Maximum intensity projection (MIP) image was generated. ITVs of the primary tumour were delineated using three methods as following:
- the GTVs on each of the ten respiratory phases were delineated and fused ten GTV to produce ITV_{10};
- the GTV delineated separately based on 0% and 50% phase were fused to produce ITV_{IN+EX}
- the visible tumour on the MIP images were delineated to produce ITV_{MIP}.

Twenty patients were divided into A group and B group based on the location of the target center and were divided into C group and D group based on the tumour D, the patients were divided into E group and F group based on the 3D motion vector of the target center. The position of the target center, the volume of target, the degree of inclusion (DI) and the matching index (MI) were compared reciprocally between ITV_{10}, ITV_{IN+EX} and ITV_{MIP}, and the influence of the tumour position and 3D motion vector on the relative parameters were compared based on the grouping.

Results: The volume of ITV_{10} was larger than that of ITV_{IN+EX}, and the volume of ITV_{10} was larger than that of ITV_{MIP}, but the differences were not statistically significant. DI of ITV_{IN+EX} in ITV_{10}, ITV_{MIP} in ITV_{10} were (74.85±15.09)% and (68.87±13.69)%. MI between ITV_{10} and ITV_{IN+EX}, ITV_{10} and ITV_{MIP} were 0.75±0.15, 0.67±0.13, respectively. The median of ratio of ITV_{IN+EX}/ITV_{10} was 0.57 in group A versus 0.87 in group B, the difference between group A and group B was statistically significant ($P = 0.001$). The median of ratio of ITV_{MIP}/ITV_{10} were 0.51 in group A versus 0.72 in group B, the difference between group A and group B was statistically significant ($P = 0.001$). The median of ratio of ITV_{IN+EX}/ITV_{10} was 0.79 in group C versus 0.74 in group D, with no statistically significant difference ($P = 0.358$). The median of ratio of ITV_{IN+EX}/ITV_{10} was 0.87 in group E versus 0.68 in group F, the difference between group E and group F was statistically significant ($P = 0.004$).

Conclusions: The center displacement of the ITVs delineated separately by the three different techniques based on 4D-CT images are not obvious; ITV_{IN+EX} and ITV_{MIP} can not replace ITV_{10}, however, ITV_{IN+EX} is more close to ITV_{10} comparing to ITV_{MIP}. The ratio of ITV_{10} and ITV_{MIP} is correlated to the 3D motion vector of the tumour. When the tumour in the upper part of the liver and with a 3D motion vector less than 9 mm, ITV_{10} should be the ideal ITV.

6538 POSTER

Comparison of the Different Planning Targets Defined Basing on Three-dimensional CT and Four-dimensional CT Images for Liver Cancer

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Background: To compare positional and volumetric differences of planning target volumes (PTVs) based on axial three-dimensional CT (3D-CT) and four-dimensional CT (4D-CT) for liver cancer.

Materials and Methods: Fourteen patients with liver cancer suitable for three-dimensional conformal radiotherapy (3D-CRT) underwent axial 3D-CT and 4D-CT simulation scans of the upper abdomen during normal breathing. Three internal target volumes (ITVs) were produced based on the clinical target volume from 3D-CT (CTV_{3D}) (The GTV to CTV margin was defined as 10 mm): A conventional ITV (ITV_{conv}) was produced by adding 10 mm in superior-inferior direction and 5 mm in left-right and anterior-posterior directions to CTV_{3D}; A specific ITV (ITV_{spec}) was created using a specific margin in transaxial direction; ITV_{vector} was produced by adding a isotropic margin derived from 3D motion vector of the tumour. ITV_{4D} was defined on the fusion of CTVs on all phases of 4D-CT. Finally,PTV_{conv}, PTV_{spec}, PTV_{vector} and PTV_{4D} were generated by adding a 5 mm setup margin to ITVs. The differences in target position, volume and degree of inclusion (DI) among PTVs were evaluated respectively. The definition of DI of volume X included in volume Y [DI(X in Y)] is the percentage of the overlap between volume X and Y in volume X.

Results: Average differences between PTVs from 3D-CT (3D PTV) and PTV_{4D} in transaxial direction were less than 1 mm, with no statistically significant difference. Comparing PTV_{4D} to PTV_{conv}, PTV_{spec}, PTV_{vector} resulted in a decrease in volume sizes by 32.27%, 24.95%, 48.08% on average. The mean degree of inclusion (ID) of PTV_{4D} in PTV_{conv}, PTV_{spec}, PTV_{vector} was 0.98, 0.97, 0.99; while the mean ID of PTV_{conv}, PTV_{spec}, PTV_{vector} in PTV_{4D} was 0.66, 0.73, 0.52 respectively.

