2053 POSTER

Determination of Gonad Doses During Robotic Stereotactic Radiosurgery for Various Tumour Sites

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Background: We evaluated the absorbed dose received by the gonads during robotic stereotactic radiosurgery (SRS) for the treatment of various tumour sites.
Material and Methods: The calibration of all thermo-luminescence dosimetry (TLD) and film dosimetry systems was performed prior to measurements. The computerized tomography (CT) images of all patients were transferred to the treatment planning system (TPS). The contours of tumour and critical organs were delineated on each slice, and treatment plans were generated for 10 patients. We measured the gonad doses at robotic SRS for various tumour sites. Measurements for gonad doses were taken from the geometric projection of the ovary onto the skin for female patients, and from the scrotal skin for male patients by sticking films and TLDs. Robotic SRS was delivered with CyberKnife ® (Accuray Inc., Sunnyvale, CA).
Results: Highest gonad doses are measured in the treatment of pelvic tumours. The highest testicle dose is measured in the prostate treatment, and maximum ovarian dose is measured in the cervical cancer treatment (Table 1).
Conclusion: Gonad doses generally seem to be below sterility limit in robotic SRS sessions for various tumour sites. However, particular attention to gonad doses should be given during robotic SRS for pelvic tumours.

Table 1. Comparison of total ovarian and testicular dose measurements for various tumour sites in patients

Tumour site	Gender	Total dose/fraction	TLD dose (cGy)	Gafcromic film dose (cGy)
Brain	Male	18 Gy/1 fraction	3.5	6.6
S4 vertebra	Male	30 Gy/5 fraction	38.0	63.5
Precaval lymph node	Male	36 Gy/3 fraction	17.4	24.9
Lung	Male	48 Gy/3 fraction	17.4	52.5
Prostate	Male	36.5 Gy/5 fraction	117.0	160.0
L3 vertebra	Male	37.5 Gy/3 fraction	20.7	30.3
Hypopharynx	Male	30 Gy/5 fraction	8.0	32.0
Cervix	Female	30 Gy/5 fraction	271.0	318
Hypopharynx	Female	13 Gy/5 fraction	8.0	21.5
L3 vertebra	Female	20 Gy/2 fraction	43.6	35.4

2054 POSTER

Measurement of Intrafraction Displacement of the Mediastinal Metastatic Lymph Nodes Based on Four-dimensional Computed Tomography for Non-small Cell Lung Cancer

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Background and Purpose: To measure intrafraction displacement of the mediastinal metastatic lymph nodes based on four-dimensional computed tomography (4D-CT) for non-small cell lung cancer (NSCLC), and then, to compare difference of the displacements between the metastatic lymph nodes at the different stations of the mediastinum and difference of the displacements on the different directions of the metastatic lymph nodes at the same station of the mediastinum, so as to provide the evidence of the definition of internal target volume (ITV) of metastatic mediastinal lymph nodes of NSCLC.
Methods: Twenty-four patients with NSCLC, whose mediastinal metastatic lymph nodes were confirmed by diagnosed contrast enhanced CT (short axis diameter$\geqslant$ 1.0 cm), were accrued.4D-CT simulation of the thorax was carried on in free breathing condition and the image sets were got. In Varian Eclipse treatment planning system, the metastatic mediastinal lymph nodes were separately delineated on the CT images of 10 phase of breath cycle, and the lymph nodes were grouped as upper mediastinal, middle mediastinal and lower mediastinal group depending on the mediastinal station in which the delineated lymph nodes localized. Then the displacement of the lymph nodes at LR, AP and SI direction were measured.
Results: Displacements in LR, AP and SI directions were (1.75$\pm$0.99)mm, (1.73$\pm$0.87)mm and (2.65$\pm$2.52)mm for the upper mediastinal lymph nodes, (2.62$\pm$1.83)mm, (2.05$\pm$1.00)mm and (3.24$\pm$2.53)mm for the middle mediastinal lymph nodes, (1.80$\pm$0.92)mm, (1.56$\pm$0.67)mm and (4.44$\pm$2.83)mm for the lower mediastinal lymph nodes. The 3D motion vector for the upper,middle,and lower mediastinal lymph nodes was (3.87$\pm$2.45)mm, (4.97$\pm$2.75)mm,and (5.23$\pm$2.67)mm. For upper mediastinal lymph nodes,the displacements in LR, AP and SI directions showed no significant difference for each other. For middle mediastinal lymph nodes, the displacements merely in LR and SI directions showed a significant difference($P < 0.05$), while the displacements of lower mediastinal lymph nodesin LR and SI, or LR and AP directions were significantly different ($P < 0.05$). The displacements of different mediastinal lymph nodes in a single or 3D direction showed no significant difference ($P > 0.05$). In SI direction, the correlation between the displacement of ipsilateral diaphragma and mediastinal lymph node was not statistically significant ($P > 0.05$).
Conclusions: In free breathing condition, the displacements of mediastinal lymph nodes in LR, AP and SI directions show significant differences for each other. It is unreasonable to using an isotropic margin in involved-field radiotherapy of NSCLC. The expansion in SI direction was larger than AP or LR directions. The use of the displacement of ipsilateral diaphragma is unable to estimate the displacement of mediastinal lymph nodes.

