OAR ved Strålebehandling Ca ani

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Inntegning av risikoorgan ved Ca ani - hvem gjør hva?

OAR:	
bladder	10/10
bowelbag	9/10 og 1/10: utvalgte tilfeller
small intestine	1/10
large intestine	1/10
femoralheads	9/10
genitals	6/10 og 1/10 ikke rutinemessig
pelvicbone	3/10 og 1/10 os sacrum inkludert iliosacrale ledd
Andre?	1/10 Bowel=small+large intestine 1/10 Sacroilicaledd

Risikoorganer – Utkast til Norsk Handlingsprogram

5.3.6 Risikoorganer (Organs at risk, OAR)

Risikoorganene er satt opp i prioritert rekkefølge, og doserestriksjonene er veiledende, ikke absolutte. Ved bruk av IMRT/VMAT må det lages hjelpevolum (OAR minus PTV) for optimalisering. Dette gjelder spesielt for tynntarm/*BowelBag*. Doserestriksjonen gjelder imidlertid for hele OAR, ikke hjelpevolumet.

Tynntarm kan tegnes på to måter:

ENTEN: Tegnes som *Bowelbag* (den delen av bukhulen tarmen antas å bevege seg innenfor), inneholder både tynn- og tykktarm, men ikke blære, uterus, prostata, vesikler, mesorektum. Det er likevel ulike måter å tegne dette på, og det er viktig å være konsekvent og bruke doserestriksjon knyttet opp mot aktuell inntegningsmåte. I henhold til DeFoe tegnes *BowelBag* fra 1,5 cm over PTV ned til rektosigmoidovergangen. Anteroposteriort fra fremre bukvegg til bakerste del av bakerste tarmavsnitt. Lateralt fra mest laterale tarmvegg til tarmvegg. Veiledende doserestriksjon ved denne inntegningsmåten: V30 < 310cc, V40 < 70cc (81). En ny australsk studie konkluderer med at *BowelBag* tegnet på denne måten er den mest sensitive prediktor for grad 3 vs grad 0-2 diare og de anbefaler at man forsøker å holde V30 <300 cc (6% vs 42% risiko for grad 3 diare) (ref).

- ELLER: Tegnes som separate tynntarmslynger fra 1 cm over PTV, også eventuelle slynger innenfor CTVe_40 tegnes. Peroral kontrast er en fordel. Veiledende doserestriksjoner: 45 Gy < 20 cc, 35 Gy < 150 cc, 30 Gy < 200 cc (80).

Det er ofte vanskelig å holde seg innenfor disse doserestriksjonene, spesielt hos kvinner som kan ha mye tynntarm beliggende nede i bekkenet og ved N1b/c sykdom (82). Man må da forsøke å få dosen til tynntarm så lav som praktisk mulig samtidig som man har akseptabel dose til PTV. Disse pasientene har en økt risiko for tynntarmstoksisitet og må vurderes for tettere oppfølgning i stråleperioden.

Andre risikoorganer, doserestriksjoner:

- *Caput femoris*, D2 < 52 Gy (risiko for caput-nekrose).
- *Blære*, D mean < 45 Gy.
- *Genitalia*, så lavt som mulig.
- *Beinmarg*, så lavt som mulig.

- SmallBowel og / eller BowelBag
- CaputFemoris
- Bladder
- Genitalia
- Benmarg

Viktig å se OAR i sammenheng med toleransegrenser

Hva finnes av retningslinjer og inntegningsmal?

NATIONAL GUIDANCE CANCER

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Organs at risk

The RTOG guidance on pelvic normal tissue contouring can offer som
below. The following organs at risk (OAR) must be delineated by the r

- *Small Bowel:* Contouring should include all individual small bo
  helpful to initially delineate the large bowel +/- endometrium
- *External genitalia:* Delineation of the male genitalia should include the penis and scrotum out laterally to the inguinal creases. In woman it should include the clitoris, labia majora and minora, out to the inguinal creases. Superior border in both sexes should lie midway through the symphysis pubis. See Appendix 3 for pictorial guidance.
- *Bladder:* entire bladder including outer bladder wall
- *Right and left femoral heads:* To be contoured separately on each side. To include the ball of the femur, trochanters, and proximal shaft to the level of the bottom of ischial tuberosities.

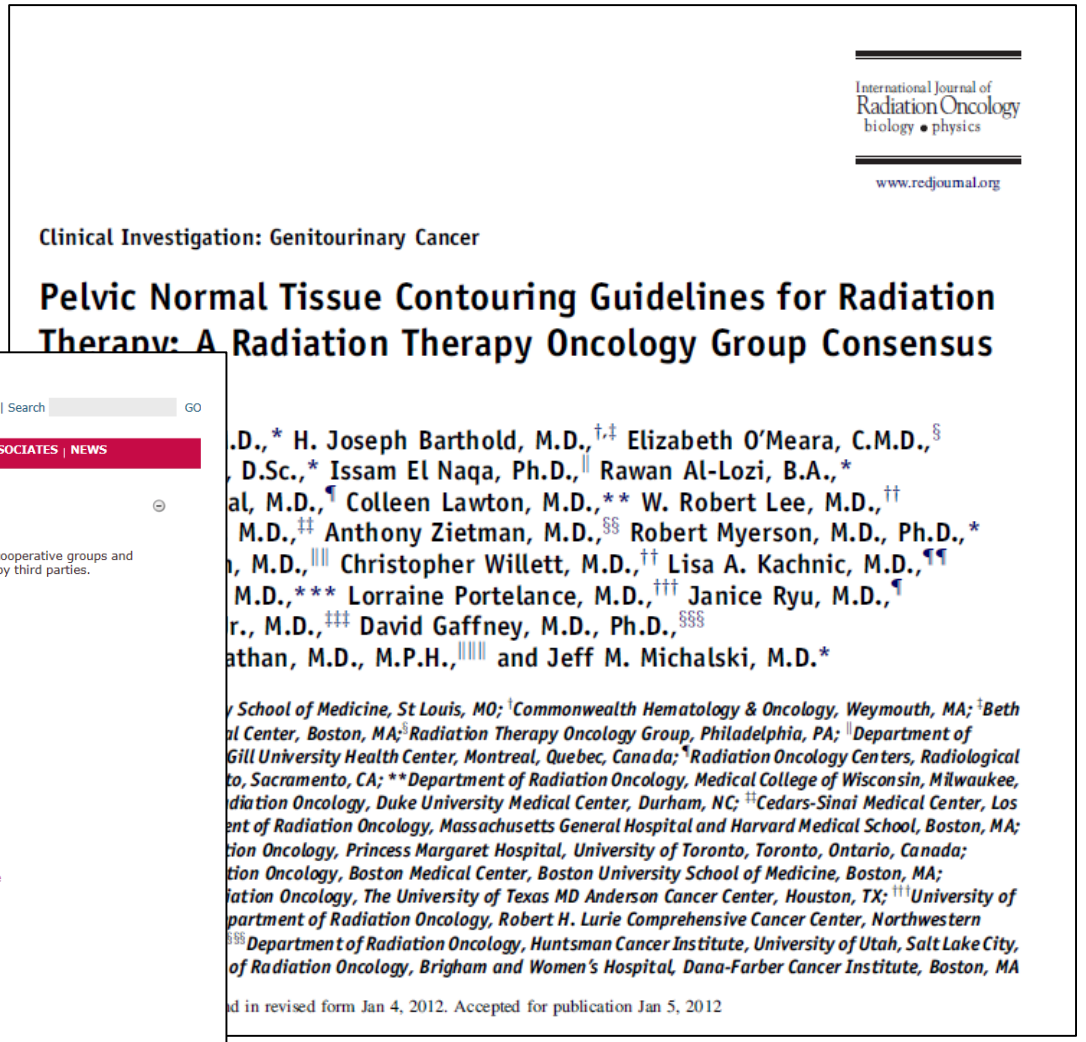
Version 4. 07/12/2016

APPENDIX 4: Anal IMRT Planning Sheet

Organ	OAR / Target	Optimal Constraint	Mandatory Constraints
PTV	D99%	>90%	>90%
	D95%	>95%	>95%
	D50%	Between 99% - 101%	Between 99% - 101%
	D5%	<105%	<105%
	D2%	<107%	<107%
Lower dose-level PTV's	D99%	>90% of prescribed dose	>90% of prescribed dose
	D95%	>95% of prescribed dose	>95% of prescribed dose
Small Bowel	D200cc	<30Gy	<35Gy
	D150cc	<35Gy	<40Gy
	D20cc	<45Gy	<50Gy
	Dmax	<50Gy	<55Gy
Femoral Heads	D50%	<30Gy	<45Gy
	D35%	<40Gy	<50Gy
	D5%	<50Gy	<55Gy
Genitalia	D50%	<20Gy	<35Gy
	D35%	<30Gy	<40Gy
	D5%	<40Gy	<55Gy
Bladder	D50%	<35Gy	<45Gy
	D35%	<40Gy	<50Gy
	D5%	<50Gy	<58Gy

Hva finnes av retningslinjer og inntegningsmal?

- RTOG-publikasjon med atlas



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Clinical Investigation: Genitourinary Cancer

Pelvic Normal Tissue Contouring Guidelines for Radiation Therapy: A Radiation Therapy Oncology Group Consensus

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- Hippocampal Sparing
- Male RTOG Normal Pelvis Atlas
- Pancreas Atlas
- Prostate Pelvic Lymph Nodes
- Prostate Post-Op
- RTOG Extremity Soft Tissue Sarcoma Atlas
- Lung Atlas
- Upper Abdominal Normal Organ Contouring Consensus
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Core Lab > Contouring Atlases

Contouring Atlases

Disclaimer: The materials presented on this web-site illustrate the consensus reached among cooperative groups and disease site committees. RTOG and authors are not responsible for any use of these guidances by third parties.

Contouring Atlases

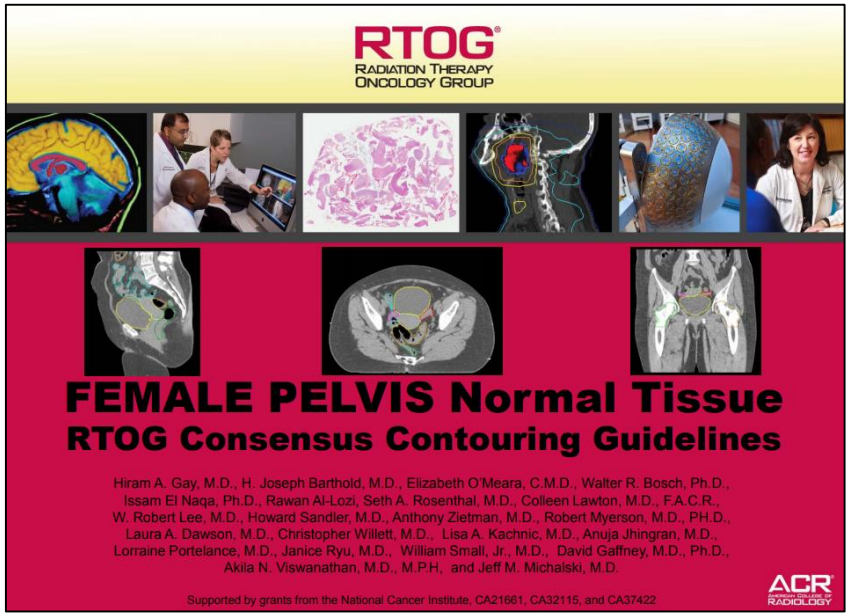
Anorectal
Bladder Atlas
Brachial Plexus Contouring Atlas
Breast Cancer Atlas
Female RTOG Normal Pelvis Atlas
GYN
H & N Atlases
- Cranial Nerves Atlas
- Consensus Atlas for CT-Based Delineation of Nodal Regions in the N0 Neck - 2013 Update
- Consensus Guideline for Nodal Level Delineation in the N0 Neck - 2013 Update