Conclusion: The center displacement of PTVs derived from 3D-CT and 4D-CT are not obvious. The size of patient-specific PTV based on 4D-CT is less than those of 3D PTVs. The treatment plans based on 3D PTVs would result in more normal tissues being necessarily irradiated. 3D PTVs generated using anisotropic expansions contribute to reducing the size of normal tissues, but a geometric miss should be focused on.

6539 POSTER

Radiotherapy of Anal Carcinoma − Outcome in an Unselected National Cohort

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Background: This study presents treatment results in a large unselected national cohort. The purpose was to evaluate our treatment results, elucidate whether national guidelines were followed, and identify areas demanding further treatment optimization.

Materials and Methods: In Norway, between July 2000 and June 2007, a total of 328 patients were treated with curatively intended (chemo)radiotherapy for squamous cell carcinoma in the anal region, according to national treatment guidelines based on tumour stage. The median age was 63 years (range 33−91), 72% were females. T stage distribution: T1 12%, T2 40%, T3 22% and T4 26%. Regional lymph node metastases were present in 35%, and inguinal lymph node metastases in 21%, no patients with distant metastases were included.

Results: Complete response after (chemo)radiotherapy was obtained in 286 (87%) patients. After salvage surgery, a total of 306 (93%) patients achieved primary locoregional control. Eighteen (43%) patients with residual tumour did not receive salvage surgery, mainly due to frailty and comorbidity.

The 3-year rate of recurrence-free survival (RFS) was 79%. Recurrence occurred in 73 (24%) patients after a median follow-up of 49 months. Locoregional recurrences were predominant, occurring in 56 (18%) patients, most commonly in the primary tumour site. Despite receiving radiation to the groins according to guidelines, 10 (3%) patients had recurrence in inguinal lymph nodes. Eleven of 20 patients initially salvaged due to residual tumour, recurred during follow-up. Treatment of recurrence had curative intent in 33 (45%) patients.

At the time of analysis, 111 of 328 patients were dead, 68 due to anal cancer. The 3-year rates for overall survival and cancer specific survival (CSS) were 79% and 84%, respectively.

The risk of adverse outcome increased significantly with more locally advanced tumours and in male gender in both uni- and multivariate analyses for RFS and CSS.

Conclusions: This study reports the outcome in an unselected national seven years cohort. Treatment results after (chemo)radiotherapy is satisfactory for patients with early-stage tumours. Still, it is essential to improve results for patients with locally advanced disease, in particular measures to reduce the rate of locoregional recurrence. Male gender as a potential risk factor for inferior outcome requires further investigation.

6540 POSTER

The Impacts of Intraoperative Radiotherapy With Image-guided Enzyme Targeting Radiosensitization (KORTUC-IORT) for Stage IVa Pancreatic Cancer

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Background: Based on our experimental results that demonstrated hydrogen peroxide to be a strong radiosensitizer in a highly radioresistant osteosarcoma cell line, we developed a new radiosensitizer injection technique in which hydrogen peroxide and sodium hyaluronate are injected immediately prior to intraoperative radiotherapy (IORT) for advanced pancreatic cancer, named KORTUC-IORT (Kochi Oxydol-Radiation Therapy for Unresectable Carcinomas + IORT). The purpose of this study was to evaluate the safety and efficacy of KORTUC-IORT in pancreatic cancer patients.

Patients and Methods: Twelve patients with stage IVa locally advanced pancreatic cancer were enrolled in the KORTUC-IORT trial after providing fully informed consent. They were treated with KORTUC-IORT, external-beam radiotherapy (EBRT), and systemic chemotherapy. KORTUC-IORT involved injection of a maximum of 9 ml of solution into tumour tissue just prior to administration of IORT under ultrasonic guidance. The solution is composed of 0.5% hydrogen peroxide and 0.83% sodium hyaluronate. For IORT, tumours were irradiated at a dose of 25 Gy in a single fraction with a 12 or 15 MeV electron beam; no tumour resection was performed. For EBRT, patients received radiation to the abdomen 5 times a week at a dose of 2 Gy/day in 15 fractions (total dose: 30 Gy) with a 10 MV x-ray. Chemotherapy was initiated at the same time as EBRT, and was continued for as long as possible. Gemcitabine hydrochloride was given intravenously

