Intraoperative CT Registration for Frameless Stereotactic Navigation of Intracranial Laser Interstitial Thermal Therapy

An Initial Experience

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Disclosures

- Vaughan – no disclosures
- Suarez – no disclosures
- Buch – no disclosures
- Lucas – no disclosures
Introduction

- Laser interstitial thermal therapy (LITT) has become an increasingly common minimally invasive treatment method for many intracranial pathologies.

- It relies heavily on stereotactic navigation and magnetic resonance imaging for accurate, precise targeting, which increase the complexity of operative case setup and transport logistics.

- We integrated intraoperative CT scan with cranial fiducials into the operative workflow for LITT and frameless stereotaxy, and report our initial experience over nearly three years.
Methods

- We performed a retrospective case review of all patients from one tertiary referral center undergoing laser interstitial thermal therapy for intracerebral lesions between September 2014 and May 2017.

- LITT has been introduced and performed by a single surgeon at our center. It has been performed for multiple indications including gliomas, brain metastases, radiation necrosis, and medically intractable epilepsy. Patients were referred for surgical evaluation through a multi-disciplinary team of neurologists, oncologists, radiation oncologists, and internists.
Pre-operative evaluation includes an outpatient high resolution MRI, which is merged with the operative registration CT scan during the case.

Intraoperative registration CT is performed with a mobile CT scanning unit in the operating room.
# Results

**Demographics**

<table>
<thead>
<tr>
<th>Age (median)</th>
<th>51 (range 23-86)</th>
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<tbody>
<tr>
<td>Gender (female)</td>
<td>28 (72%)</td>
</tr>
</tbody>
</table>

**Indication for Ablation**

- Epilepsy: 22 (56%)
- Primary CNS Tumor: 7 (18%)
  - GBM: 2 (5%)
  - Non-GBM: 5 (13%)
- CNS Metastases: 3 (8%)
- Cavernous Angioma: 2 (5%)
- Biopsy Inconclusive lesion: 3 (8%)
- Other: 2 (5%)

- Thirty-nine patients were identified, who underwent forty-one separate intracranial ablation procedures.
- Medically intractable epilepsy was the primary diagnosis for 22 of the 39 patients (56%).
- For the remaining 17 patients, five had a pre-operative diagnosis of primary brain tumor (13% of total group) and four had a mass suspected to be secondary to a primary malignancy.
Results

- Laser ablation was successfully completed in 38 patients (97%), with a total of 41 procedures utilizing 47 laser catheters. We used same-day intraoperative CT in 37 patients (95%) for frameless stereotactic registration, or in 39 of 41 procedures, and previously acquired CTs for the remaining two cases.

- All 41 procedures were supratentorial; 7 of the patients had 2 separate ablation targets during the same procedure, such that two separate laser catheters were placed and activated in series during one anesthesia encounter.

- The remaining case was aborted after biopsy revealed a parenchymal fungal abscess in this immunocompromised patient, which was washed out and subsequently treated with antifungal agents.
Results

<table>
<thead>
<tr>
<th>Operative &amp; Admission Characteristics</th>
<th>LITT n (%)</th>
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<tbody>
<tr>
<td><strong>Lesion location</strong></td>
<td></td>
</tr>
<tr>
<td>- Temporal</td>
<td>26 (63%)</td>
</tr>
<tr>
<td>- Frontal</td>
<td>10 (24%)</td>
</tr>
<tr>
<td>- Parietal</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>- Occipital</td>
<td>1 (2%)</td>
</tr>
<tr>
<td><strong>Ablations per operation</strong></td>
<td></td>
</tr>
<tr>
<td>- One</td>
<td>33 (80%)</td>
</tr>
<tr>
<td>- Two</td>
<td>7 (17%)</td>
</tr>
<tr>
<td><strong>Post-operative stay</strong></td>
<td></td>
</tr>
<tr>
<td>- Discharged on post-op day 1</td>
<td></td>
</tr>
<tr>
<td>- Discharged by post-op day 3</td>
<td></td>
</tr>
<tr>
<td><strong>Wound infection at 30-day follow-up</strong></td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

- There were no immediate registration complications during the ablation, including zero returns to the operating room for laser catheter repositioning. We had one technical complication: one laser catheter was found to be fractured after insertion, prior to transfer to MRI, and was promptly replaced without further issues.

- Two patients experienced immediate post-ablation complications during the index admission, one with worsened unilateral lower extremity weakness, and one with idiopathic bilateral hand weakness.
Summary Points

- Use of intraoperative CT with fiducial markers allows for reliable intraoperative registration in frameless stereotaxy for targeting intracranial lesions with LITT without requiring another patient transfer outside of the operating room.

- CT registration is feasible, safe, and a valuable adjunct to LITT in optimizing operative workflow and advancing the field of minimally invasive neurosurgery.