IMMOBILIZATION IN HEAD & NECK IMRT

29th July 2016
(1st IAEA National Training Course on Head & Neck IMRT – RAS 6072)

Norfadilah Mat Nor
Senior Radiation Therapist
Pantai Hospital Kuala Lumpur
OBJECTIVES

1. Introduction of RT
2. The importance of immobilization
3. Ideal Immobilization
4. Immobilization Principles for H&N
5. Decision making
6. Conclusion
INTRODUCTION

• Radiotherapy goal
  – deliver the desired radiation doses accurately to the desired target volume
  – reduce radiation exposure to specific sensitive areas of surrounding normal tissue
  – throughout the course of treatment

(Zhang et al. 2006)
INTRODUCTION

- IMRT – highly conformal dose distribution
  → sharp dose gradients between complex PTVs & OAR avoidance structures

- Although IMRT requires higher precision than conventional RT, there is an increased chance of patient displacement during IMRT treatment.

- REALITY → delivered dose distribution will likely deviate from the initial treatment plan as a result → daily anatomic variations & setup error
  (Zhang et al. 2006)
It is generally acknowledged that setup error / patient movement can be reduced significantly with the aid of immobilization devices.

- **Immobilization devices:**
  - Any devices that helps to establish and maintain the patient’s in the **same reproducible position**
  - while restricting his/her mobility during the treatment session

(Chelvarajah et al. 2004)
Head & neck NOT a rigid body

- variability in setup corrections for 3 different regions; PPM, C2 & C6
  → introduce extra setup errors
WHY IMMOBILIZATION VERY IMPORTANT?

3D-CRT
(Tumour Volume expansion 10 mm)

IMRT
(Tumour Volume expansion 5 mm)

Dosimetric impact
WHY IMMobilization very important?

**Dosimetric impact**

- Xing et al. (2000) systematically examined the dosimetric effect of small patient movements in head-and-neck IMRT;

  - 3-mm anteroposterior movement can cause a 38% decrease in the minimum target dose or a 41% increase in the maximum cord dose.
IDEAL IMMOBILIZATION DEVICES

(Saw et al. 2001)

1. Comfortable to patient
   ✓ Fully support H&N in a comfortable & relax position

2. No high Z materials
   – Minimal radiation beam attenuation
   – If have metallic materials
     • Can cause artifacts in radiographic images / CT images.
     • Creates unnecessary scattered radiation
     • Increase skin reaction
3. Easily custom-molded to the patient’s external surface contours

- i.e. plastic
  - Strong
  - Durable
  - Light-weight material
  - Radiation beam attenuation → minimal
4. Ability to **retain marks**
   ✓ Writable external surface permits - markings

5. Size constraints
   ✓ not interfere simulation/IGRT/treatment

6. Maintains its integrity throughout treatment course
   ✓ less shrinkage, stronger conforming
7. Speed – Minimal time required to prepare/setup the device

8. Inexpensive $\rightarrow$ value for money
IMMOBILIZATION PRINCIPLES FOR H&N

• Head
  ✓ Thermoplastic mask
  ✓ reinforcement
  ✓ Drape-style mask
  ✓ Pre-cut over eyes & mouth holes

• Neck
  ✓ Custom head mold

• Shoulder
  ✓ Thermoplastic mask
  ✓ Shoulder restraining methods

• Chin
  ✓ Bite block
  ✓ Mouthpiece
HEAD, NECK & SHOULDER immobilization
Comparison of setup accuracy of three different thermoplastic masks for the treatment of brain and head and neck tumors

Laurent Gilbeau, Michelle Octave-Prignot, Thierry Loncol¹, Laurette Renard, Pierre Scalliet, Vincent Grégoire*

Random 3D setup errors in 30 patients treated for brain (n = 15) or head and neck (n = 15) tumors⁴

<table>
<thead>
<tr>
<th>Immobilization device</th>
<th>Random 3D error (1 SD, mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Head</td>
</tr>
<tr>
<td>Three-fixation-point mask</td>
<td>0.7</td>
</tr>
<tr>
<td>Four-fixation-point mask</td>
<td>0.9</td>
</tr>
<tr>
<td>Five-fixation-point mask</td>
<td>1.0</td>
</tr>
</tbody>
</table>

¹ Setup errors were assessed for the three levels according to the type of mask (ten patients for each type).
² 2D error.
³ Significantly worse than with the 4 or 5 FP masks (P = 0.01).

