Study on The Development of A New Whole Body Fame

Jin-Bum Chung[a], Tae-Suk Suh[a], Won-Kyun Chung[b], Bo-Young Choe[a], Hyoung-Koo Lee[a]

[a]Department of Biomedical Engineering, College of Medicine, Catholic University of Korea,
505, Banpo-dong, Seocho-gu, Seoul 137-040, South Korea
[b]Department of Radiation, Seoul Health College
212, Yangji-dong, Sujeong-gu, Seongnam 461-713, South Korea
Corresponding Author : Tae-Suk Suh, Ph.D.
e-mail : jinbum@catholic.ac.kr, suhsanta@catholic.ac.kr

ABSTRACT

We have been researching upgrade version of a stereotactic whole body frame, used for evaluating daily setup accuracy of the patient positioning during fractionated extra-cranial stereotactic radiotherapy. Currently, we are focusing on the development of a new stereotactic whole body frame, and then will handle organ movement produced by breathing at the next stage. MeV-Green is chosen for the best immobilizer possible and the epoxy board is for the frame with the dimension of 110 cm in length, 50 cm in width in order to maximize transmission rate of the beam from lateral or posterior direction and to fit CT and PET scanners with an aperture of 55 cm at least. The key point of an upgraded stereotactic whole body frame will be set on the collision-free rotation of the gantry with the frame, and the development of the checking structure for the daily patient repositioning regarding internal target.

Keyword: whole body frame, localization, setup error, conformal radiotherapy

1. INTRODUCTION

The ability to minimize patient's setup error during daily radiotherapy, and the extra margin of a PTV due to the organ motion is the most crucial in modern fractionated radiation therapy, including IMRT and 3D conformal radiotherapy. This is especially important to set the accurate localization for the target, and to provide the reliable delivery of the prescribed doses in the fractionated treatment[1]. In order to obtain the accurate localization, a reliable and reproducible setup method is necessary. The coordinate based target localization has been used in the intra-cranial radiosurgery with stereotactic frame system. In extra-cranial region, however, a precise localization has been regarded as a very difficult goal to achieve, especially in breath-induced moving organs such as lung, liver, and pancreas [2]. Also, a more practical method is demanded to check the target poison, not just the body surface, in coordinates during daily fractionated radiotherapy. First, the rigid stereotactic whole body frame should be developed in order to accomplish target localization. Initial Lax frame, introduced in 1994 for whole body radiotherapy, provided many good clinical data at Karolinska hospital in Sweden but it shows many limitation 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 dose not consider movement of internal organ so that it won't give confidence to deliver large dose to patient in radiosurgery[3]. In order to get over this limitation, we have researched on the development of a new stereotactic whole body frame used in three-dimensional (3D) conformal radiotherapy and whole body radiosurgery. The aim of this study is to development for a upgraded version of the whole body frame, with reducing setup error and repositioning position of a patient. Currently, we are at the designing stage for the frame and we report the outcome performed up to now. Second, a gating tool should be developed in order to imitate the pattern of the breath cycle and to control target movement. It will help to reduce the planning target volume (PTV) and provide accurate delivery of the prescribed dose to the target. Since several years ago, a few good techniques have been tried to control ("freeze") target, especially in NIRS(Chiba), PMRC(Tsukuba), and Hokkaido University Hospital in Japan, and William Beaumont Hospital (Michigan), MKSCC(New York), and University of California(Davis) in USA. The apparent disadvantage in these techniques is the substantially increased treatment time due to selected gated interval. We have researched to overcome this limitation and to shorten the treatment time during the gated radiotherapy. This project is scheduled to be the next stage following a development of the stereotactic whole body frame.

