Abstract

Objective
A new, minimally invasive registration method was developed for image-guided otologic surgery. We utilized laser-sintered template of the patient’s bone surface to transfer the virtual markers to the patient’s bone intraoperatively and eliminated the necessity for preoperative marker positioning or additional CT scan.

Study design
Simulation surgeries and clinical application.

Subjects and Methods
We measured registration errors in 10 trials using replicas and 6 ear surgeries (2 cochlear implant insertions, 4 translabyrinthine acoustic tumor removals).

Results
The target registration errors varied among the surgical targets. Errors were less than 1 mm near the cochlear implant insertion target both in phantom study and actual surgeries.

Conclusion
Our newly developed method reduced the preoperative procedures for patients but did not reduce the accuracy in cochlear implant surgery. Our method would be a useful image-guided surgery method in the field of otology where both accuracy and non-invasiveness are required.

Our Image-guided Surgery system

IGS attachment for tracking drill tip throughout drilling process.
Reference tracker on dental splint or mouthpiece.

Protocol for conventional registration

Before surgery
1. Attach markers on the patient (skin or bone).
2. Obtain preoperative CT.
3. Leave the markers on the patient until surgery.

In the OR
1. Register attached markers to the markers on CT data.

PROBLEMS
1. Although CT is often already taken, additional CT is necessary for IGS registration.
2. Less time for preparation

Virtual markers

1. Place markers (2 mm dia x 10 mm len cylinders) on CT data.
2. The edited CT now looks as if it was taken after the patient had cylinders screwed on his/her temporal bone.

Transferring virtual markers using template

Surface Template-Assisted Marker Positioning (STAMP)

New protocol in STAMP registration

Before surgery
1. Create template using the already-existing CT.

In the OR
1. Expose temporal bone.
2. Attach template on the patient’s temporal bone.
3. Transfer markers from template to the bone.
4. Register transferred markers to the markers on CT data.

BENEFITS
1. No preoperative marking process needed.
2. No preoperative additional CT scan needed (we usually have CT data ready at the time the patient is scheduled for operation, and that is enough).

Registration errors

In simulation surgeries

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<th>TRE</th>
<th>TLE</th>
<th>MLA</th>
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<td>0.82 ± 0.25</td>
<td>0.04 ± 0.20</td>
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<td>Skin</td>
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<td>3.18 ± 0.42</td>
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<td>Dural membrane</td>
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<td>2.81 ± 2.50</td>
<td>3.08 ± 2.46</td>
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</table>

In actual surgeries

<table>
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<tbody>
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<td>CT 2</td>
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<td>TL 4</td>
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<td>3.46</td>
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</table>

Conclusions

1. We eliminated the necessity for preoperative bone marking process and additional CT scan by utilizing template created from CT data.
2. Registration errors were comparable to conventional methods for registration.
3. However, less accuracy was obtained when the surgical target lies deep in the temporal bone.
4. This method was considered suitable for daily otologic surgeries where both accuracy and less invasiveness is required.

References

2. Matsumoto N, Hong J, Hashizume M, Komune S. A minimally invasive registration method using surface template-assisted marker positioning (STAMP) for image-guided otologic surgery. submitted ... hopefully coming out soon

Acknowledgments

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