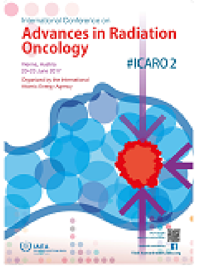

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Dosimetric Influence of translational and rotational motion correction using a robotic couch in the linear accelerator based stereotactic radio surgery and radiotherapy dose delivery

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Introduction: The linear accelerator based radiosurgery is initially started with invasive frame, like Lakshell frame and BRW frame. However in recent times improvement of setup imaging and other accessories like six dimensional motion enabled couch empower the community to move towards a frameless radiosurgery. Stereotactic radiosurgery (SRS) and stereotactic radiotherapy (SRT) deserves a very high degree of accuracy in reproducibility. While treatment, after placing the patient in couch due to the weight of the head, cranial side goes down due to fulcrum affect. In an invasive frame based case the head is attached to a couch mount with a three screws governing the rotational and translational motion able to provide all six dimensional motions to bring the head back in the appropriate position. However in a frameless SRS/SRT it is not possible. Therefore the couch six-dimensional motion is used for reproducing the patient position. The advantage of stereotactic localisation using an invasive frame can be completely or partially obtained by the cone beam imaging and six dimensional couch movements. In this study we would like to evaluate the dosimetric error in absence of couch motion.
Materials and Method: 30 patients of either stereotactic radiotherapy or radiosurgery with 33 PTVs were planned in Monaco or iPlan Treatment planning system (TPS) and delivered in Elekta Axesse (Elekta, Stockholm, Sweden) linear accelerator equipped with uniform 4 mm width multileaf collimator (MLC). After placing the patient in the couch a cone-beam CT (CBCT) was performed yielding a set of positional correction values (called as primary correction values). Patient positional error translational (lateral, longitudinal and vertical) and rotational corrections (roll, pitch, yaw) obtain by CBCT was performed using the robotic couch to obtain the correct isocentre as well as alignment of the patient. Further another CBCT was acquired to verify the couch enable patient positional correction. Positional correction obtained in the second CBCT (called as residual correction) and either cannot be corrected further or having no dosimetric influence. Planner fluence was verified using 729/octavious Phantom with and without applying the primary and residual shifts in the couch and matched with the TPS obtained values. Further gamma index evaluation was done with the TPS generated planner dose (without shift) and measured planner dose with primary and residual corrections.
Result Dose distribution was analysed using the gamma index used as sealing function. The mean difference between the {TPS-Measured with no couch shift} –{TPS-Measured with CBCT shift} and its standard deviation for a large range of γ (4.2-0.14) shows a very high variation of dose with a mean difference of 15.6% and maximum of 29.6% and minimum of 1.1%. The maximum, minimum and mean SD were 25.9% and 3.4% and 17.4% respectively. Mean 1%-1mm, 2%-2mm gamma passing when compared between TPS fluence and measurement obtained using a couch movement using primary correction values were 73.1±3.5% and 83.5±2.3% respectively. Same gamma criteria between TPS fluence and measurement obtained from applying the residual table correction yields 95.1±2.4% and 98.2±1.7% respectively.

Discussion: Brainlab Elekta has come together for first time in our centre for offering the frameless stereotactic solution. However due to the specific design that brainlab base plate can only be fixed with the Elekta couch extension but not with the main couch a significant shift in the patient position was observed. As the couch extension is not firmly adhere with the main couch its acting as a lever of first kind; while putting the patient on the couch the cranial end goes down due to fulcrum effect. Sometime the movement in more than 1 cm. This movement of the cranial end may lead to a complete geometrical miss of the tumour. This problem appear for invasive frame stereotaxy as well and corrected using the roll, pitch, yaw rotation screws attached

to the frame base. These rotational corrections attributed to the patient head weight and fulcrum effect is correctable only in terms of couch rotation and movement. As result shows the gamma passing with the primary table correction is significantly high and not suitable for therapy delivery. Nevertheless, positional error substantially decrease to an acceptable limits after applying the rotational and translational shifts to the table.
Conclusion: Conclusively it can be stated that a imaging system having capability of 6D patient position matching and a couch system having capability of correcting the 6D motion should be used for the correction in frameless stereotactic therapy. Without the six dimensional motions enable robotic couch it's not possible to correct the positional error properly and hence we strongly recommend the use of robotic couch during the frameless stereotactic radiotherapy and surgery.

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