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standard multileaf collimator by one or two steps of 20 when using multiple non-coplanar fields, there is no need for 3-mm micro-multileaf collimator in order to treat either spherical or complex GTVs.

Situation	$V_{95\%} - V_{GTV}$
One sphere (22 5-mm diameter) using 3-mm micro-multileaf collimator and 5 non-coplanar fields	0 000 ml
One sphere (22 5-mm diameter) using 9-mm standard multileaf collimator and 5 non-coplanar fields without collimator rotation	0 008 ml
One sphere (22 5-mm diameter) using 9-mm standard multileaf collimator and 5 non-coplanar fields with one collimator rotation of 20°	0 008 ml
Two spheres (15-mm diameter) using 3-mm micro-multileaf collimator and 5 non-coplanar fields	0 050 ml
Two spheres (15-mm diameter) using 9-mm standard multileaf collimator and 5 non-coplanar fields without collimator rotation	0 060 ml
Two spheres (15-mm diameter) using 9-mm standard multileaf collimator and 5 non-coplanar fields with one collimator rotation of 20°	0 056 ml

2299 Development of a New Linear Accelerator Mounted with Dual X-Ray Fluoroscopy Using Amorphous Silicon Flat Panel X-Ray Sensors to Detect a Gold Seed in a Tumor at Real Treatment Position

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Purpose: Set-up error and organ motion interferes with the accuracy of radiotherapy for extracranial tumors. We usually take a linacgram for verification of irradiation field, because the set-up accuracy is usually no better than 1.0 cm for body tumors. In the stereotactic radiotherapy, the position and movement of tumors should be detected before every treatment. Linacgram is not suitable for the verification of steretactic irradiation , because tumors (or gold seeds in the tumors) in the lower lung, liver or abdominal organ is not detected by that. So the purpose of this study is to develop the linear accelerator mounted with two fluoroscopy, using recently developed amorphous silicon (a-SI) flat panel to detect tumor position and movement for better daily positioning accuracy after a setup of a patient on the couch of the linear accelerator.

Materials and Methods: Clinac 23EX (Varian Medical Systems) was mounted with dual X-ray generators (RAD II simulator: Haynes Radiation Ltd.) on the gantry with a 90 degree angle (each one was mounted at ±45 degree from the beam axis of the Clinac). The range of output kVp of this X-ray generator is 40 to 150 in 1 kVp increments digitally displayed, and exposure time is 8 ms to 10 seconds. Two sets of a-SI flat panel X-ray sensor (PaxScan 2520: Varian Medical Systems) were also mounted on the gantry at just the opposite places of the X-ray generators. The size of this flat panel and its imaging area are 16.6 x 25.8 cm and 7.1 x 9.4 cm, respectively. The images from this sensor were obtained as 15 frames per second, and outputted as digital video signals.

The image of a gold seed on a rotating disk or in a metastatic lung cancer of a patient with Ewing tumor was tried to be detected with these dual a-SI flat panel X-ray sensors. The size of rod shaped gold seed is 0.8 mm in diameter and 3 mm in length. This gold seed is implanted into the tumor of a patient using disposable sterile needle of which a gold seed is charged in the tip.

Results: A picture of newly developed linear accelerator mounted with a dual fluoroscopy using a-SI flat panel X-ray sensors is shown in Figure 1. The images of gold seed on a rotating disk and in the lung cancer were clearly obtained by this system.

Conclusion: The new linear accelerated system developed in this present study seems to be very useful for the set-up of a patient, and to verify the irradiation field just before irradiation. This helps to lessen the systematic error that is caused by body movement of a patient and so on. We are now investigating continuous monitoring of the tumor movement during irradiation using this new system.