

Correlation of Planning Scan Anatomy and PSA Relapse in Prone Prostate Cancer Patients

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Introduction

A recent study¹ of 127 prostate cancer patients treated with 3D-CRT to 78 Gy, supine with full bladder found strong correlation of rectal distension on the planning scan and PSA relapse.

We examine correlation of PSA relapse and planning CT anatomy for 111 prostate cancer patients treated with 3D-CRT to 75.6 Gy, prone and according to our institutional protocols.

Is the correlation general or protocol-specific?

Methods and Materials

Clinical characteristics and structure definition

111 patients, treated between 3/91 and 5/95
All prone 75.6 Gy cases from rectal bleeding study of Skwarchuk et al²

33 bleeders, 78 non-bleeders

Median follow-up: 8.9 years

62 PSA relapses (ASTRO criterion)

Zelevsky et al³ definition of risk group*

15 Low risk, 34 Intermediate risk, 62 high risk

*Low: T1-T2, pre-tx PSA ≤ 10ng/ml, Gleason ≤ 6
Intermediate: One factor higher

High: Two or more factors higher

36 patients had neoadjuvant hormones.

Simulation and Structure Definitions

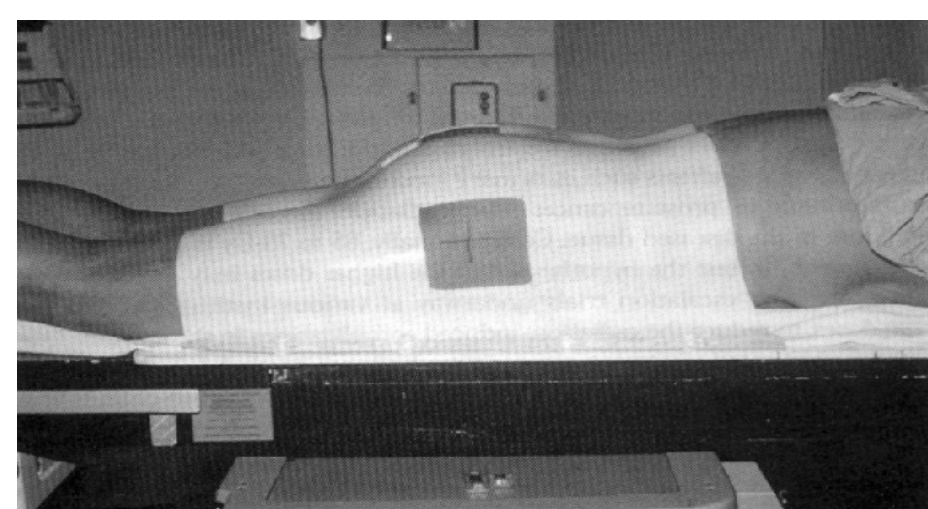
Self-administered bowel prep night before sim

Instructed to void before sim

Immobilized prone, thermal plastic shell

Rectal lumen localized by catheter

AcQSim PQ 5000, 5 mm slice separation



CTV: Prostate + Seminal Vesicles
CTV-PTV Margin: 1.0 cm except 0.6 cm at prostate-rectal interface

Planning Rectum (PR), Planning Rectal Lumen (PRL): 0.5 cm superior to 0.5 cm inferior of PTV

Anatomic rectum (AR) and anatomic rectal lumen (ARL) contoured to compare with Ref 1

