Optical Surface Imaging to Improve the Precision and Accuracy of Radiotherapy Delivery

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Disclosures

Grant for collision prediction work from Philips Radiation Oncology Systems
Overview

• What is optical surface imaging?
• What is its current role in radiotherapy?
• Existing limitations
WHAT IS OPTICAL SURFACE IMAGING?
WHAT IS (OPTICAL) SURFACE IMAGING?
Structured light
+
Triangulation
Planning CT

Treatment Plan

External Surface + Isocenter
Reference Surface

In-room, real time Surface

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRT mm</td>
<td>0.2</td>
</tr>
<tr>
<td>LNG mm</td>
<td>-0.4</td>
</tr>
<tr>
<td>LAT mm</td>
<td>0.5</td>
</tr>
<tr>
<td>MAG mm</td>
<td>0.7</td>
</tr>
<tr>
<td>Yaw °</td>
<td>0.4</td>
</tr>
<tr>
<td>Roll °</td>
<td>-0.7</td>
</tr>
<tr>
<td>Pitch °</td>
<td>0.3</td>
</tr>
</tbody>
</table>
VRT LNG LAT
Yaw Roll Pitch

----- Thresholds-----

Positional adjustments
Beam Hold
WHAT IS ITS CURRENT ROLE IN RADIOTHERAPY?
Patient position at simulation

+ Location of treatment isocenter

Initial positioning aid    Intra-fraction monitoring
Patient position at simulation
+
Location of treatment isocenter

Initial positioning aid
(Replace tattoos + lasers)

Intra-fraction monitoring
Patient position at simulation
+
Location of treatment isocenter

Initial positioning aid  Intra-fraction monitoring
Deep Inspiration Breath Hold (DIBH) for left-sided breast patients

Stereotactic Radiosurgery (SRS)
Deep Inspiration Breath Hold (DIBH) for Left-Sided Breast Treatments

• DIBH → Heart sparing
• Voluntary breath-hold with Surface Imaging
• Automatic beam-hold possible
• Visual guidance available

Photo source: Conroy et al, JACMP 2016 (doi:10.1120/jacmp.v17i4.6188)
• Evaluation of cardiac abnormalities post-DIBH RT with AlignRT
• 20 patients, pre-RT and 6-month post-RT SPECT scans
• No recorded perfusion or wall motion abnormalities
Stereotactic Radiosurgery (SRS)

- Real-time patient monitoring throughout treatment
- Open mask needed – patient selection!
- CBCT for initial positioning
- Patient monitoring and position correction

Photo source: VisionRT
Initial clinical experience with a frameless and maskless stereotactic radiosurgery treatment  

(Cerviño et al, PRO 2012)

Frameless, real-time, surface imaging-guided radiosurgery: update on clinical outcomes for brain metastases  

(Pham et al, Transl Cancer Res 2014)

Initial clinical experience with surface image guided (SIG) radiosurgery for trigeminal neuralgia  

(Paravati et al, Transl Cancer Res 2014)
Equivalent outcomes to framed and other frameless techniques + increased patient comfort
EXISTING LIMITATIONS
EXTERNAL Surface
Correlation with target?
Untracked internal motion?

Monitoring area of interest
Lack of topography
Shift affected by sheets, clothes, masks...
Tolerance settings and confounding motions

Surface Occlusion
Treatment machine
Non-ionizing radiation / no markers
Real time quantitative evaluation of patient movement

Improve radiation delivery accuracy and precision
Non-ionizing radiation / no markers
Real time quantitative evaluation of patient movement

Improve patient safety
Thank you