Accuracy and Predictability in Stereotactic Stem Cell Transplantation

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Introduction

- Stereotactic transplantation of stem cells has been studied for use in multiple conditions including Parkinson's disease (1-3), Huntington's disease (4), ALS (5), spinal cord injury (6), and stroke (7)
- Animal studies have been promising but clinical trials have had mixed results
- Stereotactic injection techniques have received little critical attention (8-9)
- Use of intraoperative CT guidance and accuracy of implantation have not been reported

Methods

Population

- 10 patients with history of ischemic stroke

Intervention

- Stem cell transplantation performed as part of ongoing clinical trial
- Stereotactic targeting with intraoperative CT
- Cells delivered along 3 tracts adjacent to stroke bed

Data collection and analysis

- Intraoperative CT merged with pre- and postoperative MRI
- Air deposits (CT) and cell suspension (T2-weighted MRI) mapped in relation to surgical targets
- Distances analyzed with 1-sample t-test, with comparison to zero

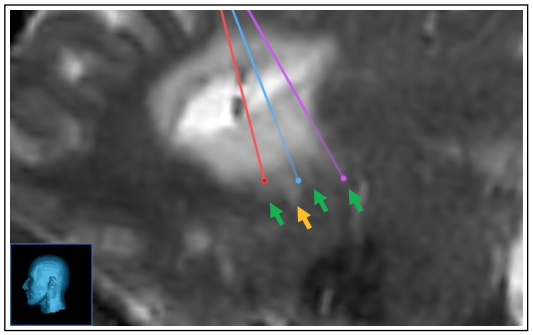

Fig 1. Visualization of cell suspension tracts on T2-weighted MRI. Cell suspension (green arrows) can be differentiated from encephalomalacia (orange arrow) by comparison to preoperative MRI.

Results

- Air deposits varied by location and distribution (Fig 2), and were often seen in stroke cavity and along injection tract (Fig 3)
- Deepest air deposit found 4.5 +/- 1.0 mm (mean +/- 2 SEM) from target
- Deepest cell suspension deposit found 2.8 +/- 0.8 mm from target
- On average, air deposits were anterior (1.2 +/- 1.1 mm, p=0.04) and superior (2.4 +/- 1.0 mm, p<0.001) to target (Fig 4)
- No directional bias for deepest cell suspension deposit relative to target (Fig 4) or air deposit (Fig 5)

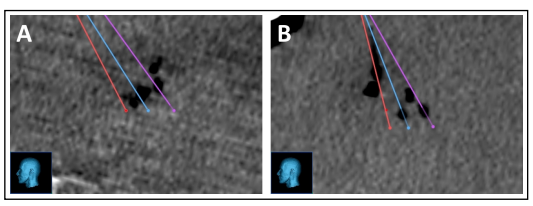

Fig 2. Variation in intracerebral air deposits seen on CT.

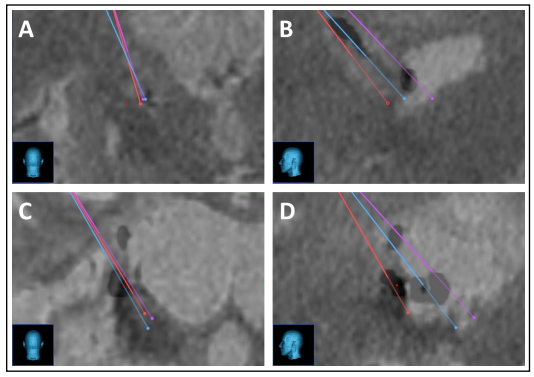

Fig 3. Air can accumulate in stroke cavity and along injection tract. Fused postoperative CT and MRI are shown for two patients (A & B, C & D).

Conclusions

- Precise stereotactic cell transplantation is a little-studied technical challenge (8-9)
- Reflux of cell suspension and air, and the structure of the injection tract, affect delivery of cell suspension
- Intraoperative CT allows assessment of delivery and potential trajectory correction, as required for certain indications (e.g. when targeting brainstem or deep brain nuclei)

References

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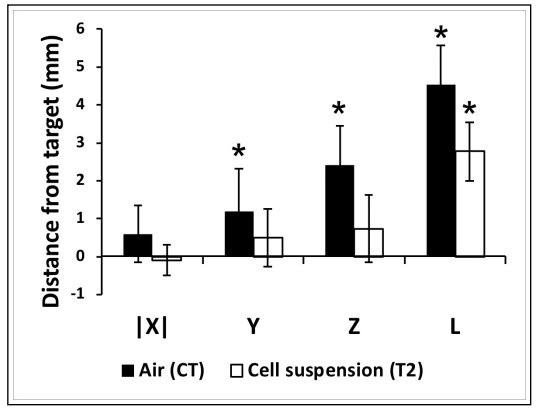

Fig 4. Distance from deepest air deposit (on CT) and from deepest cell suspension deposit (on T2-weighted MRI) to target. |X| = absolute value of difference in X axis. L = Euclidean distance. *P<0.05.

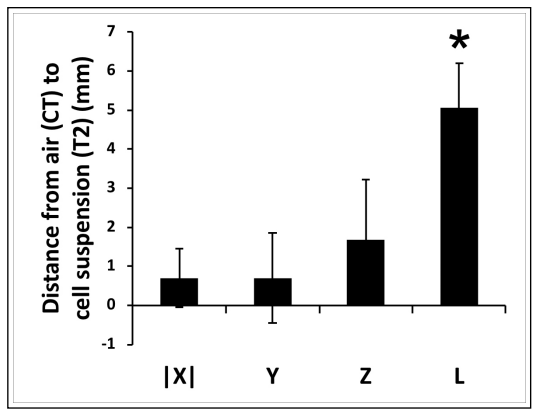

Fig 5. Distance between deepest air deposit and deepest cell suspension deposit. X| = absolute value of difference in X axis. L = Euclidean distance. *P<0.05.