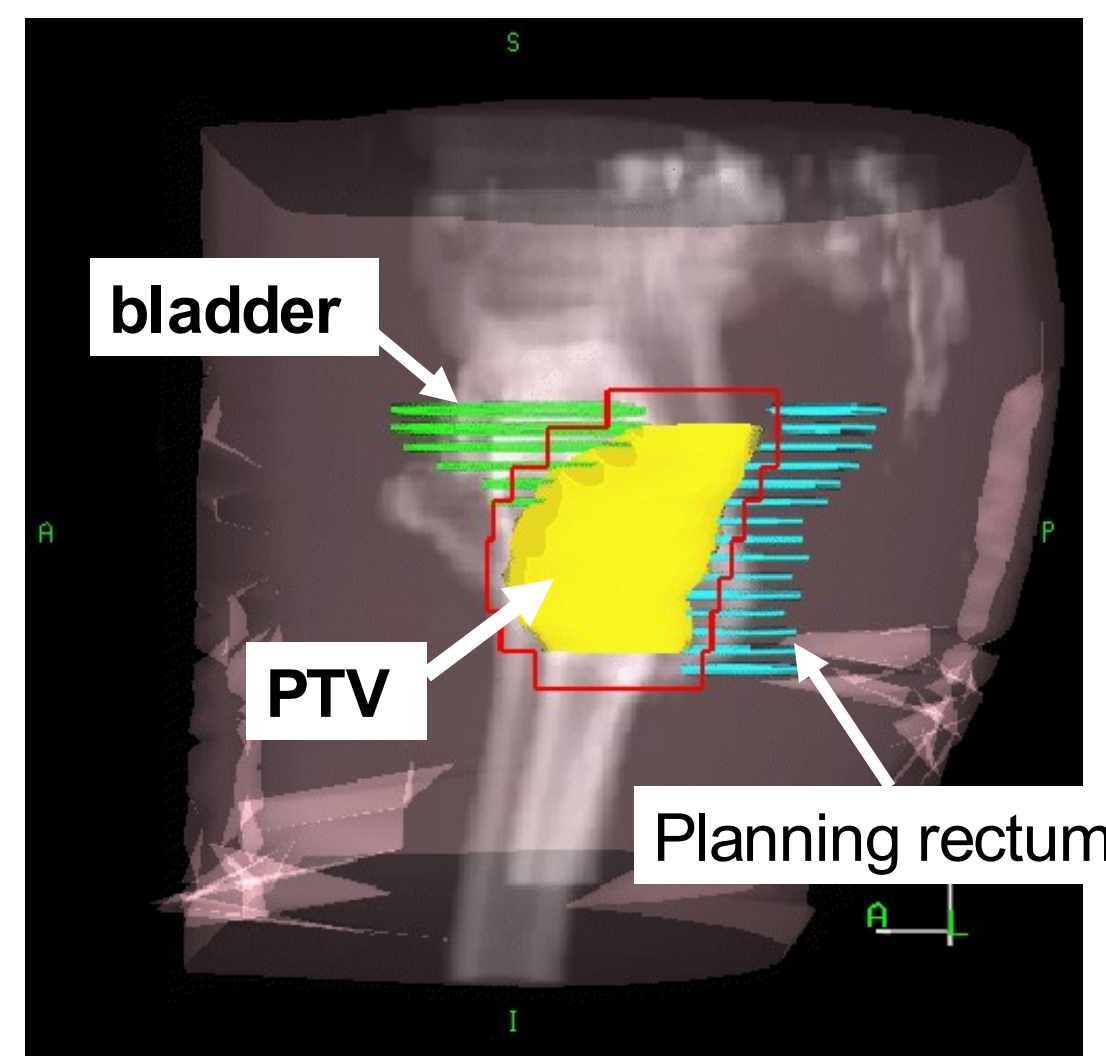
Outer bladder to 0.5 cm superior of PTV

References

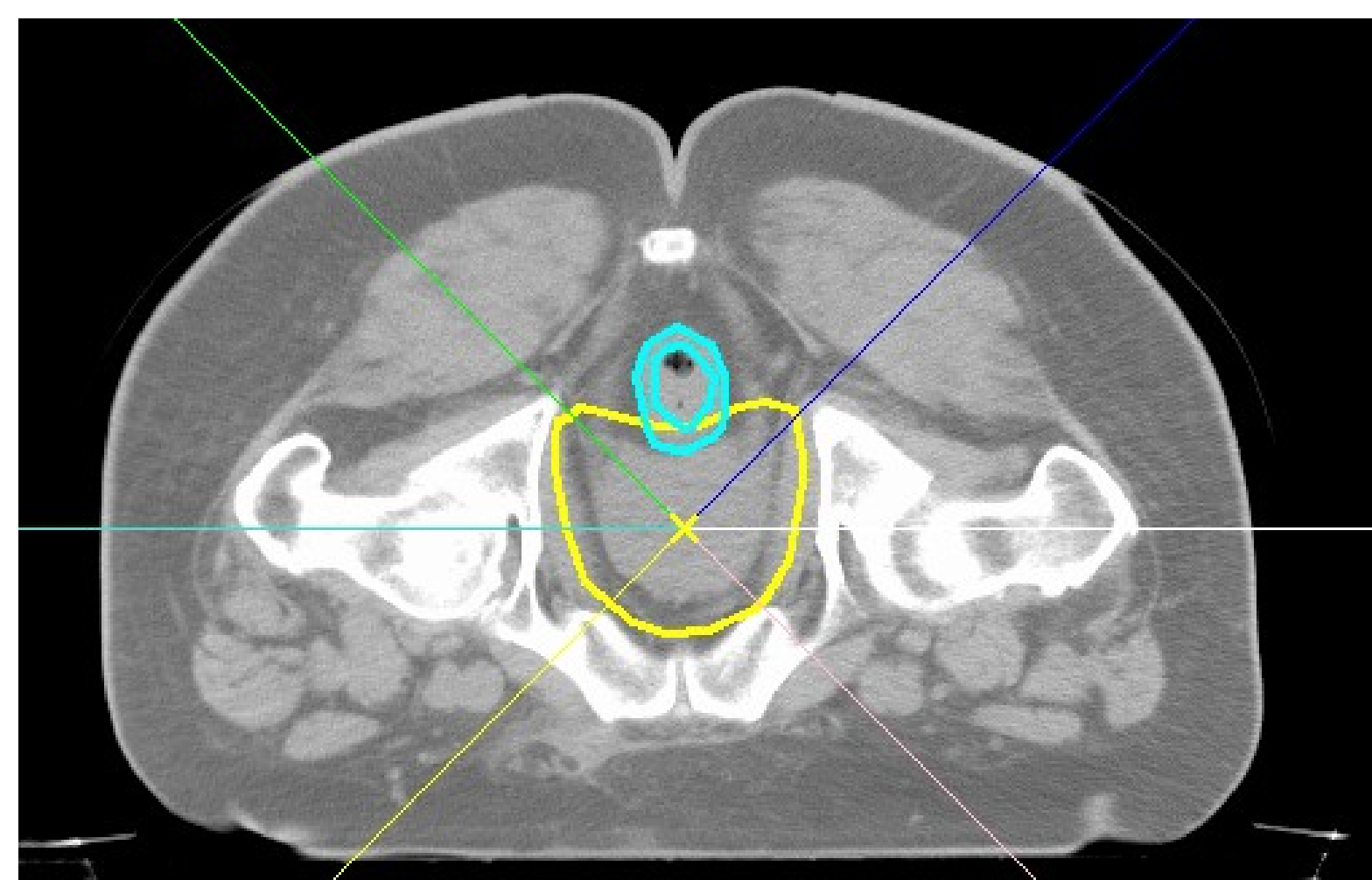
- De Crevoisier et al, IJROBP 62,964-73; 2005
- Skwarchuk et al, IJROBP 47, 103-113; 2000
- Zelevsky et al, J Urol 166, 876-81; 2001.
- Zelevsky et al, IJROBP 41, 491-500, 1998

Treatment Planning/Treatment

PTV to block or MLC edge: 1 cm superior and inferior, 0.5 cm transverse in beam's eye view



- 6 fields, 15 MV photons
- 75.6 Gy covers PTV, principal planes thru isocenter
- No special bowel prep; void before treatment advised



