Comparison of three immobilisation systems for radiation therapy in Head and Neck Cancer

Christiansen R.L.1, Hansen. C.R.1, Nielsen T.B.1,2, Johansen J.3, Brink C.1,2
1 Laboratory of Radiation Physics, Odense University Hospital, Denmark, 2 Institute of Clinical Research, University of Southern Denmark, Odense, Denmark, 3Department of Oncology, Odense University Hospital, Odense, Denmark

INTRODUCTION

Daily online Cone Beam CT (CBCT) scans are becoming increasingly common. However, immobilisation remains important since rotational setup errors are generally insufficiently corrected. Rotational errors might especially be of concern in the head and neck region due to the close adjacency of target and organs at risk.

This study investigates the precision of three commercially available immobilisation systems by measuring the random and systematic setup errors for three equal groups of Head and Neck Cancer patients.

METHOD AND MATERIAL

The evaluated systems were: A) Orfit AIO base plate, standard neck supports and a pre-cut 5-point reinforced Efficast mask fixed to the base plate with L-shaped profiles, B) Q-Fix AccuFix Cantilever Board Featherline base plate with adjustable shoulder locks, Vaucif neck support and a U-Frame Aquaplast mask for the head, and C) Aquaplast mask, covering the head and shoulders, fixed to a Vacfix cushion at 8 points with velcro strips (current clinical system in Odense).

Forty-two patients, divided in three equal groups, all receiving 66-68 Gy in 33 fractions were used to evaluate the precision of the three systems. Daily CBCT was performed with a few exceptions yielding a total of 1303 CBCT scans. Automatic registration was performed on the bony structures of the neck (clipbox). Translational and rotational setup errors were extracted from the CBCT system.

RESULTS

Translational setup errors in mm

Rotations

Random setup error in rotation (σrotation) for system A was less that for system B in all directions (p < 0.02) (Fig. A-c). System A had less than C in the lateral direction (p < 0.002).

In the longitudinal and vertical directions, difference between σrotation for systems A and C were not statistically significant.

For all systems no large trend were observed in σrotation during the treatment course.

Systematic setup error (Σsystematic) was similar for all systems in the lateral direction.

In the longitudinal and vertical directions Σtranslation for system A was less that than for B and C (Table 1).

DISCUSSION

As daily online CBCT of head and neck cancer patients has become more common, a large part of the translational setup error is corrected. However, rotational setup error is often not sufficiently corrected, since most treatment couches do not correct for rotations. Most margin protocols assume perfect correction of the entire PTV. In case of a rotation, this is only true in a single point. The further away from this point a given structure is, the larger the impact a rotation will have on the precision of the treatment.

Though precise patient setup can be achieved by daily CBCT, repositioning and re-scanning a patient takes effort and time in the day to day treatment of patient. Therefore, the lower re-scan frequency for system A, resulting from its low rotational setup error, is desirable. For other image protocols than daily CBCT, a reduction in setup margin is possible for system A compared to B and C, as demonstrated in table 3, in the extreme (and clinically unlikely) case of no image protocol.

CONCLUSION

In the current clinical setting, system A had statistically significant less setup error than B and C, overall. Systematic and random setup errors for A were as good as, or better than those for B and C, for both translations and rotations.

In clinical practice, translational setup errors are usually corrected through the use of an image protocol and subsequent shift of the treatment couch. Correction of rotational setup errors requires repositioning and re-scan of the patient. System A had lower re-scan frequency than B and C due to less rotational setup error, reducing the need for time consuming patient repositioning considerably.