

BrachyNext



Working Together to Shape the Future of
Brachytherapy

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Brachytherapy

Advancements in Real-Time Imaging for Brachytherapy

Frank-André Siebert

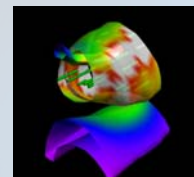
Advancements in Real-Time Imaging for Brachytherapy

- Contents
 - Introduction
 - HDR prostate (US)
 - LDR prostate (US)
 - Anal cancer (HDR)
 - Gynae (US, MRI)
 - Conclusion



Advancements in Real-Time Imaging for Brachytherapy

- Real-time planning in LDR prostate BT
 - Clinical results already published 1999/2000 (Stock and Stone et al.)
 - Overview e.g. in Polo et al. 2010



Systematic review

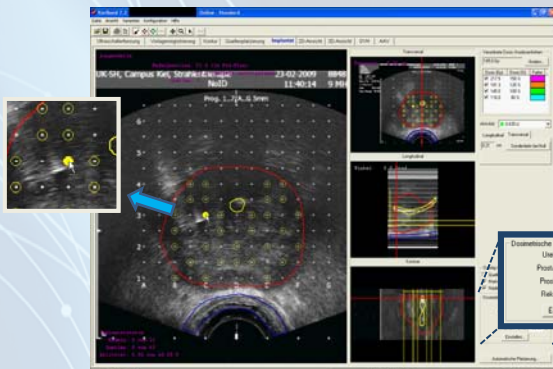
Review of intraoperative imaging and planning techniques in permanent seed prostate brachytherapy

Alfredo Polo^a, Carl Salembier^b, Jack Venselaar^c,
Peter Hoskin^{d,e}, on behalf of the PROBATE group of the GEC ESTRO

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Advancements in Real-Time Imaging for Brachytherapy

- Pre-planning problematic
 - What we plan, is not what we deliver
 - Needle deviation, source displacement





Advancements in Real-Time Imaging for Brachytherapy

- Solution: Real-time imaging approach:
 - Constant update of imaging during implant
 - > possibility to react at once



Table 1

Terminology.

Planning modality	Description
Intraoperative planning	Creation of a plan in the OR just before the implant procedure, with immediate execution of the plan
Interactive planning	Stepwise refinement of the treatment plan using computerized dose calculations derived from image-based needle position feedback
Dynamic dose calculation	Constant updating of calculations of dose distribution, using continuous deposited seed position feedback

Polo et al. 2010, according to ABS

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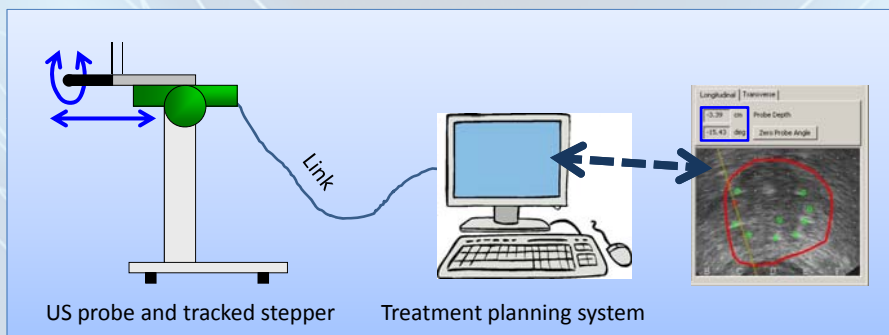
- Equipment