Geometric Measurements on Planning Scan

- Length and volume: PR, AR, PRL, ARL, bladder, PTV
- Rectum diameter in isocenter plane
- Maximum planning rectum (PR) diameter
- Diameter of bladder in most superior PTV slice
- Maximum distance from posterior PTV border to coccyx
- CSA for PR, AR, PRL, ARL and bladder:

$$CSA = (\text{Structure Volume}) / (\text{Structure Length})$$

Clinical variables

Risk Group³, T-stage, Gleason Score, Pre-tx PSA, rectal bleeding², hormones, age, treatment end date

Statistical Analysis (S+)

Cox Proportional Hazards: Uni, multi-variate correlation: PSA relapse with geometric and clinical variables

Results

Quantity	Mean ± SD	Median	Range
PTV volume (cc)	196.3 ± 45.4	189.0	100.7 - 373.0
PR vol (cc)	102.7 ± 44.8	91.6	33.2 - 251.8
AR volume (cc)	118.1 ± 51.9	107.4	33.3 - 299.7
PRL vol (cc)	51.4 ± 37.5	42.7	3.5 - 180.3
ARL vol (cc)	58.0 ± 42.6	45.6	4.0 - 217.6
PR length (cm)	7.7 ± 1.0	7.5	5.0-12.0
AR length (cm)	9.2 ± 1.2	9.5	6.5 - 12.5
PRL CSA (cm ²)	13.2 ± 5.2	12.3	4.4 - 26.5
ARL CSA (cm ²)	12.6 ± 4.8	11.7	4.4 - 27.2
Blad CSA (cm ²)	21.7 ± 7.4	20.7	7.9 - 44.2
PTV-coccyx (cm)	5.7 ± 1.0	5.6	3.7 - 8.8
Max Rect Diam(cm)	5.5 ± 1.2	5.5	2.9 - 9.0
Rect Diam at iso	4.2 ± 1.1	4.1	2.2 - 6.9

No planning scan variable significant (at p=0.05 level)

Best planning scan variables (univariate "trends")

Planning rectum: PRL volume (p=0.057), PR CSA (p=0.066)

Anatomic rectum: ARL vol (p=0.075)

(variable ↑, PSA relapse ↑)