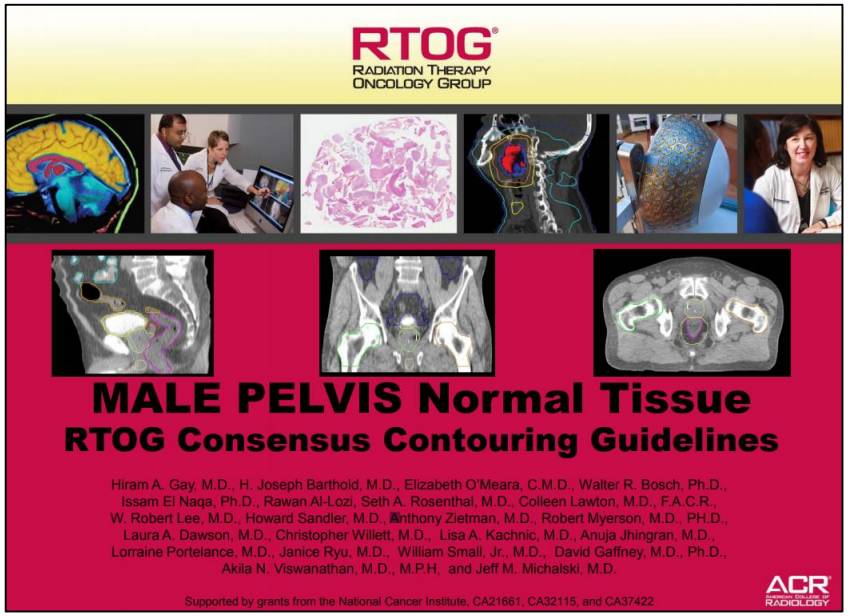
Hippocampal Sparing
Male RTOG Normal Pelvis Atlas
Pancreas Atlas
Pelvic Lymph Node Volumes for Prostate Cancer Atlas
Prostate Post-Op
- Post-Op Positive Apex Margins
- Post-Op Positive Seminal Vesicle

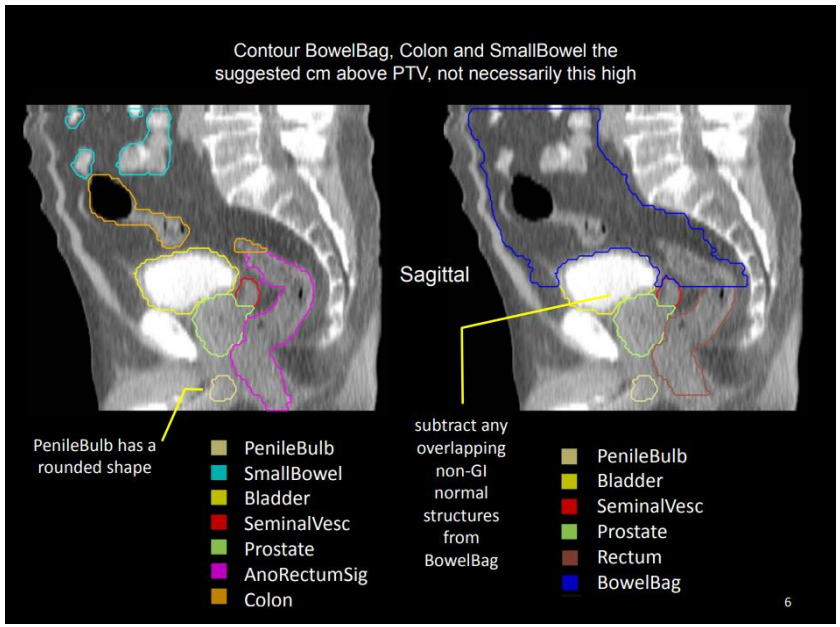
RTOG Extremity Soft Tissue Sarcoma Atlas
Lung Atlas

https://www.rtog.org/CoreLab/ContouringAtlases.aspx

Hva finnes av retningslinjer og inntegningsmal?







Litt forskjell mellom diagnosegruppene

- Eksempel: Cervix-cancer

- Men dessverre ofte mangelfull beskrivelse, også i strålestudier
- Sjelden vedlagt inntegningsatlas

EMBRACE II study protocol v.1.0

Image guided in
External beam rad
MRI based adapt
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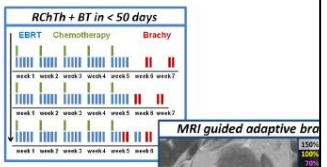
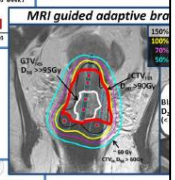
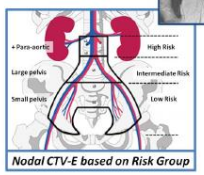
EMBR





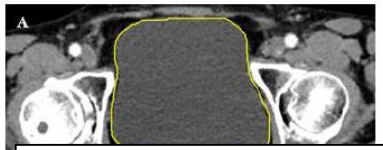


Protocol writing committee: Kari Tander
Christian Kirisits, Ina Juergenliemk-Schul
Kathrin Kirchheiner, Dietmar Georg, Ren
Wolfgang Dörr, Thomas Liederer, Li Tee

22.5.12 CONTOURING OF ORGANS AT RISK

The outer contour of the following organs should be delineated separately:

Bladder: Outline the whole organ including the bladder wall and the bladder neck (figure 17).



Sigmoid: From the recto-sigmoid junction to the left iliac fossa (figure 22.5.18).

Figure 22.5.17 CT

Femoral heads:

Rectum: Outline
including the rec

Figure 22.5.18 Ri

Bowel: Outer contour of bowel loops including the mesenterium. Do not include abdominal cavity without bowel or sigmoid (figure 22.5.20).

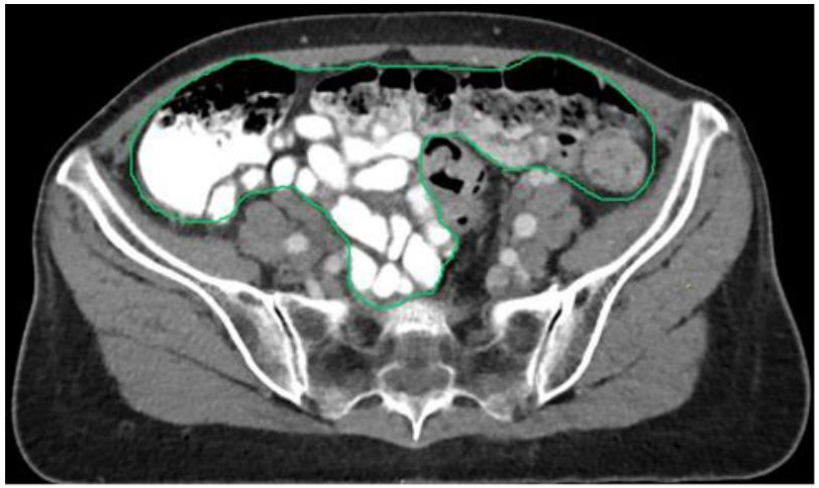


Figure 22.5.20 CT. bowel contour (green)

Generelt

- Prinsipielt en fordel å tegne likt uansett om ca rekti /ani, ca prostata eller gynekologisk cancer
- Lurt å tegne mest mulig likt innad i avdelingen – forutsetning for bruk av toleransegrenser
- En burde tegne mest mulig likt i mellom institusjonene – både nasjonalt, i Skandinavia, og ellers
  - Viktig ift multisenter-studier
  - Forutsetning for å kunne gjøre opp data rundt toksisitet

Bladder

Bladder: Outline the whole organ including the bladder wall and the bladder neck (figure 17).

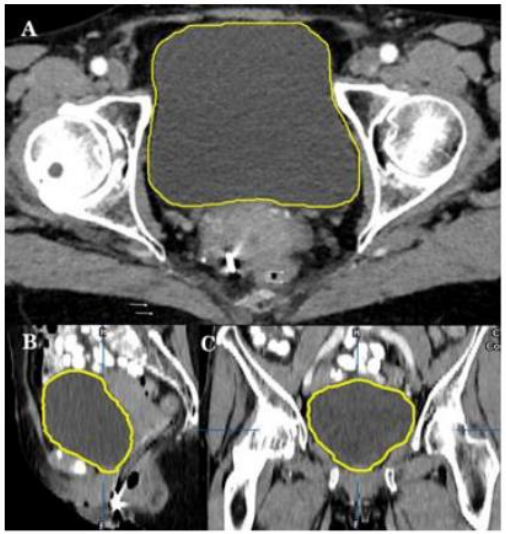
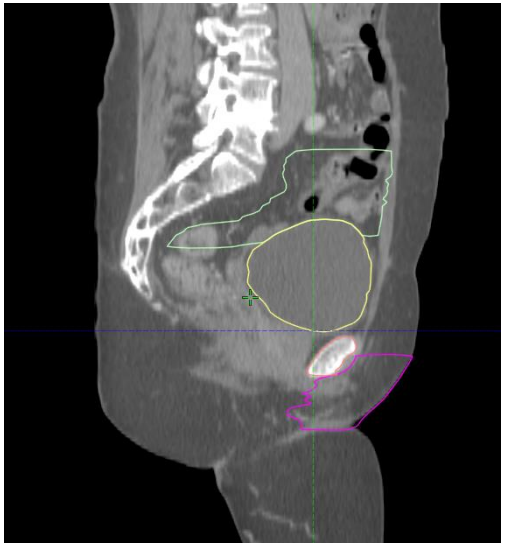


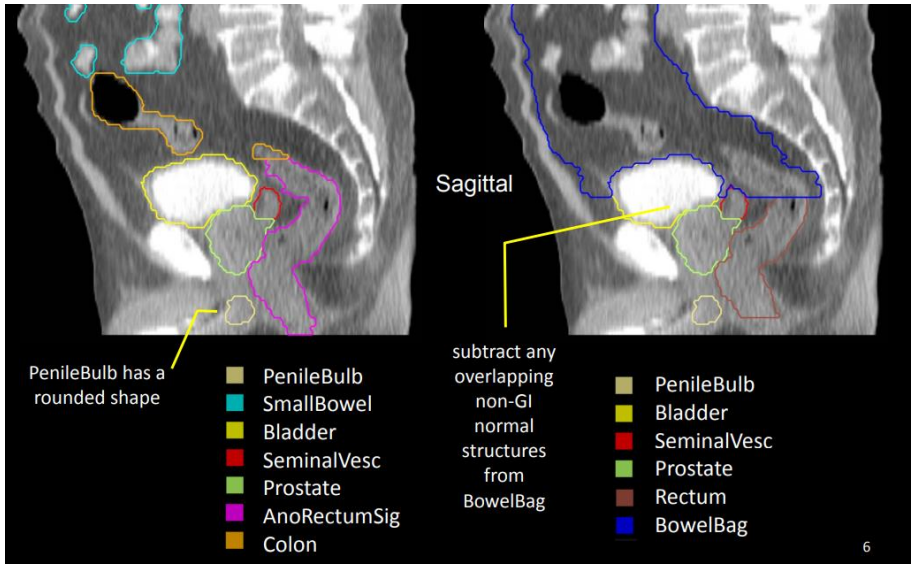
Figure 22.5.17 CT, Bladder contour (yellow) A :axial view, B : Sagital view, C : Coronal view

Embrace



Case B, OUS

RTOG

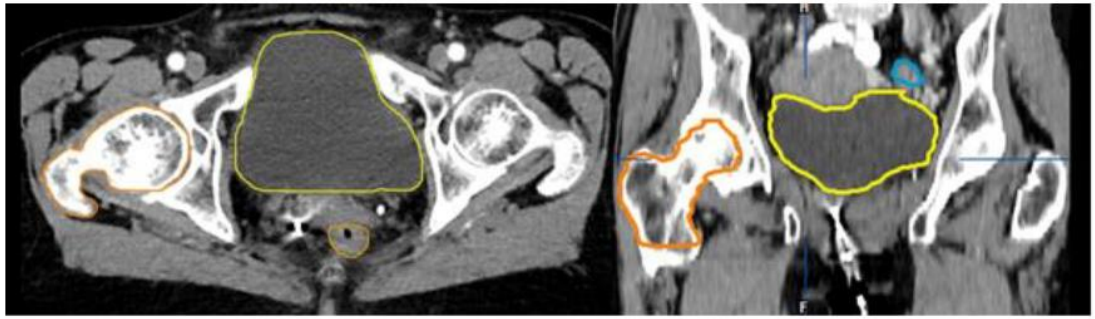


- Nedre begrensning kan være vanskelig
- Viktig med mest mulig standardisert forberedelse
  - Tromsø: Tømme 60 min før, så drikke 2 glass vann

CaputFemoris

Femoral heads: Both femoral head and neck to the level of the trochanter minor. (figure 22.5.18)

Rectum: Outline the rectum from the ano-rectal sphincter (level of PIPS) to the recto-sigmoid junction (retroperitoneal deflection), including the rectal wall (figure 22.5.19).



