Dosimetry in an IMRT Phantom Designed for a Remote Auditing Program

Y Han*[1], EH Shin[1], MK Yoon[2], SB Lee[2], SG Ju[1], CI Lim[3], SH Park[4], SK Kang[5], JE Lah[6], SH Cho[7], G Ibbott[7],YCAhn[1]

(1)Samsung Medical Center, Sungkyunkwan Univ. School of Medicine, Seoul, KR (2) National Cancer Center, Goyang, KR (3)Korea Food and Drug Administration, Seoul, KR (4)Asan Medical Center, Seoul, KR (5)Kang Dong Sacred Heart Hospital, Hallyum Univ. Seoul, KR (6)College of Medicine, The Catholic Univ of Korea, Seoul, KR (7)UT MD Anderson Cancer Center, Houston, TX

1. Introduction

Accurate delivery of the most-up-to-date treatment techniques, such as Intensity-modulated radiation therapy (IMRT), is essential. An anthropomorphic phantom was designed and constructed in order to conduct a remote-audit program that allows evaluation of an institution's accuracy for delivering IMRT. The dosimetric characteristics in the phantom were investigated.

2. Method & Material

Phantom Design

An IMRT anthropomorphic phantom (PMMA) that simulates the head and neck was developed. The phantom has the shape of a cylinder with one target and three organs-at-risks (OARs) inside the unit. The target and OARs were shaped analogous to those of nasopharynx cancer patients. Two additional structures, an air cavity and a bony structure, were also included. The air cavity and bony structure were designed to be replaceable with tissue equivalent material when there is a requirement to perform dosimetry in a homogeneous medium.

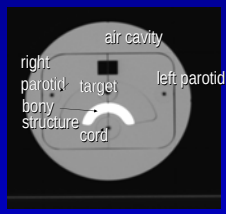

Figure 1. Axial CT image of the phantom

Dosimetry

■ TLDs or ion chambers can be used for the measurement of an absolute dose in the phantom. TLD or IC holders are inserted into the center of each ROI.

■For the relative dose distribution across the target and OARs Gafchromic®EBT (ISP, International Specialty Products, Wayne, NJ USA) was used. Two film slots were orthogonally placed near the center of the phantom. One slot was along the transverse plane and the other was on the saggittal plane. The phantom can be converted into cube shaped phantom.

■ Dose measurements were performed at the center of the target and ROIs using TLDs and Ion Chambers. Two institutions (Korea Food & Drug Administration: KFDA, and Radiological Physics Center : RPC) provided TLDs and analyzed the TLD dose after irradiations.

Measurements

■ Measurements with TLDs and ICs were done for four different cases. The first was an anterior one port 6MV X-ray (Primus, Siemens, USA) irradiation to the homogeneous phantom. The doses at the center of the target were measured using TLDs and an PTW31015 ionization chamber (PTW-Freiburg, Freiburg, Germany). The second case had the same beam geometry and MUs, but inhomogeneties were inserted into the phantom. The third case was the 3 port beams which represents the multi-port 3D-CRT treatments. Three ports of beam were distributed in equi-gantry angle, which were 0°, 120° and 240°.

The fourth case was an IMRT plan which was generated with the same constraints that apply to a clinical case. For each case, four sets of TLDs were measured to reduce the statistical uncertainty, and three measurements were taken with an IC.

For the two dimensional dose measurements, EBT film dosimetry was comparised with the EDR film measurement for one IMRT clinical case.

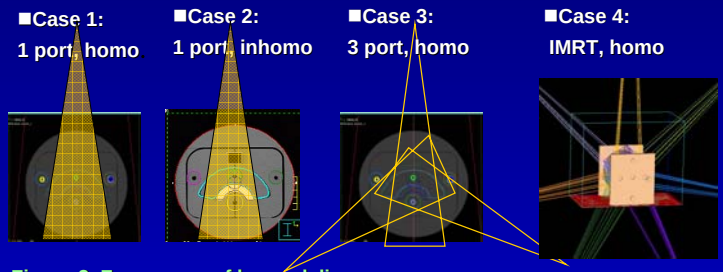

Figure 2. Four cases of beam delivery

3. Results

The dosiemtric results are summarized in Figure 3 and 4. As for the results, for the first three cases the IC readings and TLD measurements agree within a 0 ~2.9% deviation . In the IMRT case, the IC readings and TLD measurements agreed within 4%, except for one site where the discrepancy was 7%. For film dosimetries, any exact quantitative computation of difference was not feasible, but a very close agreement was observed for most of the dose ranges (90–40%) and a small deviation existed for the 100% and low dose (30% of the delivered dose) regions (Figure 4).

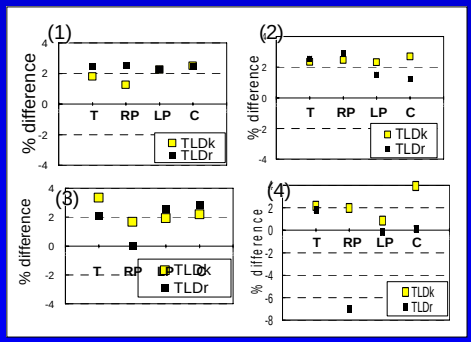

Figure 3. % differences of (1) case 1, (2) case 2, (3) case 3, and (4) case 4. Data were normalized to IC measurements. TLDk: KFDA data, TLDr: RPC data. T: target, RP; right parotid, LP: left parotid, C: spiral cord.

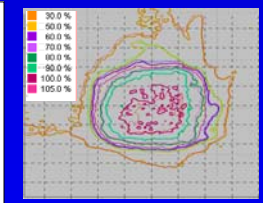

Figure 4. The isodose lines measured by EBT film and the EDR2 film for the IMRT plan delivered to a plastic-water phantom. Thick solid lines: isodose lines on EBT film, Thin solid lines: isodose lines on EDR2 film.

4. Conclusion &Discussion

The TLD measurements in the developed phantom agreed with IC results within an acceptable difference although a large difference in IMRT plan was caused by a setup uncertainty. The developed phantom with TLD dosimeters as well as EBT film is feasible to be used for remote monitoring of IMRT.