and were administered at a rate of 2 ml/min. Groups of three animals each received one of three doses ranging from 150 μ Ci to 400 μ Ci intended to deliver 50, 100 or 150 Gy. An external magnetic field was focused on the tumor throughout the infusion and for 15 min following treatment to localize the microparticles to the area of interest. Radioactivity was measured in blood collected 30 min and 1 hr after dosing. Biodistribution of ^{90}Y in the liver, lung, spleen, and bone was evaluated in three rabbits >24 hr after treatment. Remaining animals were recovered and kept for 7 days. Prior to necropsy and subsequent histopathological examination, animals were evaluated by CT to measure tumor size and MRI for particle localization. No embolization or adverse clinical signs were associated with magnetic targeted delivery of MTC-^{90}Y. Blood levels of radioactivity were ≤ 1% of ^{90}Y administered and decreased between 30 min and 1 hr. Organ levels of radioactivity measured >24 hr post-dosing showed the majority of the intra-arterially administered ^{90}Y was localized in the liver with magnetic targeting. MRI performed 7 days after treatment showed the presence of the iron component of the MTC particles primarily in the liver tumors. Microscopic examination of tissue showed the presence of particles confined to the liver. Liver necrosis was greater in treated animals (≥ 70% necrosis) as compared to controls (50% necrosis). The highest dose resulted in complete destruction of the tumor as well as the underlying liver parenchyma, but it was limited to the left tumor-bearing lobe. This study suggests the feasibility of intra-tumoral radiotherapy using magnetic targeting and provides the foundation for additional investigations.

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Treatment margins and treatment fractionation in conformal radiotherapy of muscle-invading urinary bladder cancer

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Background: The size of daily doses and treatment margins varies greatly in conformal radiotherapy (CRT) of urinary bladder cancer. In this planning study dose-volume histogram (DVH) data and normal tissue complication probability (NTCP) predictions for intestine and rectum were compared for different combinations of clinically applied margin widths and fractionation schedules in bladder irradiation.

Material and Methods: Normal tissue dose distributions in fifteen bladder cancer patients treated with radical CRT were studied retrospectively, using standard three-field (Ant/Laterals) and four-field (Ant/Post/Laterals) beam configurations as model set-ups. The impact of margin width on the normal tissue dose distribution was initially evaluated using DVH data. NTCP modelling was used to compare the impact of choice of margin size and fractionation schedule. The analysis included CTV-PTV margin combinations of 1.0 cm isotropic (narrow margins) and 1.2-2.0 cm non-isotropic (wide margins) and fractionation schedule alternatives of 52.5 Gy/20, 55 Gy/20, 57.5 Gy/20 and 64 Gy/32.

Results: Using wide margins, the volumes of intestine and rectum receiving high doses increased by factors of approximately two and four, respectively, compared to using narrow margins. Similar factors between wide and narrow margins were also found for intestine and rectum NTCPs at the different fractionation alternatives, but the impact of margin size depended on the volume effect expressed by the NTCP model parameters. However, using standard NTCP parameters, the choice of margins and fractionation schedule had a similar impact on intestine NTCP predictions, while for the rectum, the choice of margin had a greater impact than the choice of fractionation. For a given choice of margin, the intestine and rectum NTCP predictions using 55 Gy/20 and 64 Gy/32 fractionation schedules were comparable. For clinics using narrow margins and a fractionation of 52.5 Gy/20, the NTCP modelling suggested that a moderate dose escalation (to 55 Gy/20 or 64 Gy/32) or changing to wide margins had a similar effect on the intestine and rectum NTCP predictions.

Conclusion: This modelling study of bladder irradiation suggested that the choice of margins was as important as the choice of fractionation in terms of intestine and rectum DVH parameters and NTCP predictions. The 55 Gy/20 and 64 Gy/32 fractionation schedules appeared to be comparable in terms of intestine and rectum NTCP predictions.