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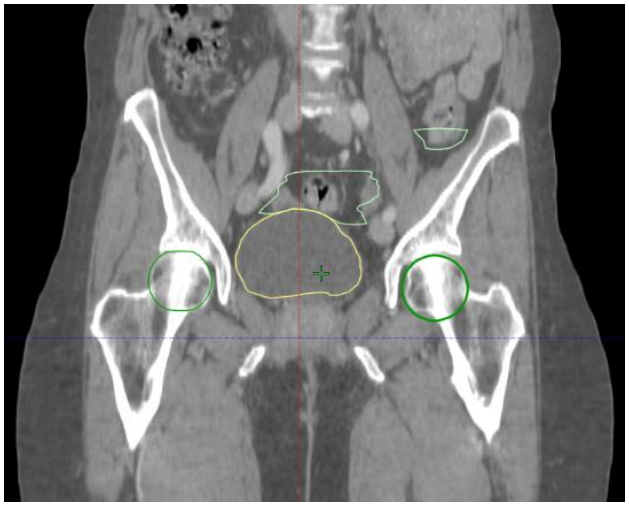
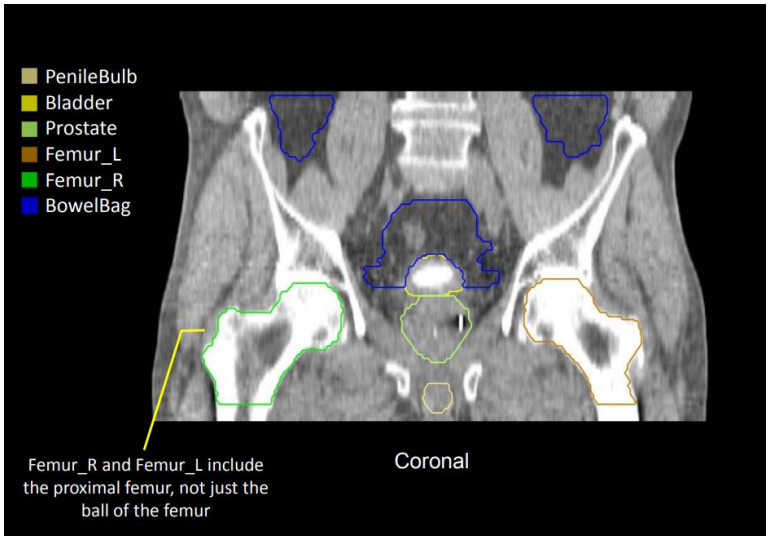


Case B, OUS



- En bør tegne caput og collum ned til trochanter minor (viktig når man ser på flere constraints enn kun maxdose

Genitalia

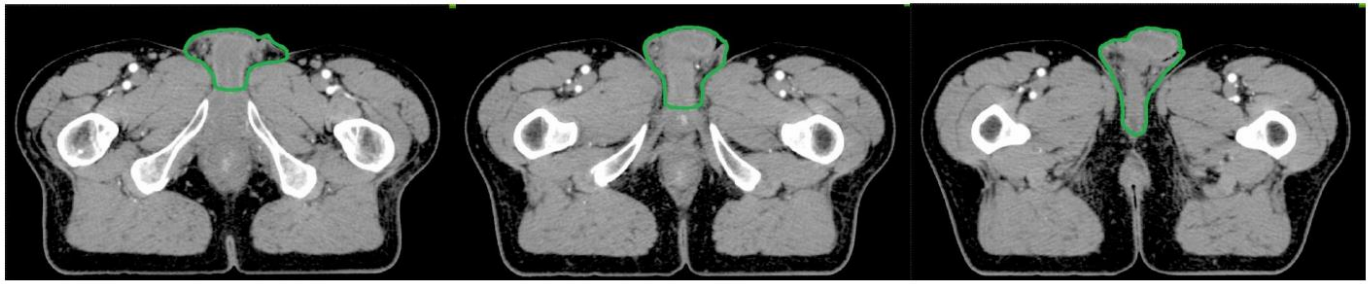
NATIONAL GUIDANCE FOR IMRT IN ANAL CANCER

Versjon 3, 2016

APPENDIX 3. Delineation of the genitalia

Male:

A B C



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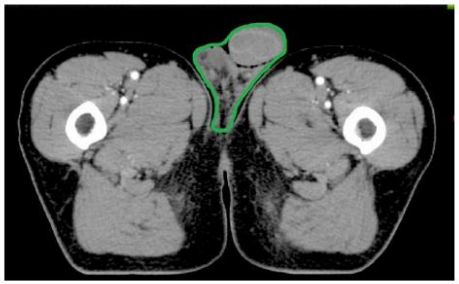
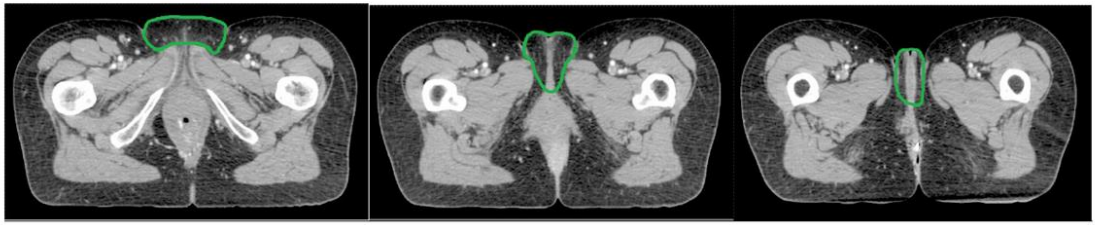
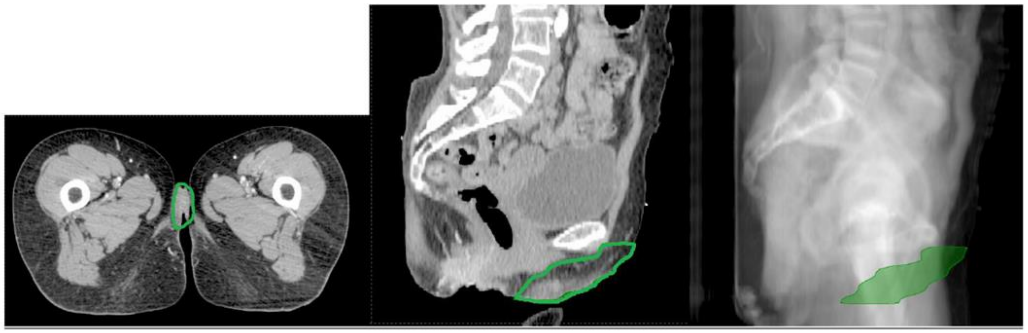


Female:

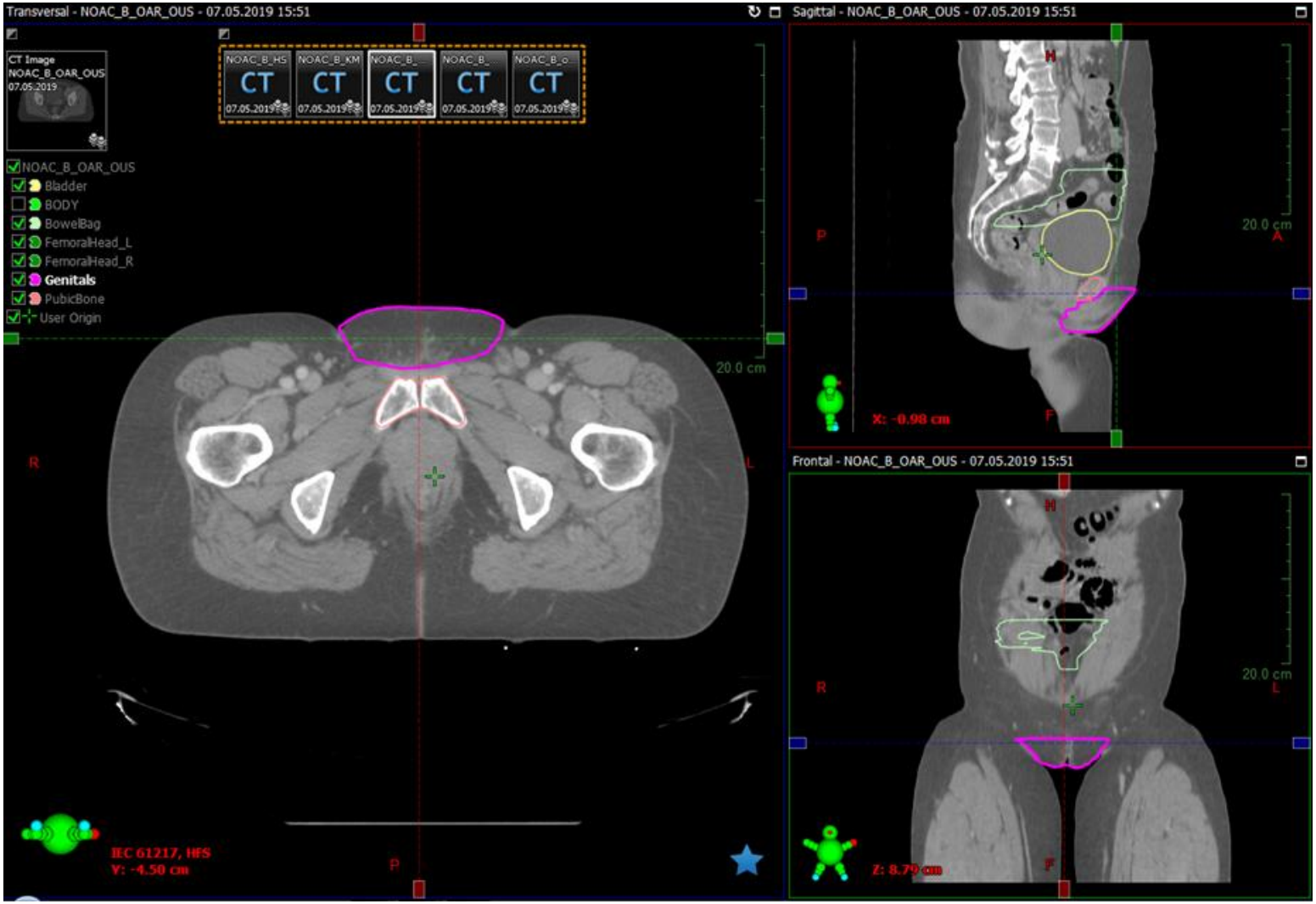


Superior slice: Half way through the symphysis pubis



Inferior slice: Last slice where the vulva are visible.

Genitalia



- Oslo ser ut til å følge engelske retningslinjer

Genitalia

BJR

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Cite this article as:
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SHORT COMMUNICATION

Proposed genitalia contouring guidelines in anal cancer intensity-modulated radiotherapy

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The Royal Marsden NHS Foundation Trust, Sutton, UK

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Objective: Intensity-modulated radiotherapy (IMRT) for anal canal carcinoma (ACC) is associated with favourable toxicity outcomes. Side effects include sexual dysfunction, skin desquamation, pain and fibrosis to perineum and genitalia region. The genitalia are situated anterior to the primary ACC between two inguinal regions providing a challenging structure to avoid. Techniques improving outcomes require robust, consistent genitalia contouring to ensure standardization and production of fully optimized IMRT plans. Official recommendations for genitalia contouring are lacking. We describe a potential genitalia contouring atlas for ACC radiotherapy.

Methods: Following a review of genitalia CT anatomy, a contouring atlas was generated for male and female patients positioned prone and supine. Particular attention was paid to the reproducibility of the genitalia contour in all planes.