at a dose of 300 mg/body once per week, with an occasional rest week during EBRT, and at a dose of 1000 mg/m^2 every 3 weeks after EBRT was completed. For evaluation of efficacy and safety, all patients were examined at regularly scheduled follow-up visits. Medical examinations were performed every month. Contrast-enhanced computed tomography was also performed at pre-treatment, and at 1 month and 6 months after KORTUC-IORT.
Results: All treatments, including KORTUC-IORT, were well tolerated in all patients, with few adverse effects. No severe complications were experienced. The follow-up period for all patients ranged from 5 to 29 months; the 1-year survival rate of them was 67%, and the median survival period was 15 months.
Conclusions: We performed this study based on our experimental data indicating that hydrogen peroxide is a potent radiation sensitizer, and showed that the present formulation can be delivered safely and effectively under the conditions used.

6541 POSTER

Gradient-based Delineation of the Primary GTV on FLT-PET in Esophageal Cancer and the Influence on Radiotherapy Planning

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Background: The aim of this study was to validate a gradient-based segmentation method for GTV delineation on FLT-PET in EC through surgical specimen, in comparison with threshold-based approaches and CT. Discuss the influences of gradient-based methods delineate the primary GTV to radiotherapy planning.
Materials and Methods: Ten patients with esophageal carcinoma treated with radical surgery were enrolled and detected by ^{18}F-FLT PET/CT before operation transferred the images to MIM software. For each patient, four GTVs were defined. GTV-ct was based on CT data alone. GTV-$_{GRAD}$, GTV-$_{1.4}$, GTV-$_{30\%max}$ were automatically segmented on PET images using the gradient-based method, fixed threshold values at 1.4 and 30% of SUV_{max}, respectively. The GTV-$_{GRAD}$, GTV-$_{1.4}$, GTV-$_{30\%max}$ were compared with GTV-$_{CT}$ by overlap index. Lengths of GTVs were recorded as L_{CT}, L_{GRAD}, $L_{1.4}$, $L_{30\%max}$, respectively. The length of surgical specimen was recorded as $L_{Path,}$ and compared with L_{CT}, L_{GRAD}, $L_{1.4}$, $L_{30\%max}$. Next, two radiotherapy plans were designed for each patient based on GTV-$_{GRAD}$ (plan-$_{GRAD}$) and GTV-$_{CT}$ (plan-$_{CT}$). The radiation dose was prescribed as 60 Gy in 30 fractions. The dose-volume parameters of target volume and normal tissues, CI and HI of plan-$_{GRAD}$ and plan-$_{CT}$ were compared.
Results: The mean L_{Path} was 6.47±2.7. The mean L_{ct}, L_{GRAD}, $L_{1.4}$ and $L_{30\%max}$ were 7.17±2.28, 6.22±2.61, 6.23±2.80, 5.95±2.5. The correlation coefficients were 0.862, 0.989, 0.920 and 0.920 when compared with L_{Path}, respectively. The overlap index of GTV-$_{GRAD}$, GTV-$_{1.4}$, GTV-$_{30\%max}$ when compared with GTV-$_{CT}$ were 0.75±0.12, 0.71±0.12, 0.57±0.10. The values for mean lung dose, total-lung volume receiving more than 5, 10, 20, and 30 Gy, mean heart dose and heart volume receiving more than 30 Gy of plan-$_{GRAD}$ were significant lower than plan-$_{CT.}$
Conclusions: The gradient-based method provided the closest estimation of GTV length. The gradient-based method radiotherapy planning reduced the irradiated volume in the lung, heart and other normal tissues.

