Improvement in positioning reproducibility for head-and-neck cancer patients using six degree of freedom couch corrections

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Motivation

• Head-and-neck patients are challenging to position reproducibly
  • Large treatment fields
  • Independent sub-regions (e.g. mandible, neck flexion/rotation)
  • Weight loss

• Setup variations may include rotations

6D treatment couches

• Treatment couches with 6 degree of freedom (6D) have been used for head-and-neck patients
  • e.g. ExacTrac

• We have commissioned integrated 6D couches for TrueBeam (PerfectPitch)
  • Based on 2D/3D matching (OBIs) or 3D/3D matching (CBCTs)
  • No roll correction for 2D/3D match
  • Pitch & roll limited to ± 3°
DHP: I would show a pic of a TRAC H&N versus a 3D CBCT H&N image to really emphasize the FOV limitations and also maybe superimpose the large PTV on both TRAC and CBCT images.

Lorraine A Courneyea, 10/3/2014
Do 6D couches with CBCT data improve positioning?

- Evaluated through a retrospective study
  - 26 head-and-neck patients
  - Consistent immobilization & simulation
  - Daily pre- and post- treatment CBCT imaging
- Each CBCT was evaluated for agreement with the simulation CT positioning
Immobilization & Simulation Procedure

• Simulation appointments:
  • First to fabricate immobilization
  • Second for the CT sim
  • Appointments were 2+ hours apart
    • Time for the mask to harden & shrink
    • Better reflects positioning at treatment

• Immobilization used
  • One of 6 standard headrests
  • Five-point thermoplastic mask
  • Precise Bite custom mouthpiece
Evaluation Procedure

- CBCT matching structure created on the simulation CT
  - Bony anatomy (occipital, mandible, c1/c2, c7/t1)
  - 3 or 5 mm expansion

- Offline registration to the CBCTs
  - Automatch to the 5 mm CBCT matching structure
  - 3D (translations) and 6D (translations + rotations) registrations

- Check if the bony anatomy falls within the 3 or 5 mm margin
  - Done separately for pre and post CBCTs
Results
Example of mandible with a 3 mm margin

Pre-CBCT

Post-CBCT
Example of C7/T1 with a 3 mm margin
Reproducibility of Positioning

% of fractions with bony anatomy outside 3 or 5 mm for 3D & 6D registration

Grey = Pre-CBCTs, Pink = Post-CBCTs
Anatomy Specific Reproducibility: 3 mm

3D Registration

6D Registration

% of fractions with bony anatomy outside 3 mm for 3D/6D registration

Grey = Pre-CBCTs, Pink = Post-CBCTs
Anatomy Specific Reproducibility: 5 mm

3D Registration

- % of fractions with bony anatomy outside 5 mm for 3D/6D registration
- Grey = Pre-CBCTs, Pink = Post-CBCTs

6D Registration
Rotational Corrections

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Conclusions

• Significant improvement with 6D matching
  • 3 mm positioning reproducibility requires 6D
    • Relevant for margin reduction i.e. for proton therapy
• Rotational corrections typically within couch tolerance (3°)
• Still see some anatomy outside 3/5 mm margins
  • Additional immobilization system currently under investigation
• Potential benefit when using this clinically
Acknowledgements

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Questions & Discussion