Results: Male and female genitalia positioned prone and supine are described and represented visually through a contouring atlas. Contoured areas in males include penis and scrotum, and in females include clitoris, labia majora and minora. The muscles, bone, prostate, vagina, cervix and uterus should be excluded. The genitalia contour extends laterally to inguinal creases and includes areas of fat and skin anterior to the symphysis pubis for both genders.

Conclusion: This atlas provides descriptive and visual guidance enabling more consistent genitalia delineation for both genders when prone and supine. The atlas can be used for other sites requiring radiotherapy planning.

Advances in knowledge: This atlas presents visual contouring guidance for genitalia in ACC radiotherapy for the first time. Contouring methods provide reproducible genitalia contours that allow the provision of accurate dose toxicity data in future studies.

Unlike other studies often describing the contouring of the penis and scrotum in males and the clitoris, labia majora and minora in females, we included the surrounding fat and used the inguinal crease as an anatomical reference for the lateral border. Whilst it is important to spare the penis and scrotum in males and the clitoris, labia majora and minora in females, it is also important to include tissues surrounding the structures such as the skin and fat in the inguinal crease. These areas can develop moist desquamation and if not contoured as a sparing structure may receive high doses. The atlas has been produced as ar

SHORT COMMUNICATION

Proposed genitalia contouring guidelines in anal cancer intensity-modulated radiotherapy

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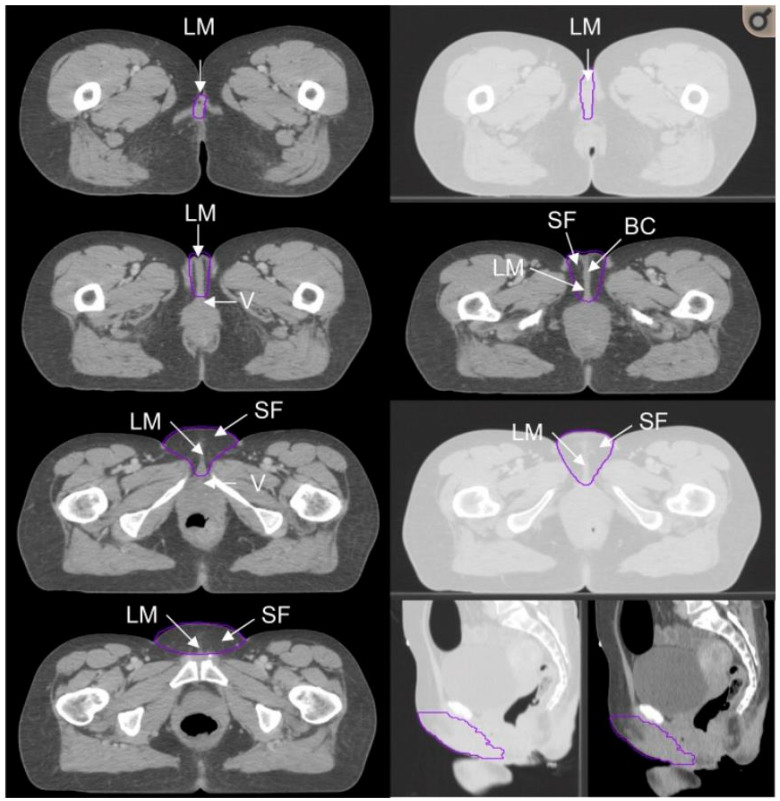
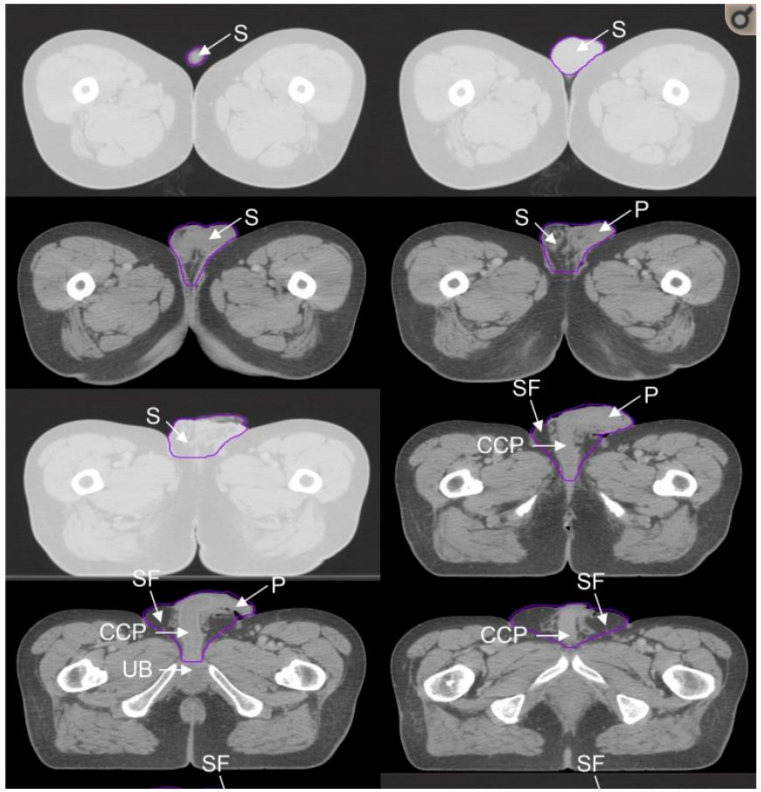
The Royal Marsden NHS Foundation Trust, Sutton, UK

Figure 1.



Genitalia outlined for a female in the supine position. BC, body of clitoris; LM, labium majus; SF, surrounding fat; V, vagina.

Figure 4.



Genitalia outlined for a male in the supine position. CCP, corpus cavernosum penis; P, penis; S, scrotum; SF, surrounding fat; UB, urethral bulb.

Genitalia

Ng et al[13] acknowledges the lack of no established genitalia guidelines and describes the area to be contoured; the penis and scrotum (males), and the clitoris, labia majora and minora (females); the skin and fat anterior to the symphysis pubis for both genders should also be included. Myerson et al[14] present a contouring atlas for clinical target volumes in anal cancer and recommend contouring the femoral heads, bladder and bowel but not the genitalia.

Gay et al[15] also present guidance for contouring normal tissues in pelvic radiotherapy but do not include the genitalia. Within the literature regarding IMRT for anal cancer, there is variation regarding the contouring method and dose constraints applied to the genitalia (Table 1) and genitalia dose reported (Table 2).

Genitalia

Table 1. Common genitalia dose constraints applied in anal intensity-modulated radiotherapy plans

Study	Prescription (Gy)	V_{20Gy} (%)	V_{30Gy} (%)	V_{40Gy} (%)	V_{50Gy} (%)	Max (Gy)	Mean (Gy)
James et al[1]	45			<50–60		50	
Menkarios et al[9]	Unclear					50	<30
Brooks et al[2]	50.4	<50	<35	<5			
Salama et al[12]	63		35–45			48	
Gay et al[15]	50.4–54	<50	<35	<5			
Lin and Ben-Josef[8]	59.4		35–45	<5–10		48	
Das et al[7]	Unclear					36	
Kachnic et al[16]	54		<50	<35	<5		
Modal constraints	Median (range) = 54 (45–63)	<50	<35	<5		48–50	

V_{XGy} = percentage of genitalia volume receiving X Gy.

to these structures, possibly at the expense of other normal structures not outlined or compromise the PTV coverage. There has been little work on genitalia dose constraints, partly because of the paucity of detailed data on outlining this OAR, and this atlas provides an opportunity to establish standardized outlining of these structures in males and females. This will subsequently allow the collection of toxicity data based on accurate and consistent OAR outlining and will help to optimize IMRT plan generation for this group of patients.

Furthermore, the atlas can be applied to other tumour sites receiving pelvic radiotherapy such as rectal, gynaecological and prostate cancers. Pelvic radiotherapy dose to the genitalia is responsible for both acute and late toxicities that have important long-term consequences in terms of sexual dysfunction and other quality of life issues. This is therefore an important area on which to focus and to ensure that there is the same level of accuracy and reproducibility as with other OARs.

- Foreslår implementering av Brooks sin atlas for inntegning av genitalia

Bones / BoneMarrow

ASTRO Online CME

CLINICAL INVESTIGATION **Anus**

ASSOCIATION BETWEEN BONE MARROW DOSIMETRIC PARAMETERS AND ACUTE HEMATOLOGIC TOXICITY IN ANAL CANCER PATIENTS TREATED WITH CONCURRENT CHEMOTHERAPY AND INTENSITY-MODULATED RADIOTHERAPY

LOREN K. MELL, M.D.,* DAVID A. SCHOMAS, M.D.,† JOSEPH K. SALAMA, M.D.,*‡ KIRAN DEVISETTY, M.D.,* BULENT AYDOGAN, PH.D.,* ROBERT C. MILLER, M.D.,† ASHESH B. JANI, M.D.,§ HEDY L. KINDLER, M.D.,‖ ARNO J. MUNDT, M.D.,¶ JOHN C. ROESKE, PH.D.,* AND STEVEN J. CHMURA, M.D., PH.D.*

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Purpose: To test the hypothesis that the volume of pelvic bone marrow (PBM) receiving 10 and 20 Gy or more (PBM-V_{10} and PBM-V_{20}) is associated with acute hematologic toxicity (HT) in anal cancer patients treated with concurrent chemoradiotherapy.

Methods and Materials: We analyzed 48 consecutive anal cancer patients treated with concurrent chemotherapy and intensity-modulated radiation therapy. The median radiation dose to gross tumor and regional lymph nodes was 50.4 and 45 Gy, respectively. Pelvic bone marrow was defined as the region extending from the iliac crests to the ischial tuberosities, including the os coxae, lumbosacral spine, and proximal femora. Endpoints included the white blood cell count (WBC), absolute neutrophil count (ANC), hemoglobin, and platelet count nadirs. Regression models with multiple independent predictors were used to test associations between dosimetric parameters and HT.

Results: Twenty patients (42%) had Stage T3–4 disease; 15 patients (31%) were node positive. Overall, 27 (56%), 24 (50%), 4 (8%), and 13 (27%) experienced acute Grade 3–4 leukopenia, neutropenia, anemia, and thrombocytopenia, respectively. On multiple regression analysis, increased PBM-V_5, V_{10}, V_{15}, and V_{20} were significantly associated with decreased WBC and ANC nadirs, as were female gender, decreased body mass index, and increased lumbosacral bone marrow V_{10}, V_{15}, and V_{20} ($p < 0.05$ for each association). Lymph node positivity was significantly associated with a decreased WBC nadir on multiple regression analysis ($p < 0.05$).

Conclusion: This analysis supports the hypothesis that increased low-dose radiation to PBM is associated with acute HT during chemoradiotherapy for anal cancer. Techniques to limit bone marrow irradiation may reduce HT in anal cancer patients.

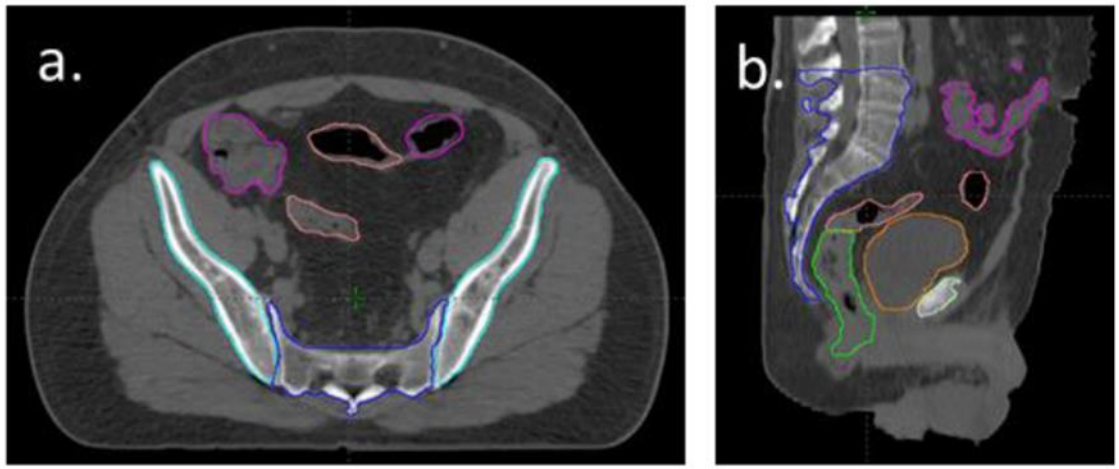
IMRT, Bone marrow, Anal cancer, V_{20}, Hematologic toxicity.

