MRI-guided radiotherapy for prostate cancer

Jochem van der Voort van Zyp, MD, PhD
Prostate cancer

- Most common cancer in men in the Netherlands

- In 2020, 12,800 men received diagnosis prostate cancer

Source IKNL.nl
Side effects of radical treatment

- Operation (robot): erectile dysfunction and incontinence
  - After 1-year, 10% remains incontinent for urine

- Modern radiotherapy: mainly urinary and bowel symptoms
All organs and tumors move and change shape

- No rotations
- No deformations
- No seminal vesicles
The MR-linac (Unity) “operate without a knife”

- Interfraction → new treatment plan for each treatment day
- Intrafraction (see real-time during treatment) → new plan for anatomy of the moment
  - Further reduction in grade ≥2 GU and GI toxicity
Toxicity FLAME-study

Monninkhof Radiother Oncol 2018
Workflow MR-Linac for prostate cancer treatment

n >400 patients treated on the MR-Linac
• Cohort
  ➢ Compare MR-Linac vs standard of care
    (prostatectomy, radiotherapy and active surveillance)
  ➢ Collect clinical, treatment and QOL data

• Technical developments MR-Linac

• Early economic health evaluation
  ➢ Cost-effectiveness (prospective)
PSA after MR-Linac
EPIC-26 Urinary obstruction/irritation

MRL

RALP
EPIC-26 urinary incontinence

MRL

RALP
EPIC-26 bowel domain
IIEF-5 (erectile function)

MRL

RALP
Technical developments
Evaluation of cost effectiveness on the MR-Linac

Early Health Economic Evaluation

Modelling the expected clinical effects and costs based on literature

Health Technology Assessment

Quantification of the impact based on empirical data: Utrecht Prostate Cohort
Comparison of...

5 fractions MR-Linac

versus

5, 20 and 39 fractions

Low-dose-rate brachytherapy

Hehakaya IJROBP 2021
### Average (mean) costs per patient

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean costs per patient (Euros)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-Linac 5 Fx</td>
<td>10,609</td>
</tr>
<tr>
<td>LDR Brachytherapy</td>
<td>9,945</td>
</tr>
<tr>
<td>EBRT 5 Fx</td>
<td>8,188</td>
</tr>
<tr>
<td>EBRT 20 Fx</td>
<td>15,003</td>
</tr>
<tr>
<td>EBRT 39 Fx</td>
<td>21,784</td>
</tr>
</tbody>
</table>

Hehakaya IJROBP 2021
MR-Linac plans for the future

• Neurovasculair sparing radiotherapy for prostate cancer
  ➢ ERECT-trial

• Focal salvage MR-Linac treatment for recurrent disease
  ➢ MRI-SABRE

• 2 fractions on the MR-Linac
  ➢ Hermes-trial (fast-adaptive contouring/planning )

• High risk patients 5x7.25 Gy (boost on DIL), randomized study
  • hypo-FLAME 3.0 study
EREctile function preservation for prostate Cancer radiation Therapy (ERECT-trial)

- Study protocol -> IRB approved
- MR-> beter visualization soft tissue

Donovan NEJM 2016
Delineation study: variability and reproducibility

1. right neurovascular bundle
2. left neurovascular bundle
3. right arteria pudenda
4. left arteria pudenda
Planning studie: feasability?

Constraints

Prescribed dose PTV: 36.25 Gy (≥80%)
(no concession op GTV)
Minimal dose PTV: 30 Gy

NVB (soft constraint): D0.1cc ≤32.75 Gy
IPA: Dmax ≤20 Gy
MR-Linac for prostate cancer

• MR-Linac for prostate cancer: better visualisation
  ➢ Reduce uncertainty margins → < toxicity
  ➢ Viewer treatment fractions (comfort/cost effective)
  ➢ Reduce recurrence of prostate cancer
  ➢ Change treatment approach in the next 10-15 years