Potential Benefits of Endo-Rectal Balloons During IMRT for Localized Prostate Cancer

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Potential Benefits of Endo-Rectal Balloons (ERB’s)

• Visualize target better in bilateral THR patients
• Move sigmoid and or small bowel out of field
• Limit prostate intra-fraction motion during IMRT
• Decrease volume of rectum and anus receiving high dose radiation
• Decrease rectal and anal wall late toxicity
• Allow “normal” diet during IMRT course
Patient with Bilateral THR
John Sylvester MD  21st Century Oncology Bradenton/Sarasota

CT

MRI
CB-CT treatment planning and daily set-up

CT

MRI
CB-CT treatment planning and daily set-up

CT

MRI
CB-CT treatment planning and daily set-up
Move Bowel out of Field
How about limiting prostate motion?
Cine of Rectal / Prostate Motion
Courtesy of William Beaumont Hospital
• Intra-fraction prostate motion during IMRT
• Prostate moved during IMRT/3dCrt in 34/35 patients in initial Calypso studies
Endorectal Balloon- MDAH

Robert Jan Smeenk et al; Radiotherapy and Oncology 95 (2010) 277–282
30 patients analyzed with the calypso system: threshold for correction 3mm

- In No-ERB-group 207 corrections were made vs. 88 in the ERB-group ($p = 0.02$).
- During the first 150 s, in both groups only small deviations were observed.
- After 150 s, ERB significantly reduced intrafraction deviations
- The largest reductions were observed in the AP direction.
- The Balloon does reduce prostate motion during the daily treatment session

Smeenk, ASTRO 2010, MD Anderson
1. Random interfraction variation does not decrease;
ERB always in combination with position verification. van Lin, IJROBP 2005

2. Calypso system (transponders) Nijmegen/MD Anderson Orlando, Smeenk/Kupelian:
ASTRO 2010: with ERB improved intrafraction stability after 150 sec.
Rectal balloon limits prostate motion

Wachter et al. IJROBP 2002

The graph shows the distribution of displacements (mm) for patients with and without a rectal balloon. The x-axis represents patients from 0 to 10, and the y-axis represents displacements from -20 to 20 mm. The graph includes markers for patients with and without a rectal balloon.
• Investigate intrafraction prostate motion with Calypso and daily endorectal balloon (ERB)
• 24 patients in 787 treatment sessions was evaluated
• The overall mean time with prostate excursions >3 mm was 5%.
• Conclusions:
  - Daily endorectal balloon consistently stabilizes the prostate,
  - prevents clinically significant displacement (>5 mm)
  - 3-mm margin may sufficiently account for 95% of intrafraction prostate movement for up to 6 minutes of treatment time.
Motion Summary:

ERB Limits Intra-Fraction Motion
ERB does not Prevent Inter-fraction Motion
ERB Decreases Volume of Rectum and Anus receiving High Doses Radiation
Endorectal Balloon ERB

ERB issues:
Tolerable?
Rwall anterior higher dose?

No ERB

With ERB

Emil van Lin M.D.
Air-filled (ERB) reduces Rectal wall and Anal wall doses

van Lin, IJROBP 2005; Smeenk, Rad Onc 2009
Inner Rectal Wall Dose Surface Maps (DSM)

Virtual Rectal Wall Unfolding

Courtesy of Aswin L. Hoffmann University Medical Centre Nijmegen (NL)

Lateral extent for certain dose level
Curved 100 cc air-filled ERB reduces Rwall and Awall dose exposure in IMRT

Dose: 78 Gy
Endorectal balloon for Postoperative or Salvage RT

PTV = CTV + 9 mm Dose 70 Gy
3 beams: AP + 2 lat
Endorectal balloons in post prostatectomy: Do gains in stability lead to more predictable dosimetry?

M. Jameson¹,², J. De Leon¹, A. Windsor¹,³, K. Cloak¹, J. Dowling⁴, S. Chandra⁴, P. Vial⁵, M. Sidhom¹, L. Holloway¹,²,⁵, P. Metcalfe²

Holloway et al Med Dosim 2012

• To perform a comparative study assessing potential benefits of endorectal balloons (ERB) in post-prostatectomy patients
  – Geometrically & Dosimetrically
Motion Comparison
Results – EUD

ΔEUD (Gy)