Bone marrow delineation

The external contour of the PBM was delineated on the planning CT using bone windows. Pelvic BM was divided into three subsites: (*1*) iliac BM (IBM), extending from the iliac crests to the superior border of the femoral head, (*2*) lower pelvis (LP), consisting of the pubes, ischia, acetabula, and proximal femora, extending from the superior border of the femoral heads to the inferior border of the ischial tuberosities, and (*3*) lumbosacral spine (LS), extending from the superior border of the L5 vertebral body to the coccyx but not extending below the superior border of the femoral head.

Cumulative dose–volume histograms (DVHs) corresponding to the delivered IMRT plan were generated for each contoured BM region. The volume of each region receiving 10 Gy or more was quantified and designated PBM-V_{10}, IBM-V_{10}, LPBM-V_{10}, and LSBM-V_{10}, for the pelvic, iliac, lower pelvic, and lumbosacral BM, respectively. Dosimetric parameters for other dose levels (5, 15, 20, 30, and 40 Gy) were designated similarly.

These two studies yielded remarkably similar results, despite the differences in patients studied, total radiation dose, treatment volume, and chemotherapy delivered. Both studies identified significant associations between WBC and ANC nadirs and the V_{10} and V_{20} of PBM and LSBM, suggesting that these associations might be true generally for patients receiving concurrent chemotherapy and radiation to the pelvic region. The lack of correlation between Hgb or platelet nadirs



- Også de lavere stråledosene til benmarg ser ut til å betydning

Bowelbag / SmallBowel / Bowel?

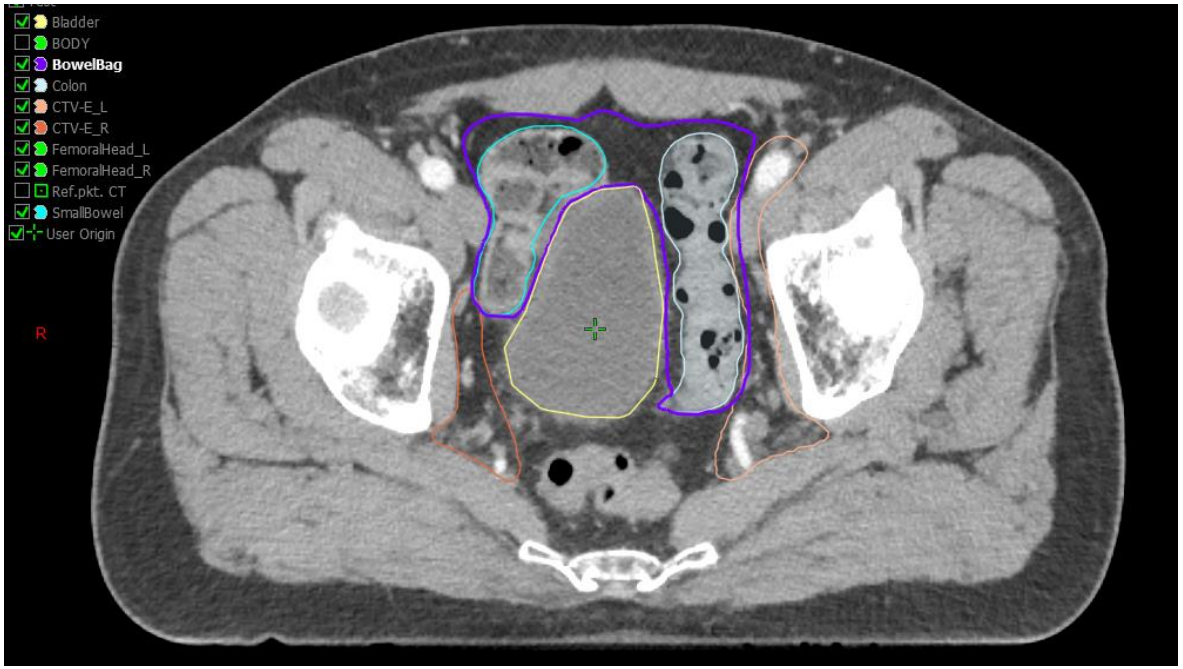
Tynntarm kan tegnes på to måter:

ENTEN: Tegnes som *Bowelbag* (den delen av bukhulen tarmen antas å bevege seg innenfor), inneholder både tynn- og tykktarm, men ikke blære, uterus, prostata, vesikler, mesorektum. Det er likevel ulike måter å tegne dette på, og det er viktig å være konsekvent og bruke doserestriksjon knyttet opp mot aktuell inntegningsmåte. I henhold til DeFoe tegnes *BowelBag* fra 1,5 cm over PTV ned til rektosigmoidovergangen. Anteroposteriort fra fremre bukvegg til bakerste del av bakerste tarmavsnitt. Lateralt fra mest laterale tarmvegg til tarmvegg. Veiledende doserestriksjon ved denne inntegningsmåten: V30 < 310cc, V40 < 70cc (81). En ny australsk studie konkluderer med at *BowelBag* tegnet på denne måten er den mest sensitive prediktor for grad 3 vs grad 0-2 diare og de anbefaler at man forsøker å holde V30 <300 cc (6% vs 42% risiko for grad 3 diare) (ref).

- ELLER: Tegnes som separate tynntarmslynger fra 1 cm over PTV, også eventuelle slynger innenfor CTVe_40 tegnes. Peroral kontrast er en fordel. Veiledende doserestriksjoner: 45 Gy < 20 cc, 35 Gy < 150 cc, 30 Gy < 200 cc (80).

Utkast til Norsk Handlingsprogram

- Noen pasienter har mye tynntarm langt nede i bekkenet
  - Spesielt utfordrende etter prostatektomi eller hysterektomi



Alternativ 1: SmallBowel…

- ELLER: Tegnes som separate tynntarmslynger fra 1 cm over PTV, også eventuelle slynger innenfor CTVe_40 tegnes. Peroral kontrast er en fordel. Veiledende doserestriksjoner: 45 Gy < 20 cc, 35 Gy < 150 cc, 30 Gy < 200 cc (80).

Oncology

Clinical Study

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arameters Predictive of Acute nal Toxicity in Patients with Anal Carcinoma Treated with Concurrent Chemotherapy and Intensity-Modulated Radiation Therapy

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Key Words
Intensity-modulated radiation therapy · Anal cancer · Dosimetric parameters · Gastrointestinal toxicity · Concurrent chemoradiation

Abstract
Objective: To determine the dosimetric parameters predictive of acute gastrointestinal (GI) toxicity in anal cancer patients treated with intensity-modulated radiotherapy (IMRT) and concurrent chemotherapy. ***Methods:*** Fifty-eight anal cancer patients were treated with concurrent chemotherapy and IMRT. The bowel was delineated on the planning CT and included the intestinal cavity. Regression models with multiple independent predictors were used to test associations of clinical factors and dosimetric parameters with clinically significant GI toxicity (grade ≥3). Significant dosimetric factors were fitted to a normal tissue complication probability curve using a logit function and subsequently analyzed at multiple bowel volumes to determine the threshold for clinically significant GI toxicity. ***Results:*** Two patients (3.4%) experienced no acute GI toxicity, whereas 20 (34.5%) experienced grade 1 toxicity, 20 (34.5%) experienced grade 2, 16 (27.6%) experienced grade 3 and none experienced grade 4. Analysis showed that the volumes of bowel receiving 30 Gy (V30) and 40 Gy (V40) both correlated with clinically significant acute GI toxicity. In patients whose V30 was >310 cm^3, the rate of clinically significant acute GI toxicity was 38.9%, compared to 9.1% if V30 was ≤310 cm^3 ($p = 0.016$). If V40 was ≤70 cm^3, the rate of acute grade ≥3 toxicity was 6.3%, versus 35.7% if V40 was >70 cm^3 ($p = 0.045$). ***Conclusion:*** This analysis demonstrates that the bowel dosimetric parameters are associated with clinically significant acute GI toxicity when IMRT is used in the management of anal cancer patients.

Introduction

The standard treatment for patients with anal carcinoma is concurrent 5-fluorouracil (5-FU)/mitomycin (MMC)-based chemotherapy and radiation therapy (CRT). Although this approach is an effective sphincter-sparing treatment for anal carcinoma and has since been validated in several randomized controlled trials [1–4], patients experience high rates of acute toxicities when conventional radiation techniques are utilized.

In prospective series, a commonly used technique of radiation therapy delivery consists of a conventional 3-di-

- Trengs ikke tegnet lengre opp og fram enn 30Gy`s-isodosen går

SmallBowel…

NATIONAL GUIDANCE FOR IMRT IN ANAL CANCER

R Muirhead[1], RA Adams[2], DC Gilbert[3], M Harrison[4], R Glynne-Jones[4], D Sebag-Montefiore[5], MA Ha
[1]The CRUK/MRC Oxford Institute for Radiation Oncology, Oxford, UK; [2]School of Medicine, Cardiff University, Cardiff, UK; [3]Sussex Cancer Centre, Roya
Vernon Hospital, Northwood, UK; [5]University of Leeds, St James Institute of Oncology, Leeds, UK

1.0 Disclaimer

The guidance presented on this web-site illustrates the consensus reached among th
groups. This document provides guidance for IMRT treatment in anal cancer and there
implementation and use, remains the responsibility of the treating clinician.

Organ	OAR / Target	Optimal Constraint	Mandatory Constraints
PTV	D99%	>90%	>90%
	D95%	>95%	>95%
	D50%	Between 99% - 101%	Between 97% - 101%
	D5%	<105%	<107%
	D2%	<107%	<110%
Lower dose-level PTV's	D99%	>90% of prescribed dose	>90% of prescribed dose
	D95%	>95% of prescribed dose	>95% of prescribed dose
	D50%	<110%	<125%
Small Bowel	D200cc	<30Gy	<35Gy
	D150cc	<35Gy	<40Gy
	D20cc	<45Gy	<50Gy
	D5cc	<50Gy	<55Gy
Femoral Heads	D50%	<30Gy	<45Gy
	D35%	<40Gy	<50Gy
	D5%	<50Gy	<55Gy
Genitalia	D50%	<20Gy	<35Gy
	D35%	<30Gy	<40Gy
	D5%	<40Gy	<55Gy
Bladder	D50%	<35Gy	<45Gy
	D35%	<40Gy	<50Gy
	D5%	<50Gy	<58Gy

If mandatory constraints cannot be met, please discuss with the trial team. In principle the PTV takes priority, however in advanced cases, especially in dose escalation arm, there might be difficulties depending on patient anatomy and tumour location.

Organs at risk

The RTOG guidance on pelvic normal tissue contouring can offer some guidance [6] although there are some slight differences to what is suggested below. The following organs at risk (OAR) must be delineated by the radiographer/dosimetrist/physicist/consultant:

- *Small Bowel:* Contouring should include all individual small bowel loops to at least 20mm above the superior extent of both PTVs. It may be helpful to initially delineate the large bowel +/- endometrium to exclude these from subsequent delineation of small bowel.
- *External genitalia:* Delineation of the male genitalia should include the penis and scrotum out laterally to the inguinal creases. In woman it should include the clitoris, labia majora and minora, out to the inguinal creases. Superior border in both sexes should lie midway through the symphysis pubis. See Appendix 3 for pictorial guidance.
- *Bladder:* entire bladder including outer bladder wall
- *Right and left femoral heads:* To be contoured separately on each side. To include the ball of the femur, trochanters, and proximal shaft to the level of the bottom of ischial tuberosities.