Univariate significant clinical variables

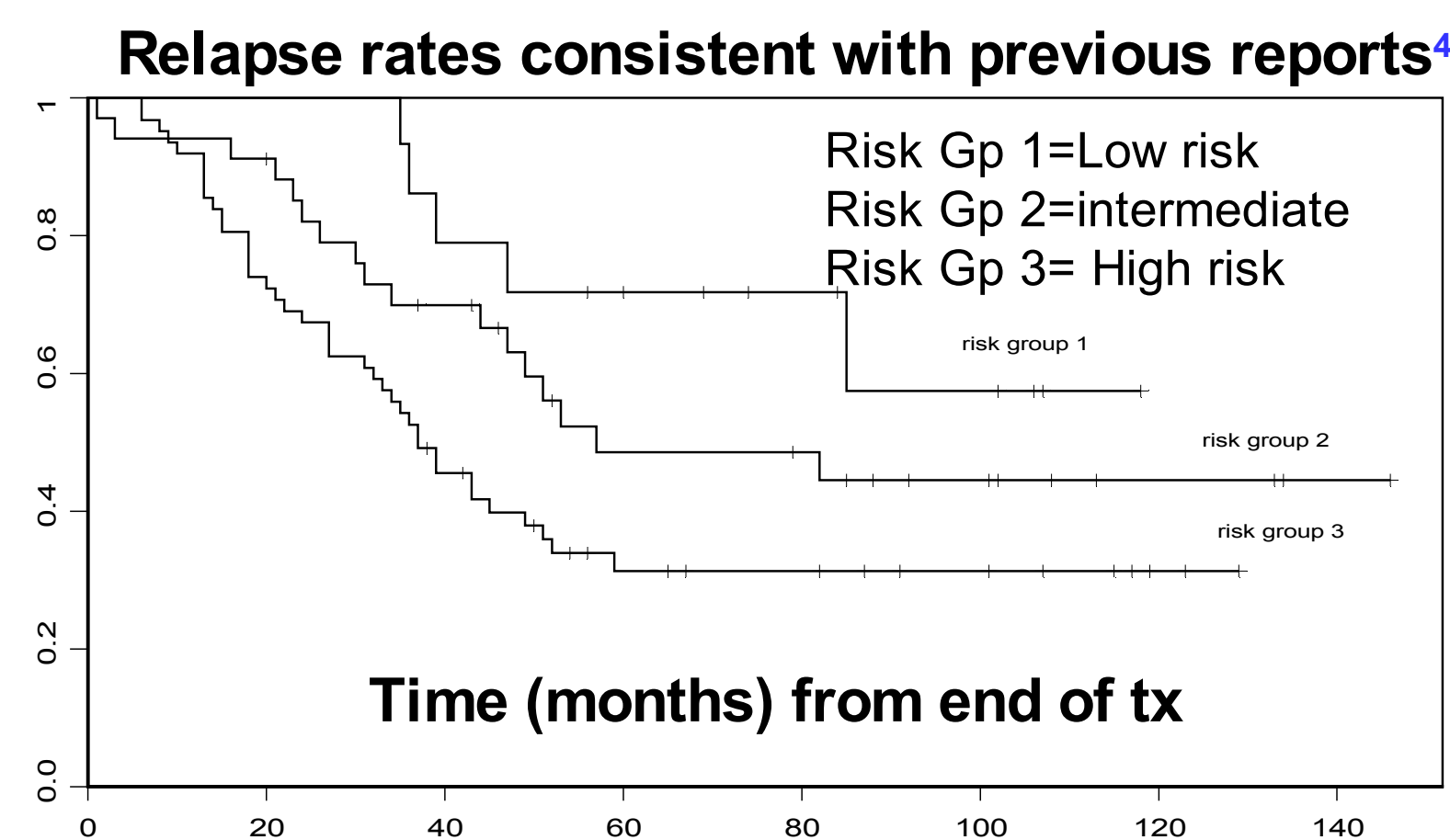
Risk Group (p=0.0054: risk group ↑, PSA relapse ↑)

Treatment end date (p=0.023: end date ↑, PSA relapse ↓)