2055 POSTER

A Study on Displacement of the Clips in Surgical Cavity Based on Four-dimensional Computed Tomography for the Patients Undertook External-beam Partial Breast Irradiation After Breast-conserving Surgery

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Objective: To explore the displacements of the selected clips and the center of the geometry consisted of all the clips in the surgical cavity measured basing four-dimensional computed tomography (4D-CT) simulation images to provide the accordance for the definition of internal target volume (ITV) of external-beam partial breast irradiation (EB-PBI).
Methods: Fourteen breast cancer patients after breast-conserving surgery who were recruited for EB-PBI undertook big core CT simulation and the 4D-CT image data sets were got in the state of free breath. In Varian Eclipse treatment planning system, the selected four clips in the cavity were separately delineated on the CT images from 10 phase of breath cycle and all of the clips in the cavity were marked to obtain the geometry consisted of all of the clips, then the displacement of the four selected clips and the center of the geometry at LR, AP and SI direction were measured. The differences of the displacement of the same selected clip at three-dimensional directions, the difference of the displacement of the different selected clips at the same direction, and the difference and associativity between the difference of the selected clips and the geometry center were compared.
Results: (1) Displacements of the selected clips at LR, AP, SI directions were 0.41$\pm$0.24 mm, 0.89$\pm$0.37 mm and 0.9$\pm$0.57 mm for the upper clip, 0.42$\pm$0.26 mm, 0.69$\pm$0.38 mm and 0.93$\pm$0.58 mm for the inner clip, 0.41$\pm$0.16 mm, 0.78$\pm$0.42 mm and 0.74$\pm$0.45 mm for the outer clip, 0.56$\pm$0.26 mm, 0.91$\pm$0.43 mm and 1.37$\pm$0.9 mm for the lower clip; (2) The difference of the displacements between LR and AP, LR and SI for the same selected clip were statistically significant ($P < 0.05$), but the difference of the displacement at the same direction of the different selected clip was not statistically significant ($P > 0.05$); (3) The displacements of center of the geometry consisted of all of the clips in the direction of LR, AP, SI were 1.34$\pm$0.39 mm,2.01$\pm$1.02 mm and1.89$\pm$1.03 mm, respectively, and the difference of the displacement between LR and AP, LR and SI were all statistically significant ($P < 0.05$); (4) At the same direction of LR, AP and SI, the displacement of geometry center was always greater than the displacement of the selected clips, and the difference except SI direction was all statistically significant ($P < 0.05$); (5) At SI direction, the associativity between the displacement of geometry center and upper clip, geometry center and lower clip was statistically significant ($P < 0.05$).
Conclusions: When the target for EB-PBI is defined basing on 4D-CT simulation images, the displacement of the selected clips at the border of the surgical cavity is not qualified to substitute the displacement of the target defined basing on all of the clips in the surgical cavity; No matter what selected clips or geometry consisted of all of the clips in the surgical cavity, the displacement in LR direction is always statistically significantly less than that in AP and SI directions.