4D SCANNING FOR ABDOMINAL RADIOTHERAPY PLANNING

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Bellows
Why 4D?

- Abdominal SABR
  Livers, Adrenals, Renal, Pancreas, Gall Bladder, Abdominal Nodes
- Generation of mGTV
- SABR Guidelines for motion management
- Often used in conjunction with a 3D Ex-BH
How it works..

- Bellows expand / contract
- Air travels along tubing to the PTK
- Air change is measured in the PTK
- Measurement sent back along through the Pulmonary port
- This is converted into a wavelength and displayed on the CPU
Wavelength display
Positioning of bellows

• If 4DCT is the sole planning scan – do not allow it to cause skin deformation over intended area of delineation for trmt / OARs
• Tight – really, really tight!
• Flat surface for tabs to stabilise on
• Skin contact
• Where it will detect motion
Typical position for Bellows on 4D Scans for Lungs
Typical 4DCT Wave
Bellow Position for Abdo’s

✓ No skin deformation over trmt area
✓ Chest breathers
× Breast tissue can be problematic
× tabs can dig into axilla
Bellow position for Abdo’s

- No skin deformation over trmt area
- ‘Belly’ breathers
- Difficulty in gaining a trace
Abdominal SABR

• SABR consortium guidelines advise that motion restriction should be used if the motion is more than 5mm..

So this is where the fun begins..!
4DCT Vs Abdominal SABR

4DCT Needs
- Detectable breathing motion
- Good contact points
- Even, regular, steady motion

Abdo SABR Needs
- Minimal breathing motion
- No skin deformation
- Motion management

Two principles are working against each other!
Motion Management

Abdominal Compression for motion management
This patient is slim

Compresses well
Straight plate
No lateral displacement

5.2cm!
Unable to raise both arms

One arm down

Arm inside the arch
Other arm down

Slightly larger patient

Arm tucked under torso
Both arms down

No room inside arch

Hands on Chest
Abdominal 4D Wave (in compression)

Irregular
Shaky
Shallow
Abdominal 4D Wave (in compression)

Fast – hyperventilating?

“I’m panicking!”
Abdominal 4D Wave (in compression)

‘Flat-lined’

(Radiographer now panicking!)
Abdominal 4D Wave (in compression)

Slow

Controlled

?Artificial
How ‘perfect’ does the trace need to be?

- Truthfully…? Not very!
- Remember .. Its not for planning, just mGTV
- Post processing - Edit the vectors
- Pitch / Velocity is the most important
- Radiographer experience paramount
- It will reconstruct to a useable scan
Recent trace on a 4DCT Abdo

Mean BR – 22
Snapshot – 24
Small Amplitudes
Large Amplitudes
Shaky
‘Poor trace’ ??
The Reconstruction

No artefacts visible despite the trace being sub-optimal
AP View – 4D recon
Lateral Abdo 4D recon
Specifics

- Resolution: standard
- Collimation: 16x1.5
- Pitch: 0.11
- Rotation time: 0.5 sec
- FOV: 500 mm
- Filter: Standard (B)
- Enhancement: 0.0
- Window C: -500
- Center X: 0
- Matrix: 512

Images show various scan options and settings.
Why is pitch so important?

• Speed of couch movement must correlate to the breathing cycle otherwise the scan is pointless

Pitch < BR ..... Smeared images
Pitch > BR ..... Tumour may be captured at arbitrary position

Images are tagged with signals of breathing cycle and sorted to reconstruct into a 4D data set
Dose

Mode | CTDI [mGy] | DLP [mGy*cm]
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Helical | 21.1 | 896.97
Any Questions?

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