Image Guided Particle Therapy

What can we learn from conventional RT?

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Moving lung tumours
Courtesy Per Munck af Rosenschöld, Copenhagen
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Which breathing manoeuvre should be used?
Stable exhale point level

Box position relative to reference point [mm]

Time [sec]

Nøttrup et al 2008
b  Systematic increase in exhale point level

Nøttrup et al 2008
C Sudden shift in exhale point level

Time [sec]
4D PET/CT
Patient surface motion, AAPM TG 76, 2006
What about coaching?
Is coaching necessary?

Spontaneous respiration
Comparison: free breathing vs. coaching

Typical breathing curves without and with coaching

→ increased breathing amplitude
Typical respiratory pattern with and without coaching

Spontaneous breathing

Coached breathing

Gating window
Breath-hold techniques:
Intrafraction and interfraction variations

Lung patient no. 7 (2003-11-05)

Daily respiration from lung patient: 7

Nøttrup et al 2008
Interfraction variations

Nøttrup et al 2008
Fraction–baselines and linear regression

Fraction–baseline
linear fit
dAP

Fraction–baseline [mm]

0 5 10 15 20 25 30

Fraction number

R = -0.74

patient diameter AP [mm]

Nøttrup et al 2008
Intrafraction and interfraction variations

Relation between interfraction variation and total motion span

Nøttrup et al 2008
Fig. 3. Diaphragm position as a function of time for patient 7. Four separate daily sessions, one from each treatment week, are displayed. The reference trace (week 0) exhibited a time trend over the course of fluoroscopic recording. Subsequent sessions did not demonstrate the same trend.

Hugo et al, R&O 78 (2006) 326
sideration during the original proton therapy planning. This finding indicates that imaging during the original 4D-CT simulation can predict the pattern of tumor motion during the course of radiation therapy. However, in 1 case (Fig. 3),
In conclusion – the problem of protons for lung targets is not solved by:

- Proper selection of non-moving tumours
- Treatment planning based on 4D-CT
- Re-design of margins
- Audio-coaching of the patient
Probably a combination of many things is needed:

- Repeated (daily?) imaging
- Adaptive planning (plan of the day?)
- Advanced audio-visual coaching
- Gating (or breath hold techniques?)
- Apnea during anaesthesia?
Can audio coached 4D CT emulate free breathing during the treatment course?

THANK YOU FOR YOUR ATTENTION!

Intra- and interfraction breathing variations during curative radiotherapy for lung cancer

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