42 patients accrued, were analyzed for outcomes by clinical stage into 2 groups (I, II, IIIA vs. IIIB) and compared using log-rank test with significant differences in OS ($p = 0.002$); CSS ($p > 0.000$); DFS ($p > 0.000$); DMFS ($p > 0.000$); CFS ($p > 0.000$); LRC ($p > 0.000$). Patients who received FDT had a significantly better OS ($p = 0.004$) and CSS ($p = 0.01$).
Conclusions: In our experience clinical stage category of disease has a significant impact in all analyzed outcomes, patients who received FDT had an improvement in OS and CSS. Results for more advanced tumours (IIIB) remain poor, and require strategies to improve outcome. Higher doses or better treatment compliance may be required. We discourage planned treatment gaps.

6052 POSTER

Preoperative Radio-chemotherapy in Locally Advanced Rectal Cancer − Prognostic Value of Time Interval to Surgery on Cancer Specific Survival

C. Solé[1], M. Russo[2], V. Ovalle[1], R. Rivera[1], S. Solé[1], M. Frelinghuysen[3], M. Baeza[3]. *[1]Instituto de Radiomedicina, Radioterapia, Santiago, Chile; [2]Instituto de Radiomedicina and Universidad Diego Portales, Facultad de Medicina, Santiago, Chile; [3]Universidad de Chile, Radioterapia, Santiago, Chile*

Background: The last decade, preoperative chemoradiation has been the cornerstone in the intent to improve locoregional control in rectal cancer. Pathologic complete response has been associated to a better prognosis, mostly in terms of decreasing local recurrence. We planned a retrospective analysis of a series of cases treated with preoperative chemoradiation for rectal cancer in our institution. We intend to identify other prognostic factors, such as the interval to surgery, of locoregional control and cancer specific survival.
Methods: 347 patients with the diagnosis of locally advanced rectal cancer were treated preoperatively between 2000 and 2010. The median time to surgery was 57 days. 86% of the patients received a full chemoradiation treatment. Sphincter preservation and abdominoperineal resection were preformed in 65% and 35% of the patients respectively. Total mesorectal excision was accomplished in 51% of the patients. 27% were given postoperative chemotherapy. Survival estimates were obtained using Kaplan–Meier curves and Cox proportional Hazard model and logistic regression odds ratio were used in the multivariate analysis.
Results: With a median follow up of 69 months, at 5 years local control, distant recurrence free survival, disease specific survival and overall survival were 92, 75, 80 and 70% respectively. 95 patients (27%) had recurrences through out our follow up, 27 were locoregional recurrences and 84 failed distantly. In the multivariate analysis the most significant preoperative prognostic factor in cancer specific death was an interval to surgery $\geqslant$ 50 days (HR 1.8; $p = 0.03$). We preformed a multivariate analysis to determine which factors influenced pathologic complete response and total mesorectal excision. The most significant factor was an interval to surgery <50 days (OR 2.1; $p < 0.00$ and OR 2.2; $p < 0.00$ respectively).
Conclusions: Preoperative chemoradiation in locally advanced rectal cancer is an effective treatment, with good locoregional control and an excellent cancer specific survival. The most significant preoperative prognostic factor in cancer specific survival was the time to surgery interval. Efforts must be made not to delay surgery after preoperative radio-chemotherapy.

6053 POSTER

Prognostic Significance of the Lymph Node Ratio on the Treatment Outcome in Rectal Cancer

M.R. Ryu[1], J.Y. Kim[1], J.H. Lee[1], M.J. Chung[1], I.K. Lee[2], S.J. Yoo[2], C.H. An[2], J.M. Won[2], S.K. Chang[2], S.M. Chung[1]. *[1]College of Medicine The Catholic University of Korea, Department of Radiation Oncology, Seoul, South Korea; [2]College of Medicine The Catholic University of Korea, Department of General Surgery, Seoul, South Korea*

