli[1], M. Mapelli[1], N. Sagaria[1], L. Gimosti[1], G. Corradino[1], I. Milanesi[1], R. Pellegrini[2]. [1] *National Neurological Institute "Carlo Besta", Radiotherapy Department, Milano, Italy;* [2] *3DLine International srl, Milano, Italy*

**Introduction:** The Virtual Simulation (VS) is a modern technique allowing the definition of the anatomical contours of the region to treat and the simulation of the fields of the radiotherapic treatment. Once the CT and/or NMR images have been acquired, the Virtual Simulation software gives a three-dimensional view of the anatomy of the patient and allows the definition of the optimal characteristics of the treatment beams in relation to the anatomical structures of the patient, thus substituting the traditional simulator image.

**Methods:** During the acquisition of the CT scans a correct posistioning and immobilization of the patient is necessary, in order to riproduce it durino the treatment session. During the treatment planning session the contours are drawn onto the CT scans for the target volume and the organs at risk, according to the ICRU 62 recommendations. The software allows the visualization of the patient anatomy from the point of view of the radiation source (Beam's Eye View, BEV); this is essential in order to draw the area shielded by blocks or the multileaf collimator, thus conforming the radiation field. The treatment plan will then be completed with all the necessary dosimetric considerations and the final 2D and 3D dose distributions. Once the isocenter position is decided, the isocenter point is projected onto the patient skin by means of a system of lasers driven by the simulation software of the CT device, and a CT slice is acquired in correspondence of this point to minimize the geometrical set-up uncertainties. One very important feature of the Virtual Simulation Software is the elaboration of the Digitally Reconstructed Radiograph (DRR): this is a 2D radiographic image obtained by the elaboration of the volumetric data coming from the acquired CT scans. The DRR presents the exact geometrical perspective of the radiation source; thus on the DRR the exact dimension of the field edge is visualized together with the used shaping devices (MLC, blocks, mantles), the projection of the target volumes and of the organs at risk.

**Purpose:** This allows the user to perform a comparison between the field defined during the planning and the effectively supplied field visualized on the portal image.

**Results:** In our Clinical Center, not having at our disposal an Electronic Portal Imaging Device, we have studied and realized a software to print the DRR image on radiographic film, thus also offering a further permanent documentation. It is now possible to compare the shape of the radiation field (◇=0 mm)and the geometrical alignment between the DRR reference image and the portal image obtained during the treatment (◇ lateral beam=1.9 ± 1.9 mm), (◇ anterior beam =1 ± 1 mm).

**Conclusion:** The DRRs furthermore offer the possibility to realize a patient coordinate system by means of anatomical markers. As the spatial resolution of a DRR is limited by the voxel dimension of the original CT slices, dimensions not greater than 5 mm are more suitable to get a better identification the anatomical structures. The comparison with the DRR becomes unavoidable in the case of complex conformal treatments with a multileaf collimator, as in our case where a Dynamic Micro-Multileaf Collimator is used for the treatment of head lesions.

790 POSTER

## An opportunity for therapeutic index improvements in conservative therapy of early breast carcinoma

V. Paravanova[1], A. Klenova[2], V. Pandova[3]. [1] *National cancer center, of radiotherapy, sofia, Bulgaria;* [2] *cancer center, of radiotherapy, sofia, Bulgaria;* [3] *cancer center, of radiotherapy, sofia, Bulgaria*

**Purpose:** Studying the opportunity for the therapeutic index improvement in the follow directions: providing local tumour control by applying the dose of 50 Gy; and limiting the irradiation to the normal tissues.

**Material and method:** 190 patients with early breast cancer T1-2 (up to 3 cm) NO-1 MO were treated in the National Oncological Center and evaluated in two groups of case - control. In the group with coservative treatment (BCT) 122 patients were treated with postoperative radiotherapy after preserving surgery by "negative" margin between 1992 and 1997. The group-control contains 68 patients, whom was applied a radical modified mastectomy - Patey (M) between 1978-1986. The radiotherapy in N+