-8 -6 -4 -2 0 2 4 6

Bladder  Sup CTV  Inf CTV  Sup Rect  Inf Rect

ERB

No ERB
Reduce Ano-Rectal Toxicity
Anal Wall sparing with ERB in 3D-CRT and IMRT

**Incontinence pads**

<table>
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<th>Cumulative incidence</th>
<th>Time from start radiotherapy (years)</th>
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- **3D-CRT**: 41 Gy, 29 Gy
- **IMRT**: 27 Gy, 20 Gy

**Anal wall mean dose: ptv 78 Gy**

- ERB
- +ERB

*Peeters, JROBP 2006*

*Smeenk, Radiother Oncol. 2009*
Endorectal Balloon reduces late toxicity and mucosal damage

- 48 patients, with and without balloon: Follow-up 30 months.
- Acute toxicity equal.
- Late Toxicity is reduced with endorectal balloon

Van Lin, IJROBP 2007
Endorectal Balloon reduces severe rectal damage

Rectal Wall dose surface maps

T2-3 = 70-80% probability of late rectal bleeding

T2 - T3 score

Van Lin, IJROBP 2007
ERB-induced increased tolerance for late Rwall damage?

Explanation:
1. Air-cavity induced dose build-up (Teh 2005)
2. Hypoxia stretched Rwall
3. Volume effect and cell migration
RECTAL WALL SPARING BY DOSIMETRIC EFFECT OF RECTAL BALLOON USED DURING INTENSITY-MODULATED RADIATION THERAPY (IMRT) FOR PROSTATE CANCER
Baylor College of Medicine, The Methodist Hospital, Houston, TX
Using multiple-beam IMRT, a 15% dose reduction at the air-tissue interface was observed.

At distance from the cavity the dose built up rapidly, with 8% and 5% lower doses at 1 and 2 mm, respectively.

The posterior part of the prostate, located 6 mm from the air-tissue interface, received the same dose, compared to the phantom without air cavity.

These results suggest that ERBs have an anterior Rectal wall sparing effect without under-dosing the prostate.
ERB-induced increased tolerance for late Rwall damage: Recovery by Migration?

Volume effect: good neighbors?

MIGRATION??

“...it was proposed that one recovery mechanism involves the migration of non-damaged cells into the damaged area (Partridge 2008). Thus, it is preferable to have a shape with a high perimeter-to-surface ratio, which is reflected in the eccentricity because that means that there is relatively more space for the non-damaged cells to migrate into the area with damaged cells.”

Buetnner, PMB 2009, Partridge PMB 2008
Rectal toxicity = ano-rectal toxicity = bleeding

35 % of patients ≥ Grade 2 rectal toxicity in the 78 Gy arm of the Dutch dose-escalation study, after 7 years follow-up. Al-Mamgani, IJROBP 2008

Size and spatial distribution of Rwall exposed to high and low doses predicts for late toxicity
Tucker, IJROBP 2006; Gulliford, IJROBP 2010

Severe fecal complaints (incontinence pads needed) is correlated to Mean Awall dose
Peeters, IJROBP 2006

Ano-rectal toxicity (rectal bleeding, loose stools, proctitis) correlated to spatial dose distribution over the Rwall (dose surface map, dose surface histogram)
Buettner, PMB 2009
Is a balloon a daily burden for patient and therapist? No

1. Patients tolerate it very well

Acute Anal toxicity/irritation  n= 146
Grade 0  73%
Grade 1 *irritation*  23%
Grade 2 *irritation + local medication*  3%
Grade 3 *stop balloon*  0%

2. After training/education all are applying
--150 pts a year (*Emile van Lin since 2008*)
-- 250 pts a year (*Sylvester since 2010*)
Endorectal balloons

ERB facts

- reduces Rwall and Awall exposure to intermediate and high doses
  - *van Lin, IJROBP 2005, Smeenk, RO 2009*

- well tolerated
  - *Ronson, Proton-RT IJROBP 2006 ( n=3.561, 2.4 % declined )*
  - *Bastasch, Baylor Colleg, Am J Clin Oncol 2006 ( n=396, 0.8 % declined)*

- reduces late rectal damage and late toxicity,
  - *van Lin, IJROBP 2007*

- balloon and high dose IMRT (77 Gy) result in excellent long-term outcome and acceptable toxicities *Teh, ASTRO 2007*
Endo-Rectal Balloons

Summary of Advantages:

• Distends rectum so lower % of rectum treated
• Reduces objective rectal mucosal telangectasias
• Reduces anal and rectal late toxicity
• Limits prostate movement while “beam on”
• Sometimes pushes bowel away from prostate
• Increases ease of visualization in daily set-up in bilateral THR patients

• Allows patients to follow less restrictive diet
Special Thanks to Emil van lin