Background: This study evaluated the prognostic impact of the lymph node ratio (LNR, ie, the ratio of positive to dissected lymph nodes) on recurrence and survival in rectal cancer patients who received curative intent surgery and postoperative concurrent chemoradiation therapy (CCRT).
Materials and Methods: Between 1995 and 2008, 124 pathologic T3−4 or node positive rectal cancer patients were referred for postoperative CCRT. Radiotherapy was performed, median dose of 50.4 Gy (range, 45–59.4) for 6 weeks to the whole pelvis. Chemotherapy was bolus injection of 5-fluorouracil and leucovorin for the first and last week of radiotherapy (n = 114, 91.9%) or capecitabine daily administered during radiotherapy (n = 10, 8.1%). Further adjuvant chemotherapy was done after CCRT. Disease free survival (DFS) and disease specific survival (DSS) rates were estimated by the Kaplan–Meier method. The prognostic significance of the LNR was evaluated by multivariate analysis using Cox proportional hazard modeling with or without LNR as a covariate.
Results: Median follow-up was 5.1 years (range, 0.4–16.0). The median age was 62 years (range, 21−80). The median number of nodes removed was 18 (range, 6−81). By minimum p value approach, 0.2 was the cutoff value of LNR at which most significant difference in DFS and DSS was observed. The patients were classified into two groups: patients with LNR $\leqslant$ 0.2 and LNR > 0.2, which represented 66.9% and 33.1% of the study cohort, respectively. The DFS and DSS rates correlated significantly with clinical N stage, pathologic N stage, lymphatic, vascular or perineural invasion and LNR ($\leqslant$0.2 vs. >0.2). In multivariate analysis, pathologic N stage and lymphatic invasion were significant prognostic factors for DFS and DSS ($p < 0.05$). However, when the LNR was included as a covariate in the model, the LNR was highly significant ($p < 0.001$), and the number of positive nodes lost its significance ($p > 0.05$).
Conclusions: The LNR predicts recurrence and survival more accurately than pathologic N classification in our study. The number of positive nodes and LNR should be considered together in risk estimates for rectal cancer patients.

6054 POSTER

The Impact of Serum Carcinoembryonic Antigen (CEA) Normalization on Survival in Rectal Cancer Treated With Preoperative Chemoradiation

M.N. Yu[1], M.J. Chung[1], J.Y. Kim[1], I.K. Lee[2], J.G. Kim[2], C.H. An[2], S.J. Yoo[2], S.K. Chang[2], S.M. Chung[1], M.R. Ryu[1]. *[1]College of Medicine The Catholic University of Korea, Radiation Oncology, Seoul, South Korea; [2]College of Medicine The Catholic University of Korea, General Surgery, Seoul, South Korea*

