

Purpose:

Advances in image-guided treatments have made frameless stereotactic radiosurgery (SRS) feasible. Extracranial SRS treatments are highly conformal, and technical delivery precision on phantoms has been shown to be less than 1 mm. The human component of error, i.e. voluntary and involuntary motions during the treatment, plays an increasing role in the determination of PTV margins. The residual motion between imaging intervals during image-guided treatments constitutes the treatment uncertainty and needs to be compensated by the application of a PTV margin.

Method and Materials:

During Cyberknife extracranial SRS, the patient position is verified by orthogonal x-ray images every 80 seconds on average. Data of 90 extracranial SRS patients have been analyzed. The extent of patient motion has been studied during the whole treatment, the first 5 minutes and first 15 minutes of each treatment. Motion patterns of anatomical sub-sites were studied.

Results:

The maximum frequency of all translational patient motions was in the range of 0.02-0.2 mm, with 90% of all motions below 1 mm. No differences between the three translational directions have been observed. The maximum frequency of rotational patient motions was between 0.1-0.2 degrees, with a wider distribution in the degree of roll. The average patient motion for cervical spine was 0.47 mm, thoracic spine 0.34 mm, and lumbar spine 0.29 mm. In the 214 fractions analyzed, patients moved on average 1 mm away from their original setup position after 5 minutes of treatment. No statistically significant difference exists for the range of patient motion during the first 5 or 15 minutes as compared to the whole treatment.

Conclusion:

For image-guided treatments, PTV margins of 1.0 mm include 90% of observed patients motions for static lesions. Larger margins may be necessary if the treatment field is not rotationally symmetric around the isocenter.