Registration Employing Leksell Pins Provides Accurracy Similar to that Achieved with Bone Fiducials

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RATIONALE: Use of bone fiducials for stereotactic procedures such as SEEG placement or laser ablation allows accurate registration (Fig 1). Co-registration using surface anatomy may prove less reliable due to scalp displacement or swelling. Bone fiducials entail 4 or 5 tiny scalp wounds, and the purchase of some bone fiducials on the outer table may sometimes prove precarious.

During stereotactic procedures necessitating multiple trajectories, we usually employ a Robot (ROSA). The Leksell frame provides excellent head immobilization while providing a backup navigation system (Fig. 2). We reasoned that the 4 pins securing the Leksell frame to the skull could serve as bone fiducials without diminishing accuracy.

METHOD: Using ROSA software, we quantified localization error, defined as the euclidian distance between planned entry/target points and actual entry/target points, for each SEEG electrode trajectory associated with either Leksell Pin (LP) –Figs 3 and 4-- or "traditional" bone fiducial (BF) registration. Localization error was calculated in the manner described by Gonzalez-Martinez et al. In brief, error was defined as the euclidian distance between actual and planned points employing measurements of x, y, and z-axis errors obtained manually with the ROSA ruler software measuring tool. The actual electrode trajectories were taken from the postop CT scan (0.5mm thickness). (Fig. 5) Target-point and entry-point errors of 70 consecutive LP-defined trajectories were compared to those seen for 95 consecutive BF-defined trajectories.

RESULTS: Target-point errors (TPE) for the LP group (median = 1.8mm, range 0 – 5.8) were similar to the BF group (median = 1.6 mm, range 0 – 7.8) with a mean difference of -.178t(163) = -1.541, p=.125, (90% CI, -0.369 to 0.013). Likewise, entry-point errors (EPE) for the LP group (median = 1.2, range 0 – 3.2) were similar to the BF group (median = 0.9mm, range 0 – 4.7) with a mean difference of -0.016 t(163) = -0.078, p=.938 (90% CI, -0.347 to 0.315). Only one of the 64 LP entry-point errors exceeded 3.0 mm; 2 BF entry-point errors exceeded 3.0mm.

CONCLUSION: The techniques appear equally accurate, but the LP bone fiducial renders placement of 4 bone fiducials unnecessary, potentially reducing OR time and patient discomfort.

Bone Fiducial Registration

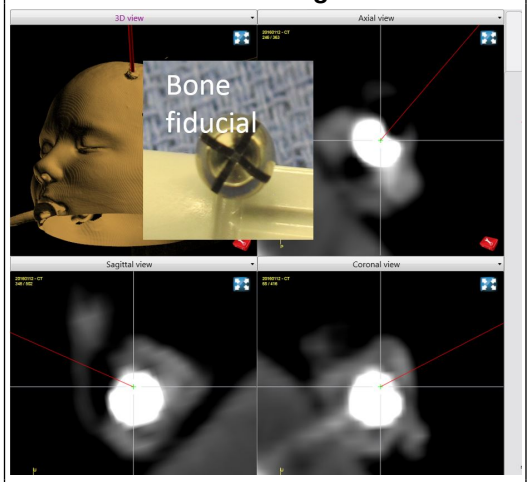

Figure 1

Leksell Frame immobilizagion

Figure 2

Leksell Pin

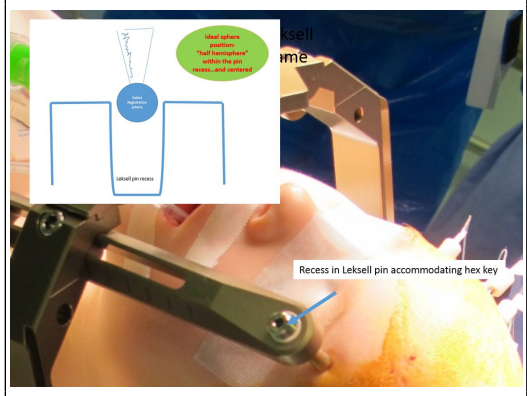

Figure 3

Correct orientation of pointer probe tip in Leksell Pin

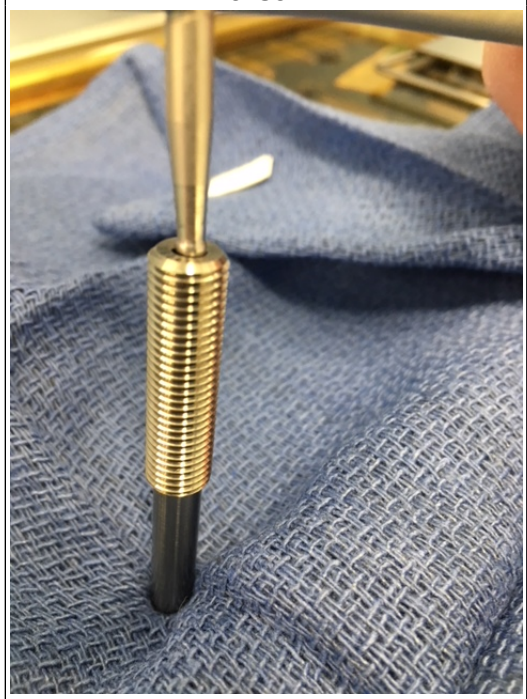

Figure 4

Co-registration of post-op CT with pre-operative plan

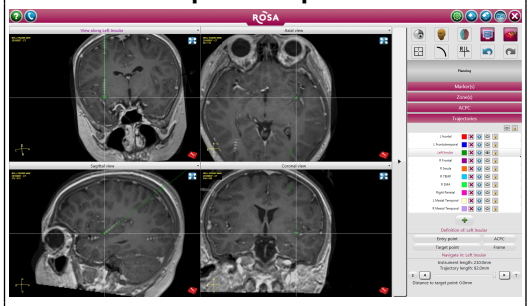

Figure 5

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