6542 POSTER

Phase I/II Study of Scheduled Interval Transarterial Chemoembolization Followed by Radiation Therapy for the Patients With Hepatocellular Carcinoma

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Background: We designed this phase I/II study to evaluate the safety and efficacy of the scheduled interval transarterial chemoembolization (TACE) followed by radiation therapy (RT) in the patients with unresectable hepatocellular carcinoma (HCC).
Materials and Methods: Patients with HCC, not suitable for standard therapies, were enrolled for scheduled interval TACE followed by RT (START). Between February 2008 and December 2009, 84 patients were enrolled. The patients who were enrolled in this study, received TACE on the first day of treatment, and then 3-dimensional conformal RT was delivered after 14 days. If the results of liver function test at simulation day (7th day after TACE) were not good enough, one week delayed RT was planned. The overall time of this whole treatment was taken almost in 4 to 5 weeks. Total RT dose and fractionation size were decided by the irradiated normal liver volume.
Results: In 81 patients (96.4%) were completed the START in planned treatment period. Delayed RT was administered to the other 3 patients because of decreased liver function or performance status after TACE. Of the 81 patients, complete response (CR) was appeared in 7 patients (8.6%), and 50 patients (61.7%) had a partial response (PR). Although one unexpected death was observed after START because of icteric hepatic failure, the other toxicity was quite tolerable. The median survival was 14.7 months. According to the response of START, there was a significant difference in overall survival rate ($p < 0.0001$).
Conclusions: START showed comparable response and survival. And the toxicity was quite tolerable.

6543 POSTER

Radiotherapy Prolongs Survival in Locally Advanced, Inoperable Gastric Cancer

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Background: Usually, in locally advanced, inoperable gastric cancer (LAIGC) radiotherapy (RT) is only indicated in cases of progressing malignant obstruction. Considering high risk of local/regional progression and poor survival of these patients, we supposed, that addition of RT to the treatment may be beneficial.
Materials and Methods: From November 1998 to August 2007 external beam conventionally fractionated RT was used for patients with LAIGC after explorative surgery or confirmation of medical inoperability. Initially, two parallel-opposed radiation fields covering primary tumour and lymphatics were applied to total 40 Gy, than boost 20 Gy to initial tumour with 3−5 isocentric fields was delivered. In 4−6 weeks after completing RT, patients were assigned to 2−6 courses preferentially platinum-containing chemotherapy (CT). Historical controls consisted of patients with LAIGC undergone CT during the same period. Overall survival calculated using Kaplan–Meier method with log-rank test was established as primary end-point, and multivariate analysis using Cox proportional regression was done to analyze factors influencing survival.
Results: Overall 110 patients were assigned to RT/CT and 32 patients received CT only. Groups were well balanced on gender, age, initial T-stage (92% T3−4), ECOG and Charlson score. Exploratory surgery and N+ stage were more frequent in CT group − 69% vs 33% (Pearson 2-sided chi-square test, $p = 0.001$) and 55% vs 26% ($p = 0.006$) respectively. At least 40 Gy, 50 Gy and 60 Gy total dose was delivered to 100%, 77% and 53% patients of RT/CT group respectively. Median survival was 20 (95% confidence interval (CI), 15−24) months and 10 (95% CI 6−15) months respectively, $p = 0.015$. In multivariate analysis, favorable survival was detected in lower T-stage ($p = 0.019$), Charlson score less than 4 ($p = 0.026$) and location of primary tumour in middle third of stomach ($p = 0.039$).
Conclusion: Addition of radiotherapy to the treatment of locally advanced, inoperable gastric cancer seems to be of survival benefit. Considering probable patient selection biases in present trial, prospective, randomized study is warranted.

6544 POSTER

Chemoradiotherapy for Extrahepatic Bile Duct Cancer With Gross Residual Disease After Surgery

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Background: To analyze the outcome of chemoradiotherapy (CRT) for extrahepatic bile duct cancer patients with gross residual disease after surgery, and to identify prognostic factors for these patients.
Methods and Materials: We retrospectively analyzed the data from 29 patients with extrahepatic bile duct cancer who had undergone CRT after bypass surgery (n = 7) or palliative resection (R2 resection) (n = 22) between January 2000 and April 2009. Most patients (n = 24) underwent CRT concurrently with 5-fluorouracil or capecitabine, and 19 out of them had maintenance chemotherapy. Nineteen and 10 patients were treated with continuous course radiotherapy (RT) and split course RT with a 2-week planned rest after 20 Gy, respectively. Six out of 7 patients who had bypass surgery received high dose RT (>50 Gy) in continuous course. The median radiation dose was 50 Gy (range; 40−60). The median follow-up period was 15.9 months.
Results: The actuarial overall survival rate at 2- and 5-years was 63.9% and 19.2%, respectively. The median survival time was 31.6 months. The 2- and 5-year disease-free survival, loco-regional progression-free survival and distant metastases-free survival rates were 38.3% and 19.2%, 31.5%