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Evaluation of cyberknife frameless real-time image-guided stereotactic radiosurgery for spinal lesions

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Background: The role of stereotactic radiosurgery for the treatment of intracranial lesions is well established. Its use for the treatment of spinal lesions has been limited by the availability of effective target immobilization devices. Conventional external beam radiotherapy lacks the precision to allow delivery of large doses of radiation near radiosensitive structures such as the spinal cord. This study evaluated a new image-guided frameless stereotactic radiosurgery delivery system known as the CyberKnife (Accuray, Inc., Sunnyvale, CA) for the treatment of spinal lesions with a single fraction radiosurgical technique.

Materials and Methods: This frameless image-guided radiosurgery system utilizes the coupling of an orthogonal pair of x-ray cameras to a dynamically manipulated robot-mounted 6-MV linear accelerator capable of six degrees of freedom that guides the therapy beam to the intended target without the use of frame-based fixation. Real-time image tracking allows for the tracking of patient movement with a 1-mm spatial accuracy. In this prospective cohort evaluation of a spine radiosurgery technique, 125 spinal lesions in 95 patients were treated with single fraction radiosurgery (45 cervical, 30 thoracic, 36 lumbar, and 14 sacral). There were 17 benign tumors and 108 metastatic lesions. Seventy-eight lesions had received prior external beam irradiation with maximum spinal cord doses. Cervical spine lesions were located and tracked relative to skull osseous landmarks; lower spinal lesions were tracked relative to percutaneously placed gold or stainless steal fiducial bone markers. All dose plans were calculated based upon CT images acquired using 1.25 mm slices. Planning treatment volume (PTV) was defined as the radiographic tumor volume with no margin.

Results: Tumor dose was maintained at 10-20 Gy to the 80% isodose line (mean 14 Gy). The maximum intratumoral dose ranged from 12.5 to 25 Gy (mean 17.5 Gy). Tumor volume ranged from 0.3 to 232 cc (mean 27.8 cc). The spinal canal volume receiving greater than 8 Gy ranged from 0.0 to 1.7 cc (mean 0.2 cc). Film dose measurement in a phantom demonstrated alignment of the treatment dose with the target volume to be within 1 mm. End-to-end tests revealed the planned dose never deviated more than 5% from the measured dose. Clinically, no acute radiation toxicity or new neurological deficits occurred during the follow-up period 3 24 mos (mean 12 mos).

Conclusions: Spinal stereotactic radiosurgery using a frameless image-guided system was found to be feasible, safe, and accurate. The major potential benefits of radiosurgical ablation of spinal lesions are short treatment time in an outpatient setting with rapid recovery and symptomatic response. This technique offers a successful alternative therapeutic modality for the treatment of a variety of spinal lesions not amenable to open surgical techniques, in medically inoperable patients, lesions located in previously irradiated sites, or as an adjunct to surgery.

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High-dose rate versus low-dose rate intracavitary radiotherapy in the treatment of cervical carcinoma: a meta-analysis

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Background: Controversy still persists regarding the clinical efficacy of high dose rate (HDR) intracavitary radiotherapy (ICR), which was introduced in early 1960s, compared with conventional low dose rate (LDR) ICR in the treatment of cervical carcinoma. We performed meta-analysis to determine the effectiveness of HDR ICR compared to LDR ICR for overall survival, disease free survival, local recurrence, and complication rate of rectum and bladder in the treatment of cervical carcinoma.

Materials and Methods: We reviewed the literatures identified in searches of the Medline database, CancerLit database and the reference lists of the located articles from 1966 to Sep 2002 reporting treatment results of HDR and LDR ICR for cervical cancer. Fourteen published articles (3 prospective randomized trials and 11 retrospective studies) were selected by qualitative meta-analysis using inclusion and exclusion criteria for quantitative meta-analysis. The effective size (odds ratio) was obtained to compare 5-year overall survival, 5-year disease free survival, local recur-