



Methodology and recommendations for using MRI in radiotherapy - a Skonsam Strålbehandling / Gentle Radiotherapy project



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MR in RT

► Benefits

- Superior soft tissue imaging contrast
- Response assessment
- Dose adaptations
- Follow-up scans (non-ionizing)



► Technical requirements

- Good spatial integrity
- Good contrast to noise ratio
- Optimized MRI protocols

► System adaptations

- Flat table top
- Immobilization equipment
- Flexible receiver coils
- External positioning laser system
- No carbon fiber!



Vinnova Gentle Radiotherapy

- ▶ Aim: Implement MR in RT
- ▶ University Hospitals in Sweden
- ▶ Five work packages
 - ▶ WP1: Optimization of sequences and markers
 - ▶ WP2: Dose calculation and dose planning
 - ▶ WP3: Segmentation and deformable registration
 - ▶ WP4: QA and geometric distortions
 - ▶ WP5: Clinical studies
- ▶ **WP1: Handbook for implementing MR in RT**



Handbook for MR in RT

► Long term goal:

- Provide help and clarity for new MRRT sites and personal
- Illustrate the differences between radiological MR and MRRT
- To give examples of working routines with illustrating images for MRRT concerning head, head and neck, prostate and brachy cervix.
- Clarify the purpose of every MR-sequence
- State the do and don'ts of how to work with the image data
- Be vendor specific (GE, Siemens, Philips)

► Short term goal:

- Increase collaboration in Sweden
- Illustrate the similarities and differences between sites, inspire and compare.

Authors: Christian Gustafsson and Maja Sohlin, PhD (Gothenburg)

Survey of MR-protocols in Sweden

- Survey
- Anonymized image data

- Head
- Head and Neck
- Prostate

4	Anatomi											
5	Sekvens	Leverantör av MR	Fältstyrka	Anända spolar (Tillverkarens namn)	Produktnamn på sekvens	TR	TE	FOV	Snittjocklek	Pixelstorlek	Bandbredd per pixel	Vinkling av snitt
7	T1 utan kontrast											
8	T2											
9	T2 FLAIR											
10	T1 med kontrast											
11	Ev Diffusion											
12	Ev Perfusion											
13	Annat?											
14												
15	Vävnadsundertryckning + teknik	Spineko eller gradienteko	2D eller 3D	Tid	Syfte med sekvens	Omfattning av anatomitäckning	Förberedelser	Fixation	Bifogade bildexempel	Annan kommentar	Spacing (mm)	3D Dist correct
17												
18												
19										Inversionstid?		
20												
21										b-värde?		
22												
23												
24												

Stockholm Umeå Lund Gothenburg Uppsala

✓ Big differences in protocols (SNR and resolution)

✓ Patient positioning



Contents

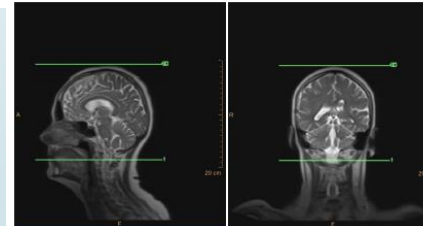
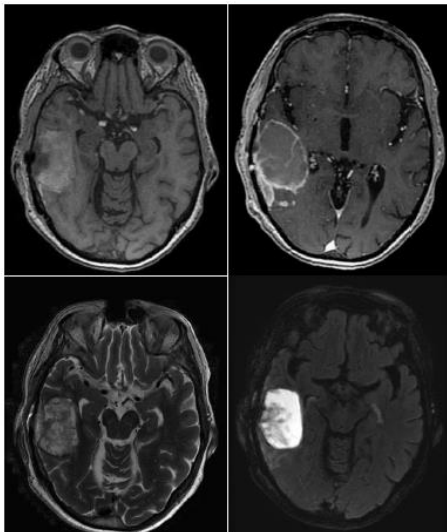
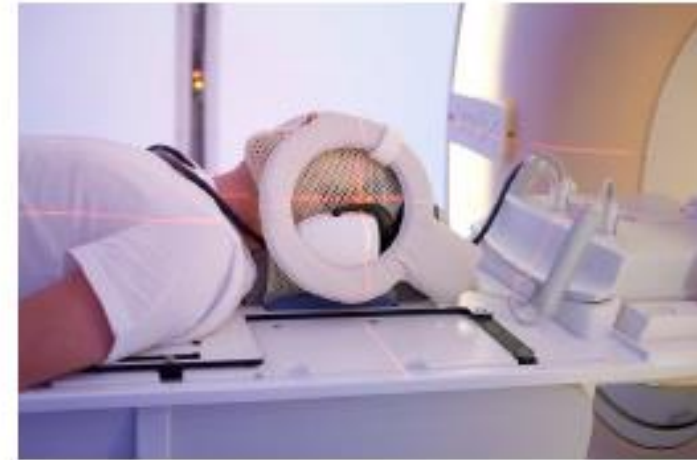
- 1) General introduction
 - 1) MRRT
- 2) Differences
 - 1) MRRT vs Radiological MR
 - 2) Geometrical distortions
- 3) Patient positioning
 - 1) MR-scanner
 - 2) Fixation and carbon fiber
 - 3) Coils
 - 4) MR-Safety
- 4) Practical implementation
 - 1) General recommendations
 - 2) Image registration
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- 6) QA
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Head

