Surface Imaging for Treatment Verification

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Outline

• Surface imaging for IGRT
• Main clinical applications
  – Patient setup
  – Breast DIBH
  – Intracranial SRS
• Emerging applications
• Summary

Surface image-guided RT (SIGRT)

• Non-invasive and non-ionizing
• Compares the acquired image with a reference image
• Provides surface motion information – not necessarily tumor motion information.
Rigid vs non-rigid registration

Rong et al., 2014

Quality assurance for nonradiographic radiotherapy localization and positioning systems: Report of Task Group 147

Tegla-Wilkinson, Jeng-Uhmann, Joel A. Bencomo, Shiret K. An, Laithan Santanam, Anit Sede, Timothy D. Golberg, Wolfgang A. Tandl, Timothy J. Weathers

AAPM COMMITTEE TREE

Task Group No. 392 - Surface Image Guided Radiotherapy (TG392)

No Website on File | Directory: Committee | Membership

Email: You may send email to the group at sex-rgs-ag@nih.gov or ask questions or or.

You may send this address 2013 TG392Web.pdf to

In your local address book. This also updates hourly from the AAPM Directory.

Charge:

1. To review current use of non-radiologic surface imaging functionality and commercially available systems.
2. To provide direction on how to use for general purposes, position, between different, and tissue bone SIS, and potential applications for remote-evaluation.
3. To provide comprehensive and ongoing quality assurance recommendations for clinical, training, and implementation of SIS or hardwearing of surface image guidance technology as a part of a local IPT program (e.g., TG-103).
4. To discuss emerging clinical applications of SIS and associated QA implications, based on evaluation of technology and risk assessment.
Current use of SGIRT in the United States

General Setup

Tattoo-less radiotherapy for breast

The tiny tattoos that patients

They also remain long after the cancer has ended, sometimes stretching and open.

Psychosocial Impact of Radiation Therapy: A Critical Review

Notts woman the first in Europe to have tattooless radiotherapy for breast cancer

The treatment usually involves the skin being extended onto the body, which can have long-term psychological effects on patients.

EP-3318: To Evaluate the Accuracy of Delivering Breast Radiotherapy without Tattoos.

Gopalan & Wu, 2012

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Deep inspiration breath hold (DIBH)

- Deep Inspiration
- Breath Hold

- DIBH: Free breathing (FB)+ breath hold at ~100% vital capacity

Dosimetric benefits of providing treatment at DIBH vs. FB

- Median heart volume with more than 50% of prescribed dose: 19.2% (FB) vs. 1.9% (DIBH)
- Median left anterior descending coronary artery volume: 88.9% (FB) vs. 3.6% (DIBH)


Gated treatment at DIBH with surface imaging

- Treat only when patient is at DIBH

Effect of visual feedback

- Reproducibility and stability improve with visual feedback

Using surface imaging and visual coaching to improve the reproducibility of deep inspiration breath hold for left breast cancer radiotherapy. Li Cervino, S Gupta, MA Rose, C Yashar, SB Jiang, PMB 2009.
Surface-guided SRS

- Open mask immobilization
- Very large dose to brain lesions
  - Single (or hypo-) fraction schemes
- One or multiple lesions
  - Accuracy is crucial
  - Set up (<1mm)
  - Treatment delivery (<1mm, ± 5%)

Local control and OS in brain metastasis

- Local control and overall survival were comparable to previous techniques

<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment modality</th>
<th>Local control</th>
<th>Overall survival</th>
<th>Ref.</th>
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<tbody>
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<td>Pan et al. (2012)</td>
<td>Focal boost SBRT</td>
<td>87.8%</td>
<td>61.6%</td>
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<td>Pham et al. (2014)</td>
<td>Frameless, real-time surface imaging-guided SRS</td>
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Initial clinical experience with surface image-guided (SIG) radiosurgery for trigeminal neuralgia

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<th>Patient</th>
<th>Age (yrs)</th>
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<th>Length of follow (months)</th>
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OSM, Barrows Neurological Institute Pain Score.
Emerging: Surface imaging for respiratory surrogate


Emerging: Safety - Collision prediction

Emerging: Patient safety - Facial recognition

- 2016 National Patient Safety Goals requires a minimum of two patient identifiers
  - Name, DOB, Photo, RFID bracelets, palm scanners, iris scanners, or fingerprint scanners
Emerging: Limited field-of-view in CT

Using a handheld stereo depth camera to overcome limited field-of-view in simulation imaging for radiation therapy treatment planning

Green – original
Magenta – truncated
Navy – reconstructed
Comparable dose distribution

Summary
- SGRT’s use has increased in the last decade
  - Breast & DIBH, SRS mostly
- SGRT has proven to improve accuracy and efficiency of treatment for a variety of treatment sites
- Changes the patient setup paradigm
  - Can remove the need for tattoos and need for lasers (eg. breast)
- New applications are starting to emerge, including patient safety applications
Thank you!

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