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Research on the Treatment Setup Using CCTV and Orthogonal X-ray System

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INTRODUCTION

Lax frame, which was commercialized in 1994 for the whole body radiotherapy, shows many limitations in clinical application such as huge setup error between simulation and treatment, lack of verification tool for the delivered dose and the geometrical limitation. It does not consider movement of internal organ so that it won't give confidence to deliver large dose to patient in radiosurgery.

For better and more practical clinical application, a new system of whole body frame has been developed in order to use it for 3-D conformal radiotherapy and whole body radiosurgery. It consists of construction of 3-D topographic body frame, development of software for the data acquisition of image from CT and MRI and for localization of target and interested organ, and most importantly preparation of verification tool such as CCTV camera and orthogonal X-ray system and their interface to PC.

METHOD

On light foamex panel of equivalent size to couch, radiopaque catheter lines are encraved for the dedicated coordinate system and MeV-Green immobilizer is attached on it with the help of side panel and many plastic rods for the patient setup. This design minimizes geometrical limitation for 3-D conformal RT and reduces dependence of radiation transmission on some particular exposure angles. Also sliding H & N holder is used for adjustment of patient size and digital vernier caliper is introduced for measuring external body coordinates accurately.

Setup errors of body surface are detected using 3 directional CCTV cameras and image subtraction technique. This procedure is handled in real time by watch variation of two different setups through the monitor.

In order to reduce setup error from the motion of internal organ, landmark screws are implanted around target and two orthogonal images are taken by orthogonal X-ray system without the change of isocenter.

RESULTS

All X, Y, Z coordinates are determined for localization of target from both external measurement and CT, MR images. Good agreements are obtained for both measurements. Minimization of setup error between simulation and treatment is established within a few millimeters depending on the target movement. Geometrical limitation of gantry on the frame is reduced noticeably and systematized according to each conformal angles. Variations of radiation transmission are measured quantitatively and tabled with respect to conformal angles. From comparison of both CCTV images, it turns out that variation of patient setup is noticed considerably for the same alignment of isocenters using 3-point laser lines, which shows that target localization is not good enough in the conventional method of 3-point laser lines. Variation of body outline is resolved visually at 3 mm discrepancy of patient setups. Using a few gold balls of 1 mm diameter around target, images from orthogonal X-ray system reveals that target localization is achieved and also implies that variation of target movement due to the motion of internal organs is quite noticeable.

DISCUSSION

With respect to most functions such as immobilization, target localization, treatment setup error and verification of the delivered dose, our whole body frame proves to be satisfactory and practical clinically but it leaves some problems to be solved. First, more easily handled, recyclable immobilization material should be used. This is important in view of cost effect and clinical adequateness. Second, fusion technique of images may be helpful for target localization. Accumulation of more improved verification technique comes from fusion images between CCTV image and simulation image, and between CCTV image and portal image. Especially fusion technique with portal image should be emphasized since portal image gives beam's eye view directly. Third, for the purpose of minimizing PTV, more active method should be introduced to control the motion of internal organs such as diaphragm and heart. Respiration-gated technique helps to solve this problem. Target movement due to the motion of internal organs can be freezed in location from the beam's eye view when the beam is gated on a certain respiration cycle. Technically this may be accomplished with some respiration sensors and study on the correlation of target movement on respiration cycle.

CONCLUSION

To improve clinical application of the whole body frame in 3-D conformal radiotherapy and radiosurgery, a new system of 3-D topographic radiotherapy is designed and constructed, and verification tools for patient setup between simulation and treatment or between fractionated treatments are developed using CCTV cameras and the orthogonal X-ray system. This leads to minimization of patient's setup error and detection of the motion of internal organ resulting in determination of more accurate PTV.