

**Purpose:** To develop an image-guided procedure for online head-rotation correction and real-time motion monitoring with threshold gating for clinical frameless stereotactic radiosurgery (SRS) using video-based optical 3D surface imaging (AlignRT) to ensure accurate tumor localization and clinically-acceptable head motion at all treatment couch angles during treatment.

**Methods:** Eight patients, immobilized with a deep-head mold and a mouth-piece fixed to the couch, were treated with single-fraction frameless SRS. The planning target volume was defined by a 3.0mm-margin around the gross tumor volume for these patients with brain metastasis. A ceiling-mounted AlignRT system with three camera pods was used to correct residual head rotation before cone-beam computed tomography (CBCT) setup, verify setup at all treatment couch angles, and monitor the head motion with 1.0mm gating threshold for beam hold. The external contour of the planning CT and on-site surface reference images were used for setup verification and motion monitoring, respectively, using the maximum visible skin surface within the entire mid-to-upper face as the region of interest. An anthropomorphic head phantom and an adjustable platform (accuracy of 0.1mm) were used to determine the geometric accuracy of frameless setup procedure and AlignRT motion detection.

**Results:** The phantom experiment shows that the motion detection accuracy was less than 0.1mm. For these patients, <1 degree head rotation was achieved at the setup by using surface-image-guided head repositioning. The patient head motion was found to be <1.0mm for 98% of the time after CBCT setup, while the beam-hold gating was used for <1% of beam-on time. The required workload and machine time of this procedure are similar to those of conventional frame-based SRS.

**Conclusions:** This non-invasive frameless SRS procedure provides accurate and reliable means to perform clinical SRS. The image-guided setup and motion control provides adequate accuracy, yet more convenient to the patients, comparing with frame-based SRS.

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