Background: This retrospective study was to evaluate impact of CEA normalization on survival in rectal cancer patients who received curative intent surgery after preoperative chemoradiation (CRT).
Materials and Methods: Between July 1996 and June 2010, 109 patients underwent surgery for histologically confirmed rectal cancer after preoperative CRT. The dose of radiotherapy was median 50.4 Gy (range, 43.2–54.4) for 6 weeks. Chemotherapy was bolus injection of 5-fluorouracil and leucovorin for the first and last week of radiotherapy (n = 84, 77.1%) or capecitabine daily administered during radiotherapy (n = 18, 16.5%). Low anterior resection (n = 90, 82.6%) or abdominoperineal resection (n = 19, 17.4%) was performed median 47 days from the end of radiotherapy, and then 4 cycles of adjuvant chemotherapy was done. Down staging was defined as the lowering of the T, N stage between pretreatment CT and pathological stage. Serum carcinoembryonic antigen (CEA) level was checked at initial diagnosis and just before surgery. Disease free survival (DFS), distant metastasis free survival (DMFS) and overall survival (OS) rates were estimated by the Kaplan–Meier method, and the Cox proportional hazard model was used in multivariate analyses.
Results: After median follow-up of 48 months (range, 9–174), 5-year DFS was 72.5% and 5-year OS was 76.7%. The initial CEA level and normalization CEA after CRT were significant prognostic factor for DMFS and OS ($p = 0.0004$, $p = 0.0051$ and $p = 0.0152$, $p = 0.0004$, respectively). The downstaging of T and N occurred in 34 (31.2%) and 70 patients (64.2%), respectively. Univariate analyses indicated that pT, pN, perineural invasion(PNI), lymphatic invasion(LI) were significant prognostic factors for DFS. cT, pT, pN, PNI, LI were significant predictive factors for OS. In multivariate analyses, pT, downstaging of N and PNI were significantly associated with improving DFS ($p = 0.017$, $p = 0.013$ and $p = 0.002$, respectively). The cT, PNI were significant prognostic factors for OS ($p = 0.013$, $p = 0.001$, respectively).
Conclusions: In our study, clinical or pathologic stage, initial CEA level were again confirmed to be prognostic factors for survival in rectal cancer patients. However, it is first suggested that patients who achieved normal CEA level at the time of surgery had more favorable outcome than who kept high CEA level after preoperative CRT. The normalization of CEA level could provide important information about prognosis in rectal cancer treatment.

6055 POSTER

Dosimetric Comparison of Three Dimensional Conformal Radiotherapy With Intensity Modulated Radiotherapy & Bone Marrow Sparing Intensity Modulated Radiotherapy in Preoperative Radiation of Locally Advanced Carcinoma Rectum

A. Biswas[1], S. Mallick[1], S. Sharma[1], D. Manigandan[1], A. Chakrabarty[2], B.K. Mohanti[1], G.K. Rath[1]. *[1]All India Institute of Medical Sciences, Radiotherapy & Oncology, Delhi, India; [2]Indian Statistical Institute, Statistics and Mathematics Unit, Delhi, India*

Background: We compared target coverage, conformity, homogeneity, normal tissue avoidance and irradiated body volume in 3 sets of

plan- 3dimensional conformal radiotherapy (3DCRT), intensity modulated radiotherapy (IMRT) and bone marrow sparing intensity modulated radiotherapy (BMS-IMRT) in 5 consecutive patients of locally advanced carcinoma rectum undergoing pre-operative radiation.
Materials and Methods: After immobilization with thermoplastic abdominopelvic cast, planning CT scan (Philips Big Bore CT; 3 mm slice thickness) was performed with intravenous and oral contrast. Clinical target volume (CTV) consisted of CTVA: mesorectal, presacral, internal iliac and obturator lymphnodal site and CTVB: external iliac lymphnodal site (in case of involvement of genitourinary structures). An isotropic expansion of 1 cm was given around CTV to generate the planning target volume (PTV). The dose-limiting organs at risk (OAR) included the urinary bladder, bowel, femoral head (FH) and iliac bone marrow (BM). Prescribed dose was 45 Gy/25#/5 weeks. 3DCRT was planned by 2 anteroposterior fields (6MV photons) and 2 lateral fields (15MV photons) after field shaping with multileaf collimator. Dynamic IMRT was planned by 7 equally spaced coplanar beams with 6 MV photons with dose prescribed at 95% iosdose (Eclipse TPS). Input constraints for BM (V20 < 40%; V10 < 50%) were used only in BMS-IMRT. Dosimetric comparison between the 3sets of plan was performed using paired t test with p value being <0.05 being statistically significant.
Results: See the table.