Ultrasound system



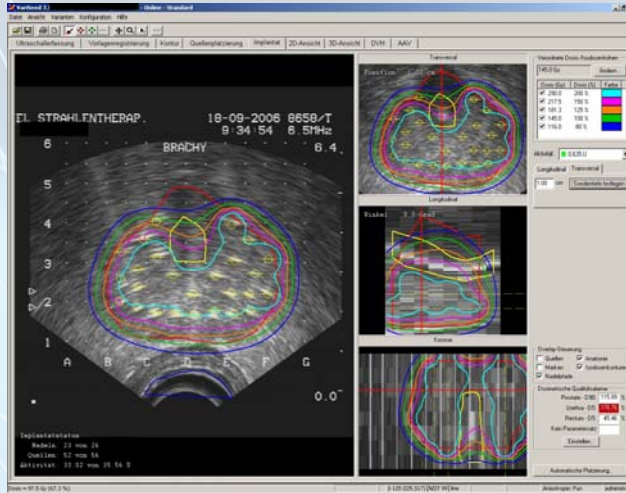
Tracked stepper





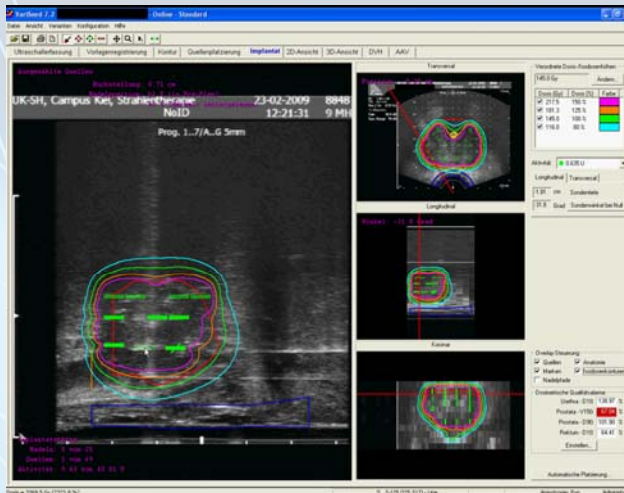
Advancements in Real-Time Imaging for Brachytherapy

- Consider needle deviations



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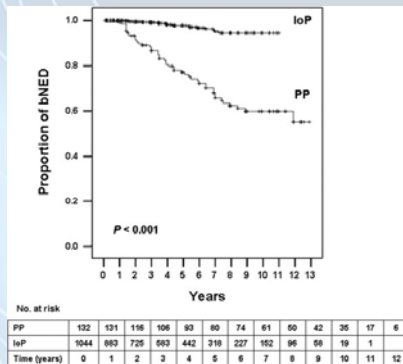
- Consider individual source positions





Advancements in Real-Time Imaging for Brachytherapy

- Enhanced patient follow-up data with LDR real-time planning



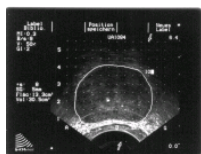
n=1176, mean FU 47 months
I-125 prostate implants

Matzin et al. Radiat Oncol 2013

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- Real-time planning in HDR prostate BT (Kiel)

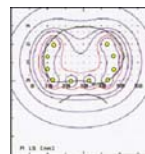
Preplanning
(1985-2003)



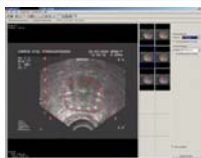
US Hardcopies



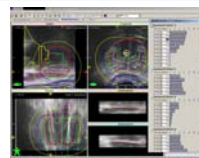
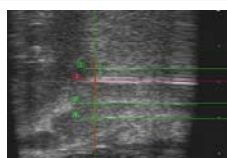
In-house software



Real-time-planning
(since 2003)



Vitesse v3.0





Advancements in Real-Time Imaging for Brachytherapy

- Concept from Kiel
What to treat , how to treat?

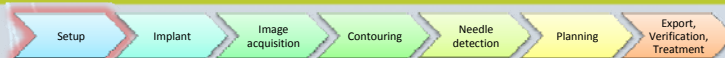
- Staging: T1-T3
- Prostate volume < 60 ml
- Distance rectum to prostate > 5 mm
- BT: 2 x 15 Gy plus EBRT: 50 Gy (pelvis), 40 Gy (prostate)



GammaMedPlus HDR Afterloader



Advancements in Real-Time Imaging for Brachytherapy



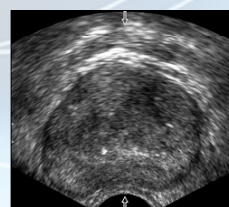
Spinal or full anaesthesia



Side table (steril)