SmallBowel…og LargeBowel

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Clinical Investigation: Gastrointestinal Cancer

RTOG 0529: A Phase 2 Evaluation of Dose-Painted Intensity Modulated Radiation Therapy in Combination With 5-Fluorouracil and Mitomycin-C for the Reduction of Acute Morbidity in Carcinoma of the Anal Canal

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**Department of Radiation Oncology, Boston University Medical Center, Boston, Massachusetts; †Radiation Therapy Oncology Group Statistical Center, Philadelphia, Pennsylvania; ‡Department of Radiation Oncology, Washington University School of Medicine, St. Louis, Missouri; §Department of Medicine, Dalhousie University, Halifax, Canada; ‖Department of Radiation Oncology, Mayo Clinic, Rochester, Minnesota; ¶Department of Radiation Oncology, State University of New York—Downstate Medical Center, Brooklyn, New York; #Department of Medicine, Brown University, Providence, Rhode Island; and **Department of Radiation Oncology, Duke University, Durham, North Carolina*

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Table 1 Dose-painted intensity modulated radiation therapy dose constraints for normal tissues

Organ	Dose (Gy) at <5% volume	Dose (Gy) at <35% volume	Dose (Gy) at <50% volume
Small bowel*,†	45 (<20 cc)	35 (<150 cc)	30 (<200 cc)
Femoral heads*	44	40	30
Iliac crest	50	40	30
External genitalia	40	30	20
Bladder	50	40	35
Large bowel†	45 (<20 cc)	35 (<150 cc)	30 (<200 cc)

Organs are listed in order of decreasing priority.

* Assigned criteria for major and minor violations; major violations were considered as part of the feasibility secondary endpoint.

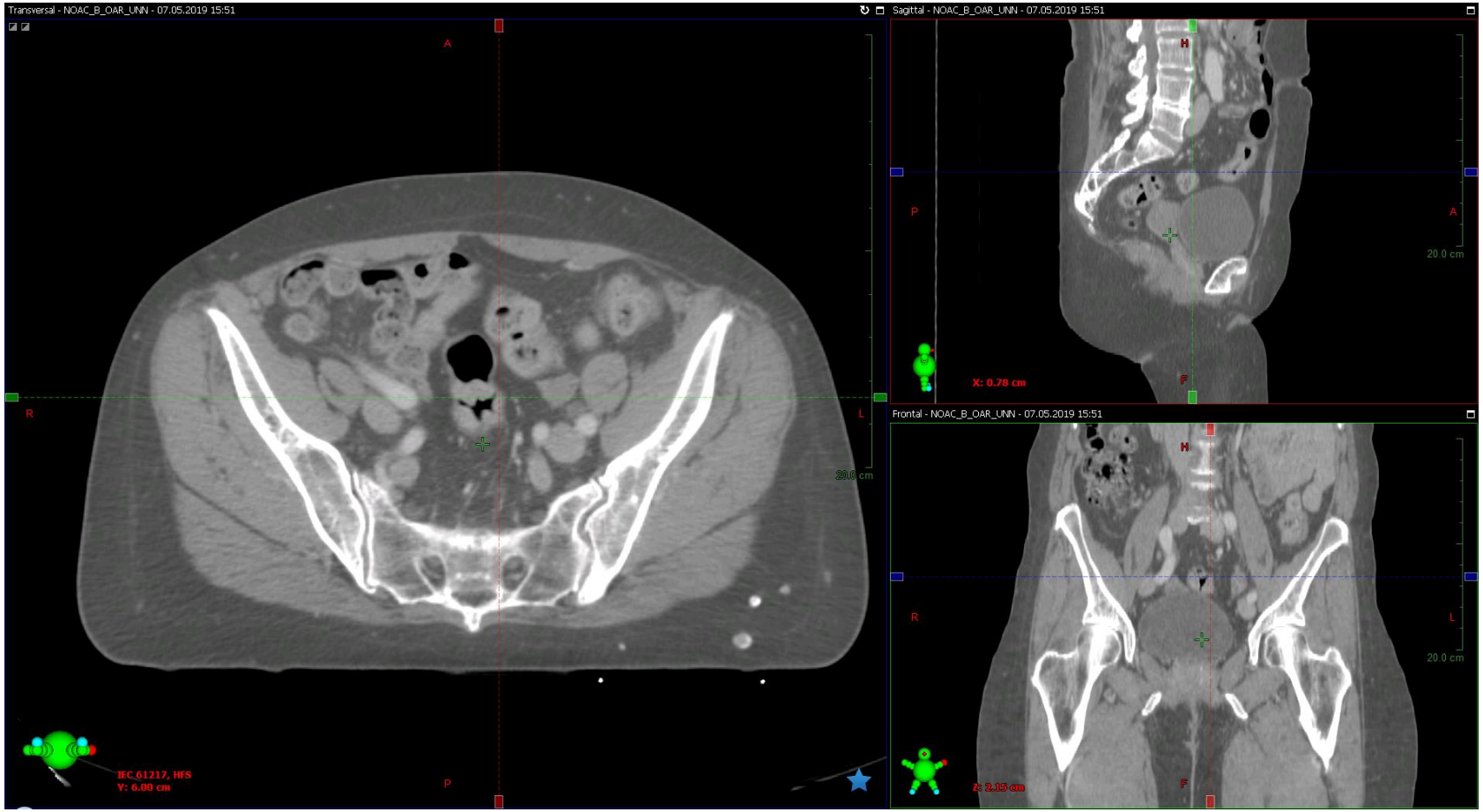
† Dose constraints based on absolute volume instead of % volume.

Normal structures (small bowel, large bowel, bladder, femoral heads, iliac bones, perianal skin, genitalia) were also contoured, the bowel as individual loops to 2 cm above the most superior extent of the target CTVs. The entire rectum was considered a target structure and therefore excluded from large bowel contouring.

SmallBowel: Hvorfor – ev hvorfor ikke?

- Ressurskrevende
- Øyeblikksbilde

- Vanskelig å definere / avgrense, spesielt når man ikke gir po-kontrast → Noen velger å tegne «Bowel» i stedet



Bowel…

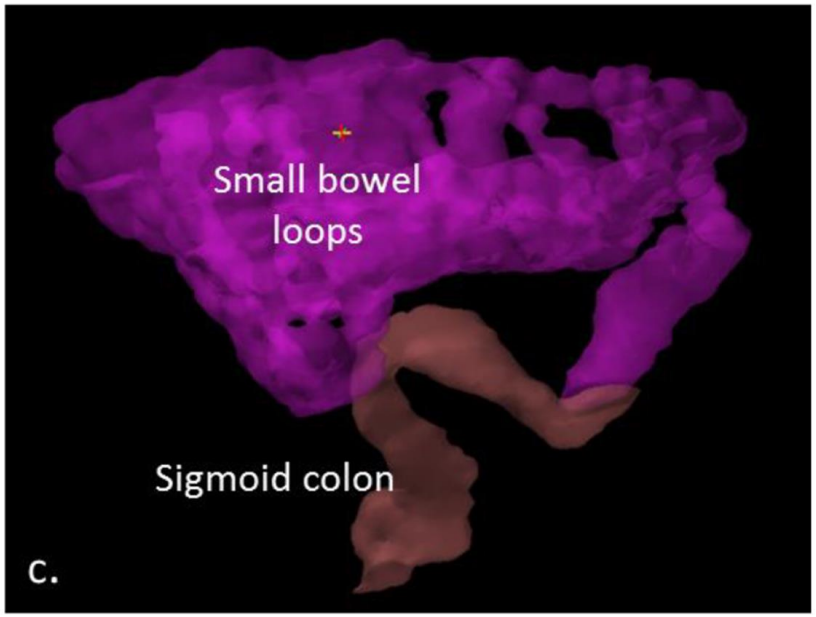


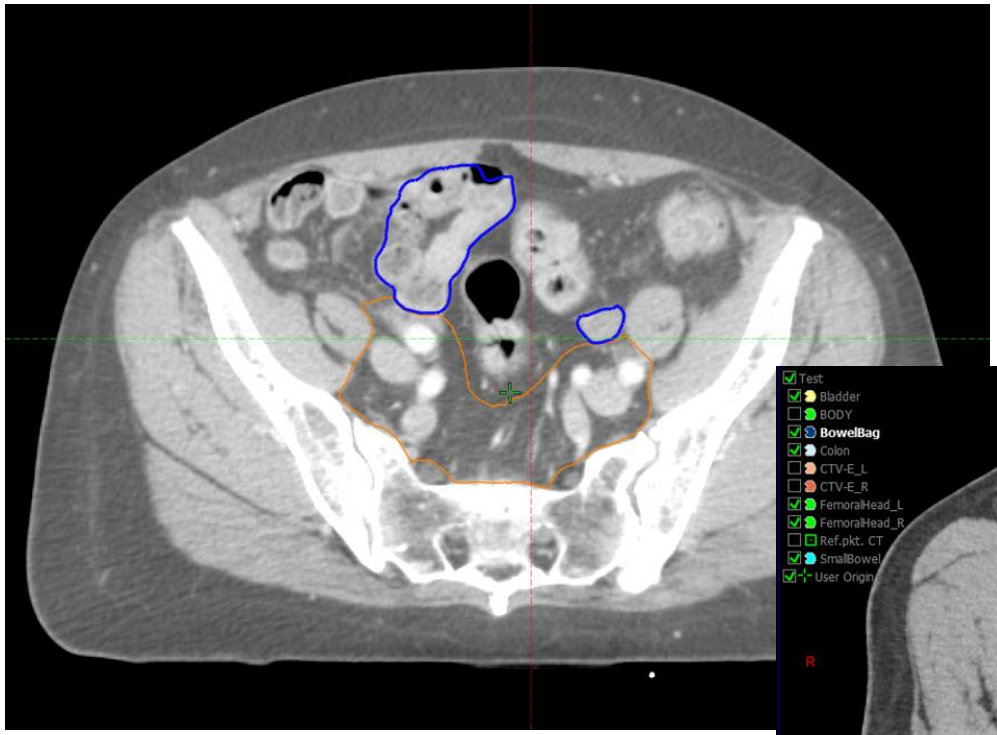
Table SUPP-1: IMRT trial dose-volume constraints for rectum and bowel.

RECTUM				BOWEL			
2Gy/fraction		3Gy/fraction*		2Gy/fraction		3Gy/fraction*	
Dose constraint (Gy)	**Volume required (%)**	**Dose constraint (Gy)**	**Volume required (%)**	**Dose constraint (Gy)**	**Volume required (cc)** Mandatory (optimal)	**Dose constraint (Gy)**	**Volume required (cc)** Mandatory (optimal)
rV50	60	**rV43**	60	**bV45**	158 (78)	**bV39**	158 (78)
rV60	50	**rV51**	50	**bV50**	110 (17)	**bV43**	110 (17)
rV65	30	**rV55**	30	**bV55**	28 (14)	**bV47**	28 (14)
rV70	15	**rV59**	15	**bV60**	6 (0)	**bV51**	6 (0)
rV75	3	**rV63**	0	**bV65**	0 (0)	**bV55**	0 (0)

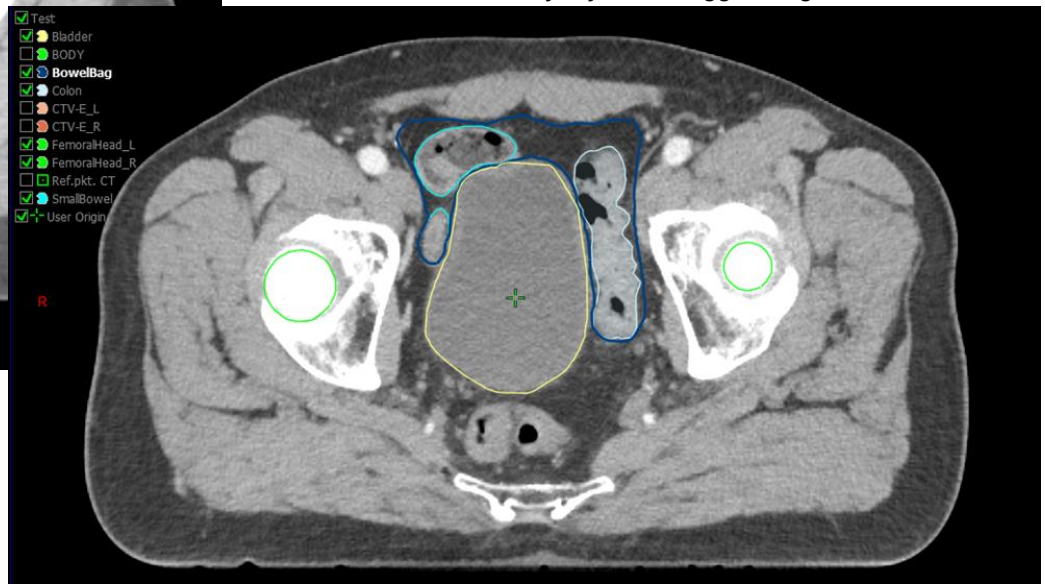
**Constraints for the 3Gy cohorts were simply extrapolated from the 2Gy cohort in a ratio of 60/70 (reflecting the initial prostate treatment dose of 70Gy) with no implicit radiobiological assumptions.*