Parameters	3DCRT	IMRT	BMS-IMRT	p-values		
				3DCRT vs. IMRT	3DCRT vs. BMS-IMRT	IMRT vs. BMS-IMRT
Target coverage						
Median D95 PTV(Gy)	45.98	45.37	45.31	0.4123	0.232	*0.012*
Median V45 PTV(%)	97.72	98	97.23	0.2055	0.9397	*0.0094*
Median PTV mean dose (Gy)	47.86	46.78	46.95	0.1336	0.1154	0.4263
Conformity index (CI)						
Median CI	1.69	1.09	1.11	*0.0004*	*0.0004*	0.5614
Homogeneity index (HI)-D2/D98						
Median HI	1.09	1.09	1.09	0.7174	0.8712	0.208
Normal tissue sparing						
Median bowel V45 (cc)	18.74	9.42	11.17	0.3059	0.3023	0.9354
Median bowel Dmax (Gy)	48.79	48.22	48.17	0.0709	0.5493	0.3199
Median bladder V40 (%)	66.48	38.84	45.5	*0.0213*	*0.0185*	0.101
Median bladder Dmax (Gy)	49.28	48.11	48.46	0.3621	0.4015	0.7715
Median left FH Dmax (Gy)	47.06	44.96	44.78	0.2397	0.26	0.464
Median right FH Dmax (Gy)	47.07	45.67	45.39	0.2952	0.3061	0.4235
Median BM V20 (%)	87.99	79.81	60.13	0.2643	*0.0041*	*0.004*
Median BM mean dose (Gy)	33.59	31.06	27.13	0.0592	*0.0009*	*0*
Irradiated body volume (IBV)						
Median IBV5 Gy (cc)	8319.81	9058	9004.78	0.053	0.0691	*0.0096*
Median IBV10 Gy (cc)	7074.61	7669.88	7570.92	*0.0211*	*0.0462*	*0.0034*
Median IBV20 Gy (cc)	5767.28	4944.41	4702.74	*0.0031*	*0.001*	*0.0022*
Total monitor unit (MU)						
Median MU	217	1235	1422	*0.002*	*0.0006*	*0.0226*

Conclusion: Compared to 3DCRT, IMRT plans led to enhanced conformity and sparing of bladder and iliac bone marrow at the cost of increased IBV at low doses (5−10 Gy) and longer treatment time(increased MU). BMS-IMRT substantially decreased the bone marrow volume receiving in excess of 20 Gy and should be explored in clinical trials focusing on preoperative radiochemotherapy in locally advanced carcinoma rectum.

6056 POSTER

Brachytherapy Versus Tomotherapy Versus Stereotactic Body Radiotherapy (SBRT) for the Delivery of a Rectal Tumour Boost – a Comparative Dosimetric Study

N. Kopek[1], L. Portelance[1], S. Rajakesari[1], W. Parker[2], M. Evans[2], R. Ruo[2], L. Comeau[1], S. Faria[1]. *[1]McGill University Health Centre, Radiation Oncology, Montreal, Canada; [2]McGill University Health Centre, Medical Physics, Montreal, Canada*

Introduction: The standard treatment for patients diagnosed with locally advanced rectal cancer includes neoadjuvant radiation followed by surgery. For patients not amenable to resection, the use of a radiation boost could provide better tumour control. Data from our institution indicates that high-dose rate endorectal brachytherapy can be used in the pre-operative setting to deliver conformal radiation to the primary tumour. In view towards the delivery of a conformal boost to rectal tumours, the present analysis compares the dosimetry of endorectal brachytherapy with Tomotherapy and SBRT.
Materials and Methods: The planning CT scans were retrieved for 10 endorectal brachytherapy patients previously treated at our centre with 26 Gy in 4 consecutive daily fractions prescribed to the deepest radial margin of the tumour. These CT scans were acquired with the endorectal applicator in place which distends the rectal wall and facilitates rectal immobilization and tumour localization. From these scans, Tomotherapy and 7-field linac-based SBRT dose distributions were generated for the same dose schedule of 26 Gy in 4 fractions. SBRT plans were prescribed to an isodose envelope covering 95% of the target and ensuring 99% of the target receives a minimum of 90% of the prescribed dose. For this comparative dosimetric study, the PTV was considered equal to the GTV for all plans. One-way ANOVA testing was used to compare mean values observed for select dose-volume parameters.
Results: All modalities achieved complete coverage of the target by the prescription dose. The target near maximum dose (D2%) was 175.9 Gy, 26.7 Gy and 29.1 Gy for brachytherapy, Tomotherapy and SBRT respectively (p =0.00). For the brachytherapy, Tomotherapy and SBRT plans respectively: the conformality index (prescription vol (cc)/target vol (cc)) was 4.1, 1.5 and 1.5 (p = 0.01) and the homogeneity index ((D2%-D98%)/D50%) was 2.79, 0.03 and 0.13 (p = 0.00).