2. METHODS

A new whole body frame is designed for immobilization and localization of interested patient body. The size and shape

of the frame was chosen to fit CT scanners with an aperture of a least 55 cm. It is frame with outer dimensions of 110 cm in length, 50 cm in width. This frame is consisted of basis plate and immobilizer to fix the patient of body. Material used in basis plate is epoxy board and immobilzer is a light and hard MeV-Green. Radiopaque angio catheter lines are engraved on basis plate of frame to show coordinate system. To immobilize vacuum pillow in Lax frame, side panel is used but it obstruct gantry rotation. Therefore, Immobilizer of this frame is installed plastic rod instead of side panel on frame plate. Plastic rod is designed that it is conveniently operated in frame plate. Also, This design minimizes geometrical limitation for 3-D conformal radiotherapy and reduces dependence of radiation transmission particular exposure angles. Finally, Design of this frame is focused in realization of target localization, variety of operation relative to patient's body, strong property and verification of stability.

3. RESULT

First, a test will be performed in order to minimize collision associated with change in rotation angle of the gantry and to maximize transmission rate of the beam at lateral or posterior of oblique direction. MeV-Green as an immobilizer, and epoxy board as a base frame will help to accomplish this goal with quantified test data. Second, CT scan will be perform using a humanoid phantom with a simulated target, and the accurate localization for the target will be tested using the 3 dimensional coordinate system in the frame. MRI, and PET scan will be the next upgrade project with the appropriated coordinated materials. Third, a checking structure will be developed for reducing error of the patient repositioning. This tool is used not on the body surface localization with laser mark used currently, but is for the localization of the target inside, sot that the real target localization should be done. This work implies the modification of the immobilizer material and part of the structure of a whole body frame depending the accuracy of the patient setup error. Fourth, real clinical test will be performed from several patients with fixed targets, and the data will be compared to the daily setup technique using CT scan and portal image. Contrast for the target localization should be better than the portal image technique, and practicability than the CT technique.

4. DISCUSSION AND CONCLUSION

Extra-cranial radiotherapy is to deliver 3-D conformal fractionated single high doses in target based on stereotactic position. Immobilizer material turns out to be the most important factor regarding patient setup error, except for the one due to the organ motion. For the precise radiosury or hypofractionated, vacuum cushion should not be used, since the error for patient repositioning proves to be too large. On the other hand, MeV-Green needs a skill for the right shape with a minimum quantity. This leaves the compromise of searching a new material for the immobilizer between convenience of vacuum cushion and reliability of MeV-Green. With a reliable frame ready, next step should be the development of the gating technique mentioned in introduction. This internal setup error would decrease as the accuracy of the surveying internal organ motion. We believe that the key point is not the accuracy of imitation of the breathing cycle, but shortening the treatment time using a more aggressive technique. Our upgraded version of a whole body frame would prove to be satisfactory and practical clinically with respect to most functions such as immobilization, target localization, treatment setup error and verification of the delivered dose.

ACKNOWLEGEMENT

This work was supported by the Highly Advanced National Projects on the Development of Biomedical Engineering and Technology (HMP-98-G-1-016) from MOHW (Ministry of Health & Welfare).

REFERENCE

1. Gunilla C. Bentel, R.N., Lawarence B. Marks, et al, "A customized head and neck support system", *I. J. Radiation Oncology Biol. Phys*, Vol 32, No. 1, pp. 245-248, 1995
2. W. K. Chung, B. Yi, et al, "Whole body frame for the target localization with CCTV Camera system and Fluoroscopy", XIII. ICCR 2000, Heidelberg, Germany, pp 582-583, 2000
3. W. K. Chung, B. Yi, et al, "Research on the treatment setup using CCTV and orthogonal X-ray system", *Japanese J. Med. Phys*, pp 76-78, 1999
4. J. Wulf, U. Hadinger et al, "Stereotactic radiotherapy of extracranial target: CT-simulation and accuracy of treatment in the steretactic body frame", *Radiotherapy and Oncology*, Vol .57, pp 225-236, 2000.
5. Yasushi Nagata, Yoshinaru Negoro, et al, "Clinical outcomes of 3D conformal hypotractionated single high dose radiotherapy for one or two lung tumors using a stereotactic body frame", *I. J. Radiation Oncology Biol. Phys*, Vol. 52, pp. 1041-1046, 2002
6. Ingemar Naeslund, Ingmar Lax, et al., "New prostate repositioning paradigm", *I. J. Radiation Oncology Biol. Phys*, Vol. 39, Supplement, 1997