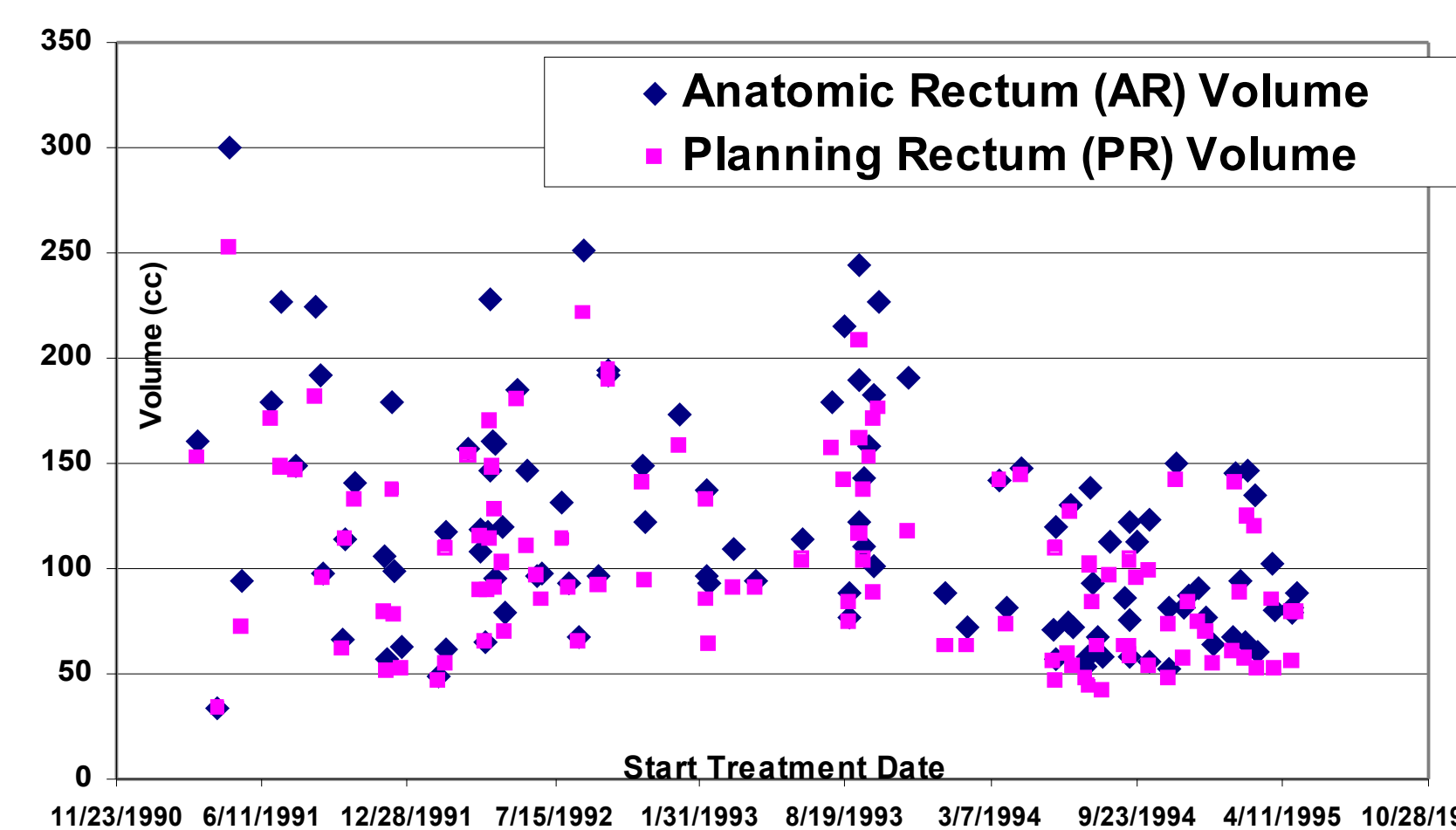
Clinical variable trends: Age (p=0.069; Age ↑, PSA relapse ↓)

Note: Rectal bleeding was **not** significantly correlated with PSA relapse. No other clinical variables were significant

Multivariate analysis: No variable gained significance. Risk Group remained significant.



Unexpected observation: Significant decrease over time for PR, PRL, AR, ARL volumes and CSAs – a "learning curve"?



Discussion

Weak correlation of PSA relapse with rectal distension on planning scan. Strong correlation of Ref 1 not found.

Similarities between the two studies # patients (111 pts vs 127 pts in¹), treatment dose (75.6 Gy covers PTV on 3 principal planes vs 78 Gy to isocenter¹), followup time, rectum CSA

	This study (ARL CSA)	Ref 1
Mean	12.6 ± 4.8	12.0
Median	11.7	11.2
Range	4.4 - 27.2	5.2-27.1

Differences most likely to weaken correlation

(this study in red)

Prone simulation and treatment vs supine

Gravity plays a different role.

Bowel prep for simulation vs no special bowel prep

Void for sim, treatment vs full bladder for both

Single phase 6-field 3DCRT (105/111) or cone-down off bowel at 43 Gy (6/111) vs ~11x11 4-field box to 46 Gy + 6-field 3D-CRT to 78 Gy

Ref 1 less sensitive to rectal changes?

Aperture design for 3D-CRT

PTV to block edge in BEV: 0.5 cm transversely, 1.0 cm sup-inf (at least 1.1 cm CTV to block edge) vs 0.75 cm from CTV to sup and post block edge, 1.25-1.5 cm to ant and inf edges

Ref 1 more sensitive to rectal changes?

Risk groups differently defined (See Refs 1 and 3)

Should not affect observations for entire patient group

Conclusions

For the simulation and treatment methods in our study, correlation of PSA relapse with rectal distension on the planning scan is at best marginally significant. Risk group remains the dominant factor.