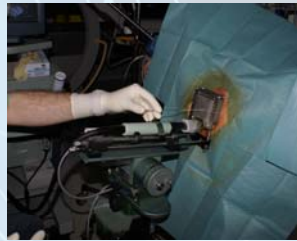
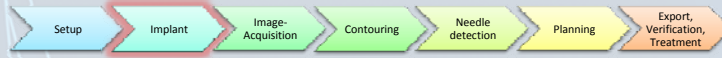
BK Profocus (8848), AccuSeed DS



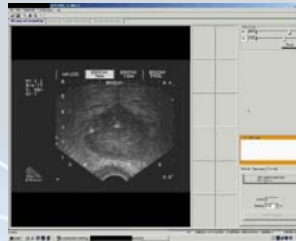
Prostate in transversal view



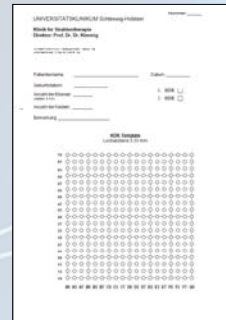
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Needle implant

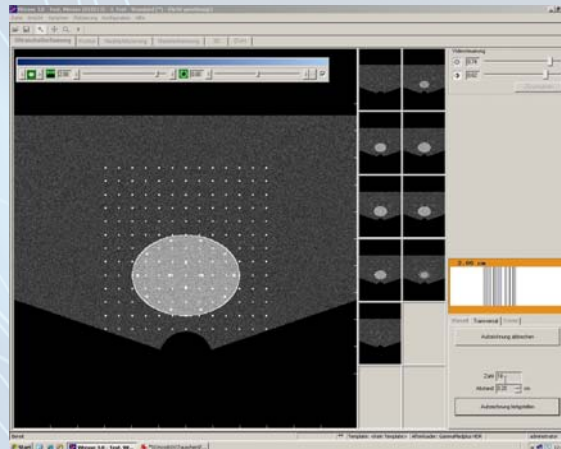


Realtime view



Worksheet

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Ultrasound data acquisition

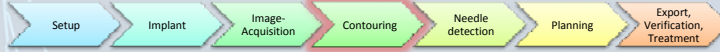
- Manual
- Transversal (autom.)
- Twister (autom.)