	Brachy	Tomo	SBRT	Sig.
Uninvolved rectal mucosa max/mean (Gy)	181.5/22.7	26.5/9.4	27.4/5.8	<0.05
Anal canal max/mean (Gy)	14.3/4.3	4.9/1.5	3.2/0.6	<0.05
Bowel max/mean (Gy)	17.4/3.2	9.3/2.0	9.4/1.4	NS
Bladder max/mean (Gy)	23.4/5.2	15.2/4.2	14.5/3.6	NS
L Fem H max/mean (Gy)	4.6/2.0	5.8/3.0	8.4/2.4	NS
R Fem H max/mean (Gy)	4.5/1.9	5.4/2.8	6.6/2.3	NS

Conclusion: The Tomotherapy and SBRT plans provided better target conformality and homogeneity compared to endorectal brachytherapy. Brachytherapy was also associated with significantly higher doses to the uninvolved rectal wall and adjacent anal canal. Conformal external beam techniques may be preferable for boost delivery, particularly with patients for whom the irradiated tissue will not subsequently be resected.

6057 POSTER

Influence of Bladder Distension Control on Postoperative Radiotherapy in Rectal Cancer Patients Using Belly Board

H. Zhang[1], R.B. Wang[1], T. Sun[1], H.J. Yan[1], Y. Yin[1]. *[1]Shandong Cancer Hospital, Radiation Oncology, Jinan, China*

Background: Prone position with a belly board and bladder distension are the most commonly applied to reduce the irradiated small bowel volume. While conventional bladder distention result in low practicability and reproducibility throughout the course of pelvic radiotherapy. A consistent bladder volume is important. This present study compared the effects of the combination of belly board with or without bladder irrigation on reducing the irradiated small bowel volume during postoperative pelvic radiation in rectal cancer patients.
Materials and Methods: 11 consecutive patients who received pelvic radiation therapy for rectal cancer with belly board were included in this study. All patients underwent three sets of CT scans. The first one was taken before radiotherapy with a full (not empty) bladder. The second was taken 4 weeks after the beginning of the radiotherapy with a full bladder, and then immediately empty the bladder, and injecting the same volume of sodium chloride to the volume of the bladder recorded in the first scan. The conventional four-field treatment plan was made using a three-dimensional treatment planning system. The total volume of small bowel in pelvis, the volume of small bowel, bladder within every isodose level and their maximum dose and mean dose were analysed for 3 scans (group I, II, III). Data were analysed using nonparametric test.
Results: Compared to group I, the bladder volume was reduced significantly in group II. The median reduction of bladder volume was 148.36 cm^3. The volume of small bowel below fourth lumbar vertebra and its volume within every isodose level was increased (p < 0.05). The median increment of small bowel below fourth lumbar vertebra in group II compared with group I was 121.23 cm^3 (31.17%). The total volume, the irradiated volume in every isodose level for small bowel and bladder had no significant difference between group I and III (p > 0.05).
Conclusions: The bladder volume declined significantly during the course of radiotherapy. Hence an increment of irradiated small bowel volume. It is regrettable that the statistical analyse showed no correlation between the volume change of bladder and small bowel. Bladder irrigation is a feasible method to guarantee a consistent bladder volume and reduce the irradiated small bowel volume.