- 3 FP ➞ brain / head
- 4 & 5 FP ➞ brain/head, neck, supraclavicular area
No significant differences in setup accuracy

Allowing to limit PTV <4 mm for H&N tumor
CLAUSTRALPHOBIA

Thermoplastic mask → HeadFIX system

CT image - simulation

Image registration

CBCT image – Day 1

Re-simulate
Finding:

- Shoulder motion was 2-5 mm in each direction on average but reached 20 mm.
- Superior shifts $\rightarrow$ under dosing of lower neck
- Inferior shifts $\rightarrow$ increased the dose to the brachial plexus

- The dose to 99% of the CTV decreased by up to 101 cGy, and the brachial plexus dose increased by up to 72 cGy.
STANDARD HEAD SUPPORT

- different heights and contours to attain the desired head angulation and/or neck position

- TIMO head and neck supports
  - durable polyurethane foam.

- Silverman head and neck supports
  - thin clear plastic
  - minimize build-up and beam attenuation

→ suitable for IMRT
• the customized headrests are made to conform to the entire posterior surfaces of the patient’s, head, neck, and upper thorax, → providing improved fixation.
Patient-specific headrests reduce the patient specific variation in neck curvature (on AP direction).
IMMOBILIZATION – BITE BLOCK/MOUTHPiece

**Figure 1.** Tongue and mandibular depressor. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

**Figure 2.** Tongue depressor in place. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

*Figure 1.* Individual patient unit. Moutpiece (MP) with vacuum area (v), anterior arms (2) and transverse plate (1). During first positioning the moutpiece is still loose and adjustable in anterior-posterior and lateral directions as well as around a crano-caudal axis. In addition, flexion of the head around a left-right axis is possible up to 15° by inserting the desired wedges. After tightening the 4 screws (4) the position of the moutpiece with respect to the transverse plate is fixed.
Findings:

1. Tumor motion occurs even when the patient is not swallowing.
2. Non-uniform margins should be used as a standard PTV margin that accounts for setup error and tumor motion in radiotherapy of HNC.
Benefit of oral immobilization devices.

- **decrease** doses to healthy structures & **delaying** the emergence of **mucositis**.

- grade III mucositis ➔ 4th weeks
  
  (Verrone et al. 2014)

- trial group is lower than control group with different about 11% for grade 3-4.  
  (Qin et al. 2007)

- **Taste dysfunction** (P<0.001),
  
  → Trial group (w) - 21.05%
  
  → Control group (w/o) - 79.17%  
  (Qin et al. 2007)
Study was conducted to improve the interfraction setup accuracy and reduce planning target volume movement using immobilization device HeadFIX mouthpiece + wax, 10 cc/mL syringe, Tongue depressor + wax.
**INTERFRACTION SETUP ACCURACY WITH DIFFERENT IMMOBILIZATION DEVICES IN VMAT FOR ORAL CANCER PATIENTS**

Norfadhilah Mat Nor, Rozilawati Ahmad, Heng Siew Ping, Low Seng Hooi, Lam Kai Seng, Ahmad Radzi Ahmad Badruddin

<table>
<thead>
<tr>
<th></th>
<th>Translational vector error (mm)</th>
<th>Rotational vector error (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HeadFIX + wax</td>
<td>1.93±0.66</td>
<td>0.002°±0.867</td>
</tr>
<tr>
<td>Syringe</td>
<td>3.85±1.32</td>
<td>0.278°±0.531</td>
</tr>
<tr>
<td>Tongue depressor + wax</td>
<td>2.57±1.36</td>
<td>-0.351°±0.559</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PTV MARGIN (mm)</th>
<th>Left-right</th>
<th>Superior-Inferior</th>
<th>Anterior-Posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.01</td>
<td>2.96</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>3.43</td>
<td>6.79</td>
<td>6.97</td>
</tr>
<tr>
<td></td>
<td>2.61</td>
<td>1.98</td>
<td>4.46</td>
</tr>
</tbody>
</table>

- HFW shows smaller transitional vector and average rotational error indicates higher reproducibility of the immobilization device.
- Non-uniform margins should be used as a standard PTV margin depend on immobilization chosen.
1. Diagnosis? ...tumor extension??
2. Patient condition
   - Physical - head, neck, shoulder size
     → eg. Big head circumference
   - Psychology – claustrophobia, anxiety
3. Modality limitation
   - Diameter CT bore/aperture? MRI-compatible?
4. Immobilization device – availability
VERBAL STATEMENTS TO IMMOBILIZE PATIENTS

- Please don't move
- Don’t wiggle, now
- Lay heavy, become as one with the table
- Be placid, man
CONCLUSION

• A good immobilization device could potentially reduce the flexibility of the H&N region and the magnitude of rotations.

• Regardless of imaging modality, to further reduce the setup uncertainties, it is essential to improve immobilization method, which appears important than the methods of image alignment.
REFERENCES


Thank you for listening..