Siemens

GE

Philips

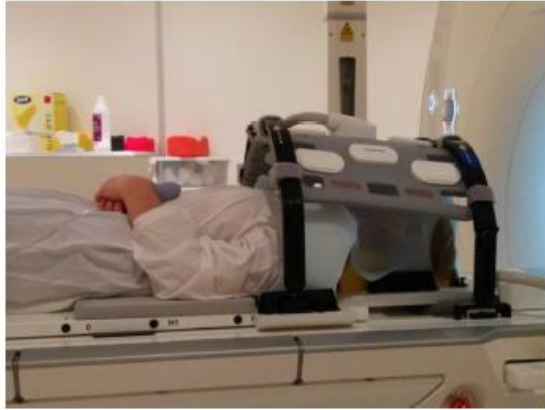


Scan	Bildanvändning	Ev. problem
Axial T1W	Matchning mot CT samt anatomi före kontrast.	
Axial T2W	Inritning av target och riskorgan.	
Axial T2W FLAIR	Utlinjering av vasogent ödem/infiltrativt gliom (ljust).	Artefakter från CSF-pulsation
Axial T1W med kontrast	Utlinjering av områden med defekt blodhjärnbarriär och neovaskularisering (ljust).	Postoperativa blodprodukter – jämför med pre-kontrast T1W

Figur 10. Bilder från GE Signa PET/MR 3.0T system i Umeå. a) T1 FSPGR tra (2:09 min), b) T1 FSPGR tra (2:09 min), c) T2 PROPELLER tra (ca 5 min), d) T2 Cube FatSat dark fluid sag reformaterac

Head and Neck

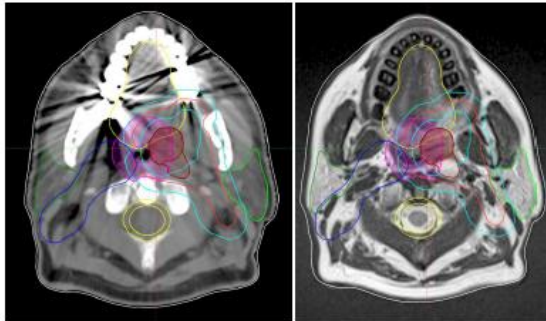
Siemens



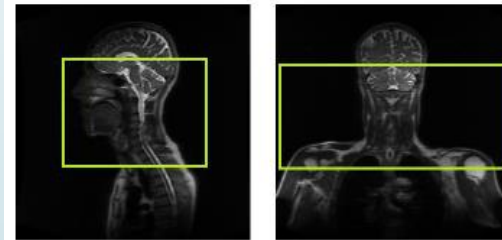
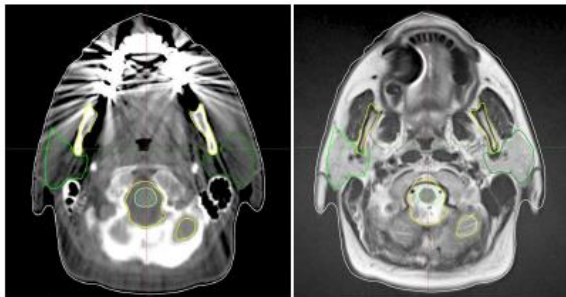
GE



Philips



Figur 26. a) Stråkartefakter på en CT-bild som uppkommer från tandlagningar, b) motsvarande avbildning med MR.