SmallBowel: Hvorfor – ev hvorfor ikke, og eventuelle utfordringer

- Tromsø: SmallBowel brukes som begrensning ved korreksjon av CTVe
  - Ligger intraperitonealt
    - Peritoneum er en naturlig begrensning for mikroskopisk infiltrasjon
  - Vi tegner først CTV (7 mm margin til iliacakarene, beskjært for muskulatur), trekker så fra SmallBowel



Utfordrende der mye tynntarm ligger langt nede i bekkenet



CTVe ved Ca prostata – PIVOTAL-trial

PIVOTAL TRIAL LYMPH NODE CONTOURING
INSTRUCTIONS & ATLAS

This document consists of 2 sections: the first is instructions and hints on how to create the lymph node CTV as described in the PIVOTAL radiotherapy planning document. The second section is an atlas with a number of a

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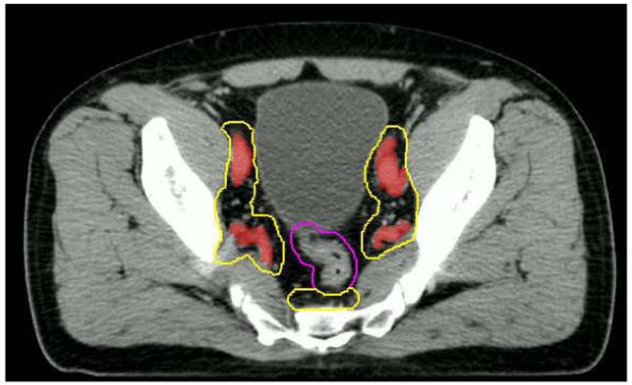
Clinical Investigation

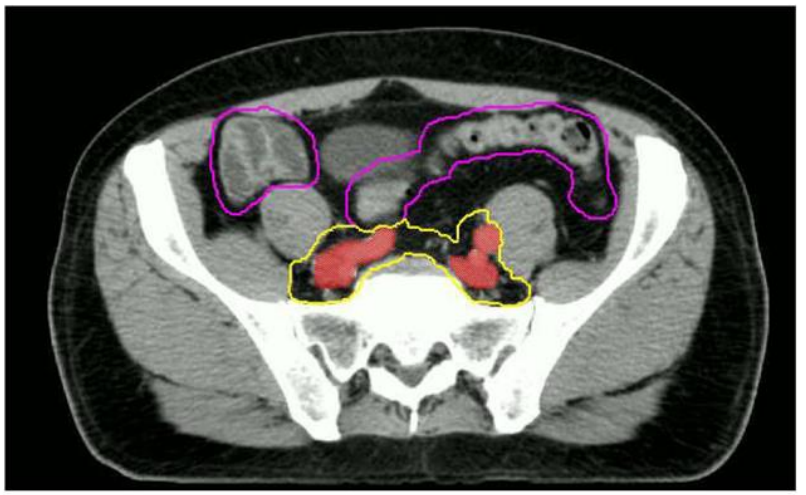
Consensus Guidelines and Contouring Atlas for Pelvic Node Delineation in Prostate and Pelvic Node Intensity Modulated Radiation Therapy

Victoria A. Harris, MBBS, MRCP, FRCR,* John Staffurth, MBBS, MD, FRCP, FRCR,† Olivia Naismith, MSc,‡ Alikhan Esmail, MSc, CSci,§ Sarah Gulliford, PhD,‡ Vincent Khoo, MBBS, FRACR, FRCR, MD,# Rebecca Lewis, BSc,‖ John Littler, MBBChir, MRCP, FRCR,¶ Helen McNair, DCR(T), PhD,# Azmat Sadoyze, MBBS, MRCP, FRCR,** Christopher Scrase, MBBChir, MA, MRCP, FRCR,§ Aslam Sohaib, MBBS, MRCP, FRCR,†† Isabel Syndikus, MD, MRCP, FRCR,¶ Anjali Zarkar, MBBS, MD, MRCP, FRCR,‡‡ Emma Hall, PhD,‖ and David Dearnaley, MA, MB, BCh, MD, FRCP, FRCR*, for the PIVOTAL Trialists

*Academic Urology Unit, Institute of Cancer Research and Royal Marsden NHS Foundation Trust, London, United Kingdom; †Institute of Cancer and Genetics, School of Medicine, Cardiff University, Cardiff, Wales, United Kingdom; ‡Joint Department of Physics, Institute of Cancer Research, and Royal Marsden NHS Foundation Trust, London, United Kingdom; §Ipswich Hospital NHS Foundation Trust, Ipswich, United Kingdom; ‖Clinical Trials and Statistics Unit, Institute of Cancer Research, London, United Kingdom; ¶Clatterbridge Cancer Centre, Liverpool, United Kingdom; #Department of Radiotherapy, The Royal Marsden NHS Foundation Trust, London, United Kingdom; **Beatson West of Scotland Cancer Centre, Scotland, Glasgow, United Kingdom; ††Department of Radiology, The Royal Marsden NHS Foundation Trust, London, United Kingdom; ‡‡University Hospitals Birmingham

8. Expand bowel by 3mm isotropically (shown in pink) ensuring it does not overlap with the blood vessels. Edit the LN CTV to exclude the expanded bowel volume (as well as bladder & rectum) using the planning software. **Please note, the LN CTV may need to be manually edited if the expanded bowel volume compromises the LN CTV.**





Alternativ 2: Bowelbag…

ENTEN: Tegnes som *Bowelbag* (den delen av bukhulen tarmen antas å bevege seg innenfor), inneholder både tynn- og tykktarm, men ikke blære, uterus, prostata, vesikler, mesorektum. Det er likevel ulike måter
konsekvent og bruke doserestriksjon kn
til DeFoe tegnes *BowelBag* fra 1,5 cm o
Anteroposteriort fra fremre bukvegg til
mest laterale tarmvegg til tarmvegg. Ve
inntegningsmåten: V30 < 310cc, V40 < 7
at *BowelBag* tegnet på denne måten er
diare og de anbefaler at man forsøker å
diare) (ref).

Clinical Oncology 30 (2018) 634–641

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Original Article

Intensity-modulated Radiotherapy for Anal Cancer: Dose–Volume Relationship of Acute Gastrointestinal Toxicity and Disease Outcomes

M. Ng *, H. Ho †, J. Skelton ‡, M. Guerrieri §, M. Guiney *, M. Chao †, D. Blakey ¶, C. Macleod ||, H. Amor ‡, B. Subramanian †, L. Melven ‡

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Received 14 April 2018; received in revised form 29 June 2018; accepted 4 July 2018

Abstract

Aims: Intensity-modulated radiotherapy (IMRT) is increasingly used in the treatment delivery of chemoradiotherapy in anal cancer with the ability to reduce toxicity. We report on 4 year outcomes since the introduction of IMRT and identify the most predictive bowel organ at risk that correlates with acute diarrhoea.
Materials and methods: Fifty-eight patients receiving definitive chemoradiotherapy for squamous or basaloid cell anal carcinoma (T1–4NanyM0) were reviewed. Fifty-four per cent of patients had stage III disease and most (79%) were treated with a dose of 54 Gy in 30 fractions. Patient acute gastrointestinal toxicity was recorded using Common Terminology Criteria of Adverse Events (CTCAE) diarrhoea grading. Four different methods of bowel were re-contoured for each patient and correlated with acute diarrhoea. Locoregional control and overall survival were analysed.
Results: CTCAE grade 3 or more diarrhoea occurred in 11/58 patients (19%). Seven patients did not complete treatment; 10 patients (17%) required a treatment break of 3 or more days. 'Bowel cavity' was the best predictor of acute grade 3 toxicity using volume ($P = 0.002$) or volume to bowel cavity in 5 Gy bins (V5–V50Gy); $P < 0.05$. Bowel cavity V30Gy $\leq$ 300 cm^3 predicts a 6% grade 3 diarrhoea risk versus $>$ 300 cm^3 predicts a 42% risk. Four year progression-free survival was 84% (95% confidence interval 73–92%) and overall survival was 88% (95% confidence interval 75–95%).
Conclusion: Chemoradiation using IMRT provides excellent local control and acceptable acute gastrointestinal toxicity. Bowel cavity is the most sensitive predictor for grade 3 versus grade 0–2 diarrhoea, with any volume receiving 5–50 Gy discriminatory.

Bowel cavity: The most practical way…

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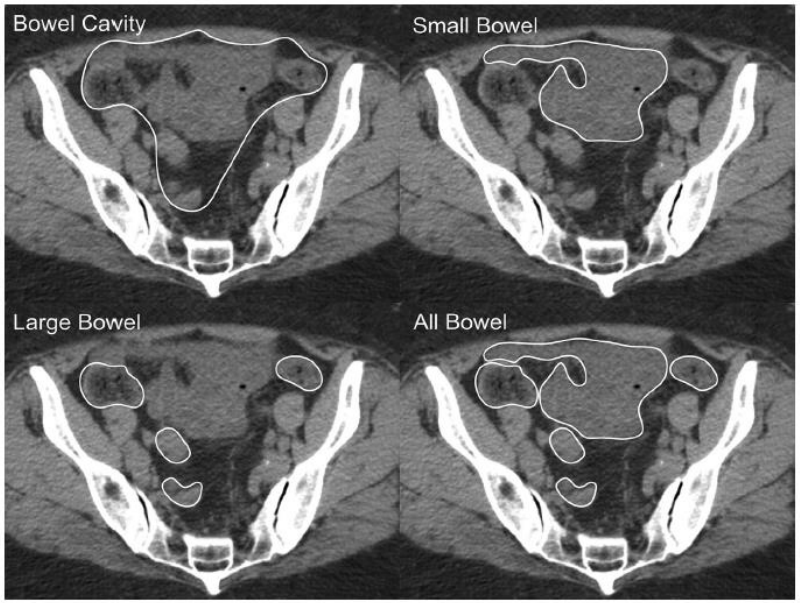

Fig 1. Four methods of bowel contouring on the same axial pelvic slice.

- Simple, fast

Our report aims to help answer the most practical way to contour bowel volume in radiotherapy treatment planning in anal cancer patients. Bowel cavity is a simple, reproducible and fast way to contour compared with marking individual loops of bowel. It is not subject to the difficulties of differentiating small versus large bowel, avoids the need for oral contrast and accounts for the 'space' bowel loops can move in the abdominal cavity inter-fractionally. We still support the recommendation of individual small bowel loop delineation in ongoing co-operative group trials [12], as long as oral contrast is specified. However, for community-based practices, bowel cavity is an efficient and pragmatic method for planning optimisation. As bowel cavity was the most sensitive predictor of diarrhoea, we recommend bowel cavity as the relevant OAR to minimise radiation dose to, and favour a single metric, V30Gy, as in other published papers, as the single bowel dose constraint in radiotherapy planning for anal cancer patients.