Integrated US simulator



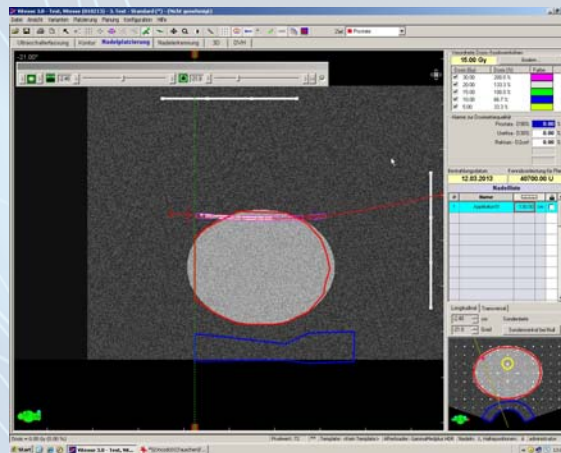


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- Delineation of organs

Advancements in Real-Time Imaging for Brachytherapy

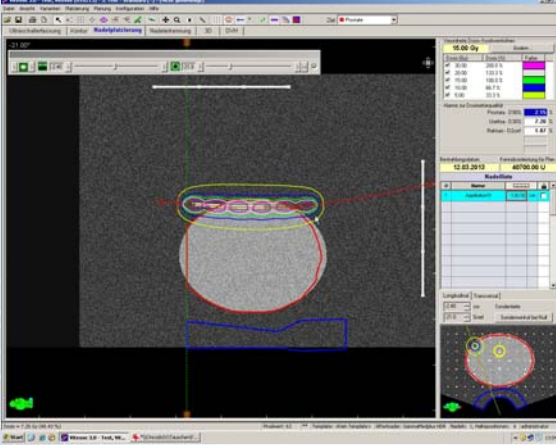


- 3D needle detection
- Definition of dwell positions



Advancements in Real-Time Imaging for Brachytherapy

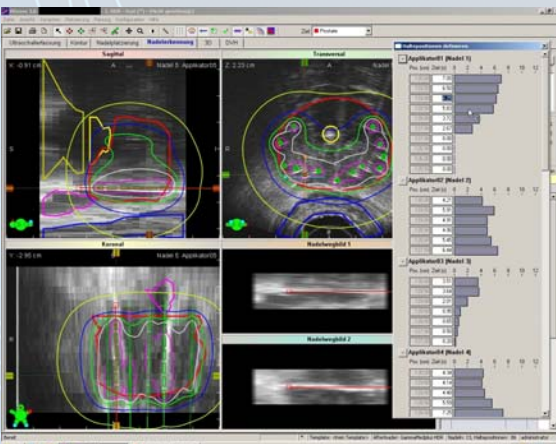
Setup → Implant → Image-Acquisition → Contouring → Needle detection → Planning → Export, Verification, Treatment



- 3D needle detection
- Define dwell positions
- Dose calculation (TG-43)
- Dosimetry alerts

Advancements in Real-Time Imaging for Brachytherapy

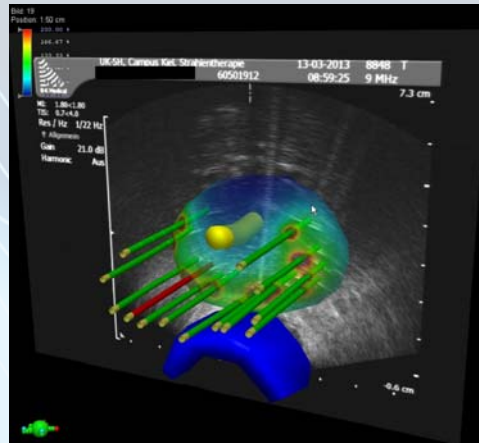
Setup → Implant → Image-Acquisition → Contouring → Needle detection → Planning → Export, Verification, Treatment



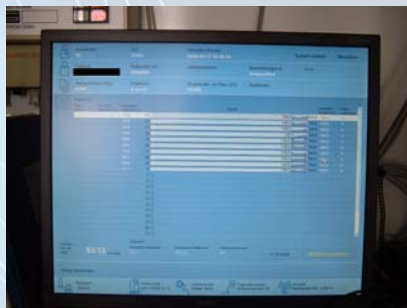
- Forward/inverse planning
- Dose shaping tools
- Adaption of needle curvature



Advancements in Real-Time Imaging for Brachytherapy



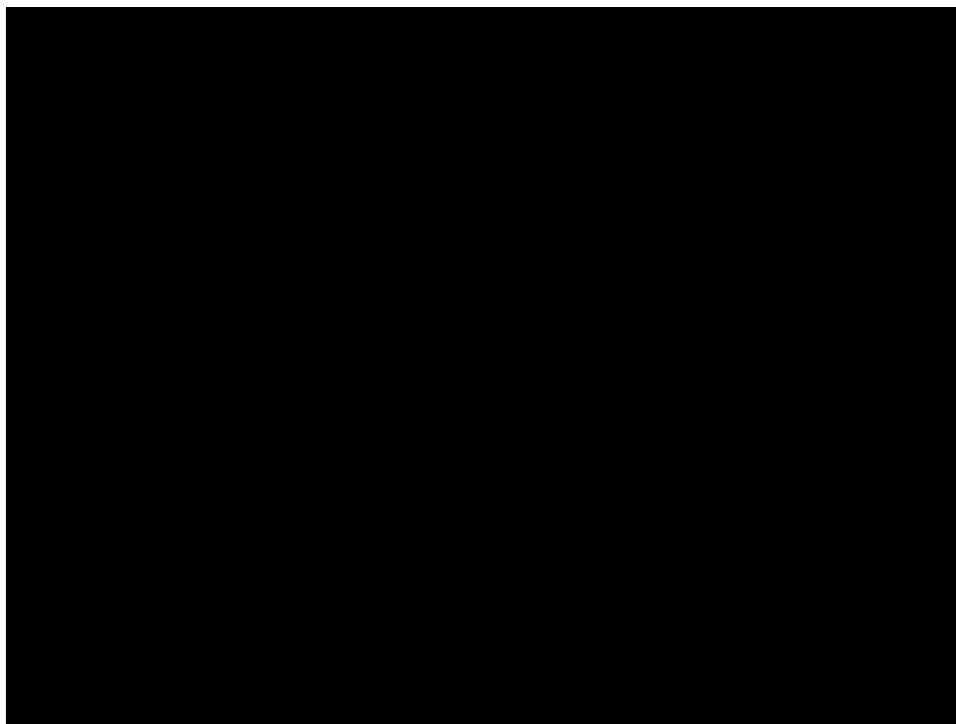
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Treatment control console