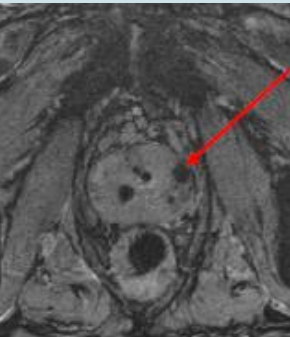
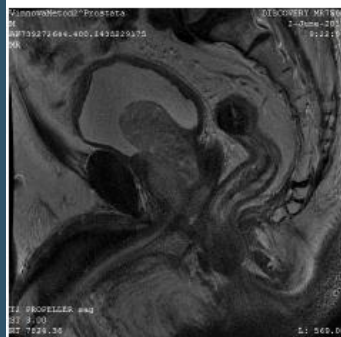
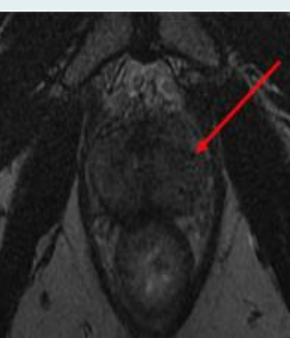
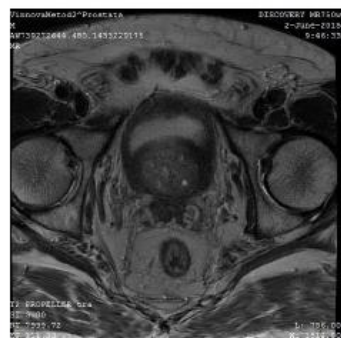
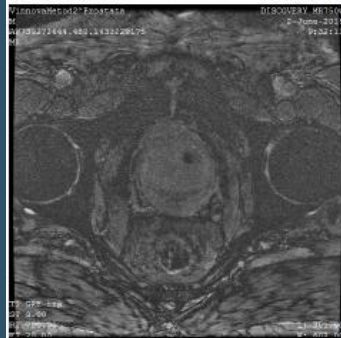
Scan	Bildanvändning	Anatomisk täckning	Ev. problem
Axial T2 STIR	Differentiera ödem (ljust)	Lillhjärna till axlar	Sväljartefakter, flödesartefakter
Axial T1	Utritning av nerver och tänder	Lillhjärna till axlar	
Axial ADC	Utritning av hypercellularitet (mörkt)	Tumör	Geometrisk distorsion
Axial Fat-suppressed postcontrast T1	Utritning av söndrig, läckande vävnad (ljust)	Lillhjärna till axlar	Sväljartefakter, flödesartefakter

Prostate

Siemens

GE

Philips



Scan	Bildanvändning	Anatomisk täckning	Ev. problem
Sag T2	Utritning av rektum och blåsa	Prostata, vesiklar	
Axial T2	Utritning av prostata och extracapsular sjukdom (mörkt).	Vesiklar ner till penisbulb	Postbiopsi blödning. Svårt att se markör.
Axial fettundertryckt T2	Utritning av intracapsular sjukdom (mörkt). Lymfnoder ljust.	?	Postbiopsi blödning
Axial T1	Detektion av postbiopsi blödning (ljust). Visualisering av markörer.	Prostata. Hudkostym och höftben vid anatomimatchning.	
Axial Diffusion ADC	Utritning av tumör (mörkt)	Prostata	Geometrisk distorsion

Where to get it?

www.gentleradiotherapy.se

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Methodology guide for MR in RT

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As part of the project we are happy to announce and distribute an advanced copy of a guidebook for the use of MR in radiotherapy. This is intended as a living document which will also be updated during the next phase of the project including new knowledge from the planned implementation process at 4 University clinics.

As of September we can now disseminate the guidebook in English as well as Swedish.

Check out the latest version below! (ver 3.0)

[Methodology Guide – Swedish version](#)

[Methodology Guide – English version](#)