Bowel cavity: The most practical way…

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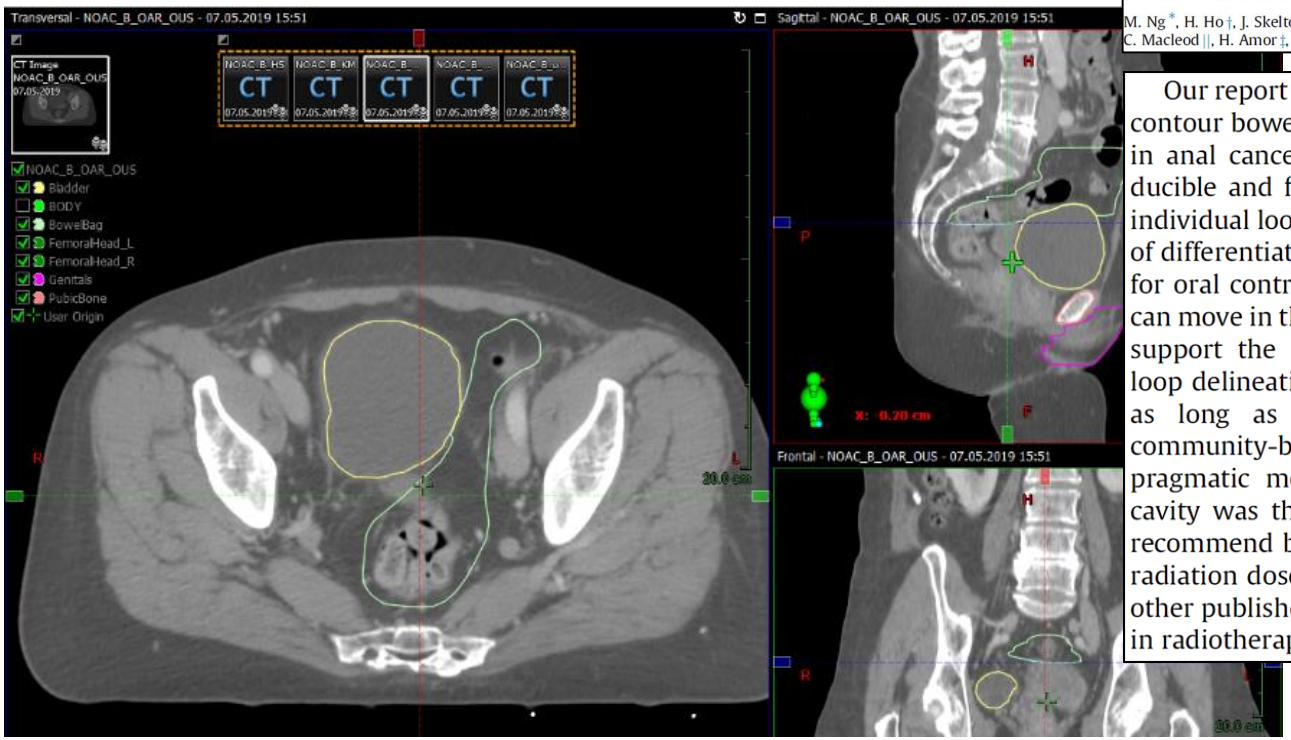
Intensity-modulated Radiotherapy for Anal Cancer: Dose–Volume Relationship of Acute Gastrointestinal Toxicity and Disease Outcomes

M. Ng *, H. Ho †, J. Skelton ‡, M. Guerrieri §, M. Guiney *, M. Chao †, D. Blakey ¶, C. Macleod ||, H. Amor ‡, B. Subramanian †, L. Melven ‡



Our report aims to help answer the most practical way to contour bowel volume in radiotherapy treatment planning in anal cancer patients. Bowel cavity is a simple, reproducible and fast way to contour compared with marking individual loops of bowel. It is not subject to the difficulties of differentiating small versus large bowel, avoids the need for oral contrast and accounts for the 'space' bowel loops can move in the abdominal cavity inter-fractionally. We still support the recommendation of individual small bowel loop delineation in ongoing co-operative group trials [12], as long as oral contrast is specified. However, for community-based practices, bowel cavity is an efficient and pragmatic method for planning optimisation. As bowel cavity was the most sensitive predictor of diarrhoea, we recommend bowel cavity as the relevant OAR to minimise radiation dose to, and favour a single metric, V30Gy, as in other published papers, as the single bowel dose constraint in radiotherapy planning for anal cancer patients.

- Simple, fast
- Reproducible (?)
  - Not subject to the difficulties of differentiating small versus large bowel
  - Avoids oral contrast
  - Accounts for the «space» bowel loops can move in the abdominal cavity inter-fractionally

  - Kommentar:
    - Nedre grense helt avgjørende for volum over for eksempel 30 Gy
    - Spesielt vanskelig hos de som har mye tarm langt nede i bekkenet

Bowel cavity: The most practical way…

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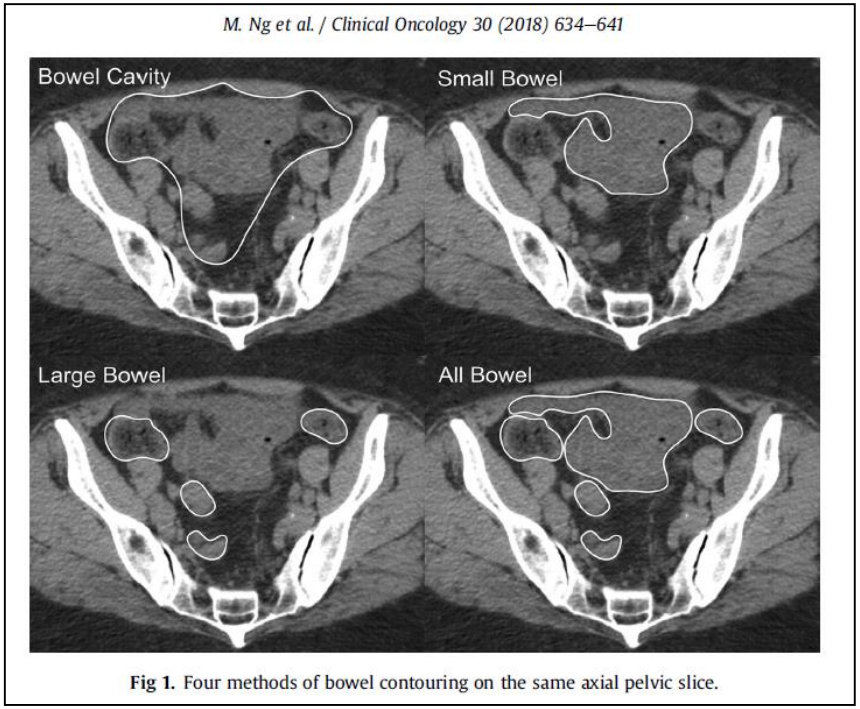

Fig 1. Four methods of bowel contouring on the same axial pelvic slice.

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- Simple, fast
- Reproducible (?)
  - Not subject to the difficulties of differentiating small versus large bowel
  - Avoids oral contrast
  - Accounts for the «space» bowel loops can move in the abdominal cavity inter-fractionally

- Most sensitive predictor of diarrhoea → recommend bowel cavity as the relevant OAR to minimise radiation dose
- Favour V30Gy as a single metric

Kirsten Marienhagen 10.09.2019

Bowel cavity: The most practical way…

'Bowel cavity' was based on a paper by Devisetty *et al.* [6] (AGITG guidelines are similar) – defined as an envelope containing all bowel from 1.5 cm cranial to the PTV to the recto-sigmoid junction. The anterior margin was the anterior abdominal wall; lateral and posterior margins being the bowel contour.

Devisetty

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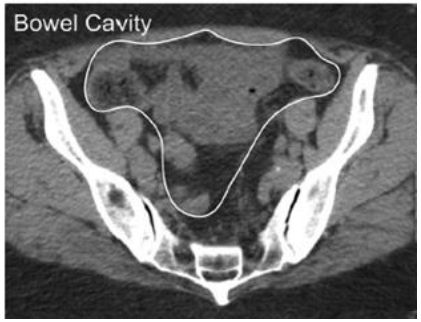
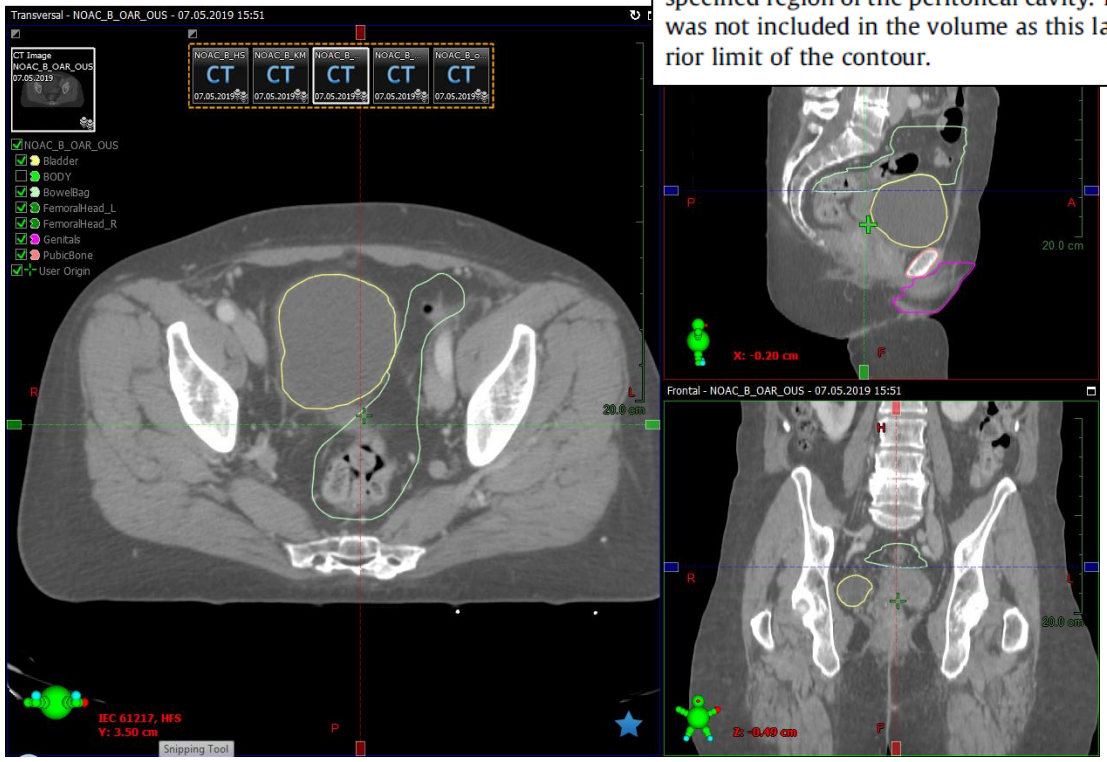
Bowel delineation

The external contour of the bowel, both opacified and non-opacified, delineated on the planning CT was similar to the contour used in our investigation of GI dosimetric parameters in gyneco-logic patients [12]. In the superior-inferior direction, the bowel was contoured from 1.5 cm superior to the PTV to the rectosigmoid junction. In the anterior–posterior direction, the bowel was con-toured from the anterior abdominal wall to the most posterior ex-tent of bowel. In the lateral direction, the bowel was contoured from bowel edge to bowel edge. Due to the variability of oral con-trast penetration, this contouring technique encompassed all opac-ified and non-opacified bowel loops (small and large) within the specified region of the peritoneal cavity. The rectosigmoid junction was not included in the volume as this landmark defined the infe-rior limit of the contour.





- Envelope containing all bowel
  - 1.5 cm kranialt for PTV
  - Kaudalt: Recto-sigmoid junction…
  - Lateralt og posteriort: Bowel-kontur
- Men ikke mesorektum
- Kanskje ikke så enkelt likevel??

Generelle kommentarer og spørsmål

- Viktig å finne ut hva risikoorganer skal brukes til
  - Primært for optimalisering av IMRT- / VMAT-plan, i så fall ok med ”korrigerte” risikoorganer / hjelpestrukturer
  - Sammen med toleransegrenser for å predikere risiko for akutt og seneffekter
    - Må da tegnes korrekt (ikke beskjæres for PTV)
- Risikoorganer bør tegnes mest mulig likt både innad i avdelingen og mellom institusjonene
  - Muliggjør på sikt å predikere risiko for toksisitet
- Prioritering målvolum – risikoorganer
- Hva med felles OAR-atlas for hele Skandinavia?