Treatment

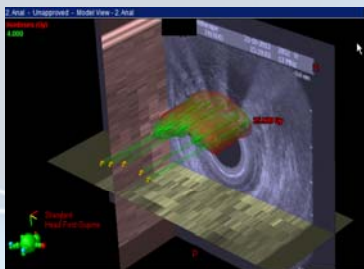


Advancements in Real-Time Imaging for Brachytherapy

- HDR brachytherapy for anal cancer
 - Similar approach as real-time prostate



Free hand implant of an anal cancer.

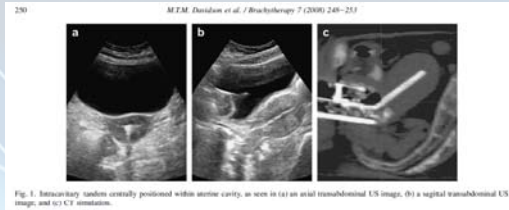


3D illustration of an anal implant.



Advancements in Real-Time Imaging for Brachytherapy

- HDR Cervix
 - Intraoperative HDR cervix BT applicator placement
 - US guidance for placement of intrauterine applicators



Davidson et al. (2008) Brachytherapy

- Successful tandem insertion (34/35)
- Optimization of tandem length in 49% cases
- Decrease of insertion time 34 to 26 mins

Advancements in Real-Time Imaging for Brachytherapy

- HDR Cervix
 - Real-time MRI guided catheter placement
 - 25 patients
 - 0.5 T MR scan (T1/T2)
 - Tandem applicator, needle placement using *fast T2* imaging

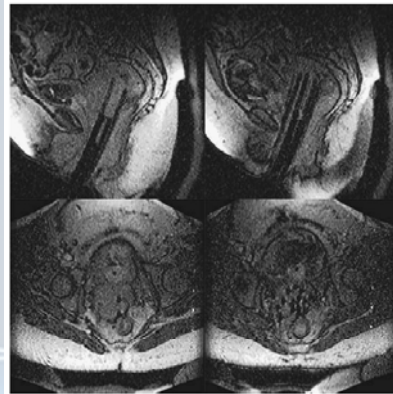


Advancements in Real-Time Imaging for Brachytherapy

Real-time guidance: findings

The median time under anesthesia, including MR scanning and insertion time, was **4 h (rg, 2.5–5.5)**. Longer insertion time was associated with earlier date of diagnosis (assumed to be related to the learning curve for the physician), increased catheter number, the need for a tandem, higher D_{90} , and residual tumor size (more complex implant). Patients who had procedures less than 3 h in duration had a median of 11 (rg, 11–17) needles placed through the template, whereas those who required more than 4 h had a median of 14 (rg, 7–23) needles placed.

All patients were transferred from the MRT unit to the CT scanner for post-MR CT simulation. On evaluation in the CT simulator, **no needles required repositioning** for any of the 25 patients, the primary endpoint of the study. Therefore, the MR-guided insertion was accepted in all cases to begin the treatment planning process. Needle position was confirmed by fusing the CT scan to the MR scan.



Viswanathan et al. (2013) Brachytherapy

Advancements in Real-Time Imaging for Brachytherapy

- Conclusion
 - Real-time planning one of the cart-horses of modern brachytherapy
 - Very well established for prostate US
 - Room for improvement in gynae and other sites