Position verification for intercranial stereotactic radiotherapy using 3D surface imaging

Lindgren-Turner, J.[3], Corsini, L.[2], Keane, R.[2], Smith, N.[3], Meir, I.[3] and Bidmead, M.[1]

[1]Department of Physics, Royal Marsden Hospital, London, UK
[2]Department of Radiotherapy, Royal Marsden Hospital, London, UK
[3]Vision RT Ltd, London, UK

Purpose/Objective:

The conformal nature of intracranial stereotactic radiotherapy means that verification using bony anatomy as identified on electronic portal images is limited due to the inherent difficulties in analyzing small irregular non-coplanar fields. The use of orthogonal imaging protocols that compare portal images centred through the treatment isocentre to CT constructed DRR's increases the radiation exposure to sensitive neighbouring structures. Other verification methods involving measurements from surface structures are time consuming and difficult to validate. The current verification protocol at the Royal Marsden Hospital is to take a verification CT slice through the isocentre and at +/- 2mm of the proposed isocentre position, prior to the first treatment (Fig 1). This study investigates the use of AlignRT, a 3D surface imaging system, as a method of verifying treatment position on a daily basis without the need for radiation exposure.

Materials/ Methods:

Volunteers were immobilised using a Gill-Thomas- Cosman (GTC) relocatable stereotactic frame (Fig 2) with personal mouth bites. The volunteers were then positioned to an arbitrary isocentre position marked onto the stereotactic positioning device (Fig 3). A reference image was then taken using the surface imaging system and the couch coordinates recorded. Once a region of interest was defined the couch was moved to a range of different locations in order to simulate positional errors. Surface images were acquired at each position and registered to the reference surface. Coordinates were output to indicate the translations and rotations to realign with the reference surface. These coordinates were then compared to the actual coordinates at the reference position. In total, 78 positions were acquired for the 2 volunteers. This study also looked at the affect of increasing the image resolution (decreasing the spacing of points which make up the surface) on both the accuracy and image processing time.

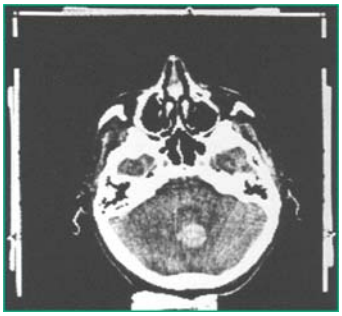

Fig 1. Current CT Verification method

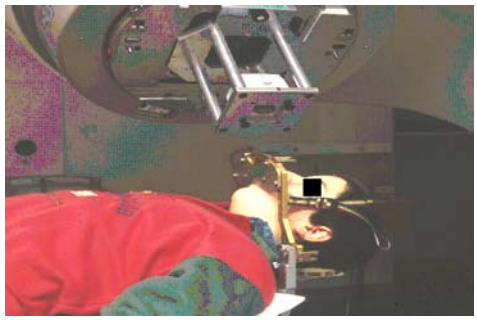

Fig 2. GTC relocatable frame

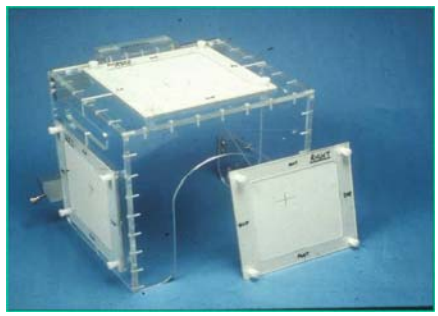

Fig 3. Stereotactic positioning device

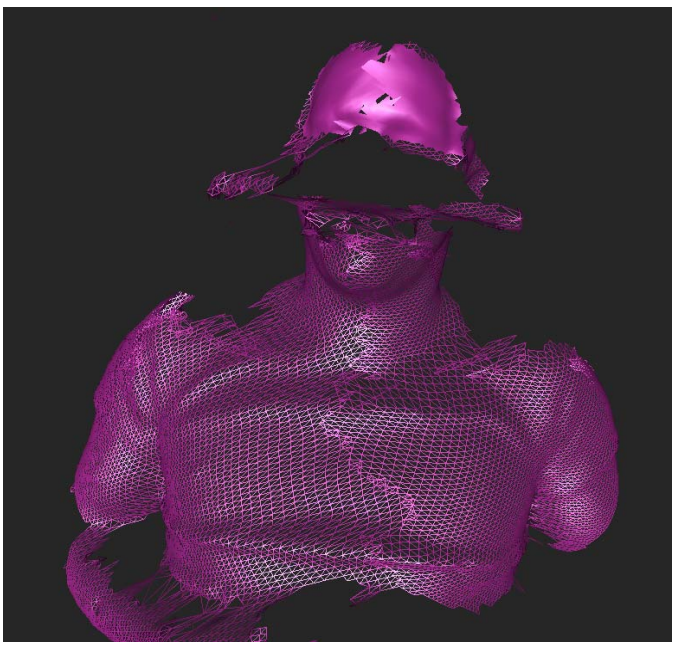

Fig 4. Region of interest on surface image to include supra-orbital ridges

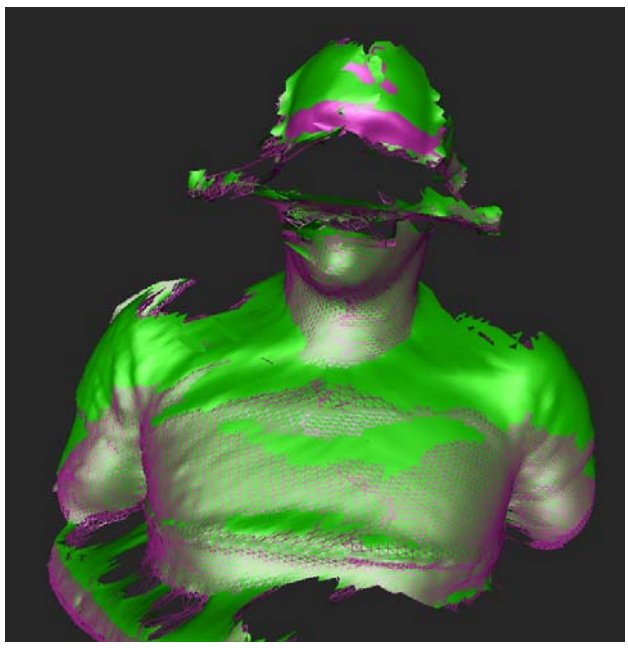

Fig 5. Visualisation of surface misalignment

Results:

The differences between the actual movements from the reference image and the movements predicted by AlignRT were all within acceptable limits. The mean differences were Vertical: 0.05cm (SD 0.06cm), Longitudinal: 0.06cm (SD 0.08cm), Lateral: 0.07cm (SD 0.09cm), Rotation: 0.85 deg (SD 0.82 deg). The combined image acquisition and processing time was typically less then 2 seconds and image registration typically took around 1 second. This study assumed that there was no movement of the subject whilst immobilised in the frame. This assumption was probably not entirely true and there was probably some movement, albeit very small, during the course of the study. Increasing the image resolution from 8mm to 2mm significantly increased the image processing time (from seconds to minutes) and had no discernable affect on the accuracy

Conclusions:

The 3D surface imaging system used in this study appears to provide a fast and accurate method for positional verification of intercranial stereotactic radiotherapy treatments. The Image resolution was adequate although further work is needed in order to refine the robustness of the acquisition for relatively small fields of view such as required for this application.