Implementation of advanced RT Techniques

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## Current RT equipments at NIO, Budapest

<table>
<thead>
<tr>
<th>Number</th>
<th>Equipment</th>
<th>Details</th>
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<tbody>
<tr>
<td>1</td>
<td>TrueBeam - Varian</td>
<td></td>
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<tr>
<td>1</td>
<td>Artiste - Siemens</td>
<td>(IMRT, IGRT with MV-CBCT and on-rail kV-CT)</td>
</tr>
<tr>
<td>2</td>
<td>Primus - Siemens (6 and 18 MV, +electrons)</td>
<td>2 VitalBeam</td>
</tr>
<tr>
<td>1</td>
<td>Primus - Siemens (6 MV)</td>
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<tr>
<td>1</td>
<td>Theratron cobalt unit</td>
<td>Unique</td>
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<tr>
<td></td>
<td>+ Lantis, Pinnacle, Aria, Eclipse</td>
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## Road map to first treatment

<table>
<thead>
<tr>
<th>Step</th>
<th>Date</th>
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<tbody>
<tr>
<td>Removal of Mevatron</td>
<td>15 January, 2014</td>
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<tr>
<td>Bunker reinforcement</td>
<td>January 2014</td>
</tr>
<tr>
<td>Installation</td>
<td>February - March 2014</td>
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<tr>
<td>Commissioning, training</td>
<td>April 2014</td>
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<tr>
<td>Measurements</td>
<td>April-May 2014</td>
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<tr>
<td>First treatment</td>
<td>15 May, 2014</td>
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</table>
Before TrueBeam experience with

- 3D-CRT
- IMRT with „step and shoot” technique
- IGRT with MV-CBCT, on-rail kV-CT and EPID
- Pinnacle, Lantis

New challenges with TrueBeam

- IMRT with sliding window technique and RapidArc
- IGRT with kV-CBCT and kV 2D imaging
- Eclipse – Aria (+IGRT) integration
- New treatment techniques (SBRT, radiosurgery, SIB, APBI)
Available beams and energies

**Photons**
- 6, 10 and 18 MV (600 MU/min)
- 6 MV FFF (1400 MU/min)
- 10 MV FFF (2400 MU/min)
- 6 MV SRS (1000 MU/min)

**Electrons**
- 6, 9, 12 and 15 MeV (1000 MU/min)
- 6 MeV HDTSE (2500 MU/min) – High Dose Total Skin Electron
Distribution of treatment techniques in 2015

- **RapidArc**: 74%
  - IMRT: 13%
  - 3D-CRT: 13%
  - SBRT: 4%
- **Conv. RapidArc**: 80%
  - SIB: 16%
Distribution of tumor sites treated in 2015

Total patient number = 635
Special treatments on TrueBeam

- prostate IMRT/IGRT with gold markers
- simultan integrated boost (SIB) - prostate
- stereotactic body radiotherapy (SBRT) - lung
- stereotactic radiosurgery (brain)
- accelerated partial breast irradiation (APBI)
- total skin irradiation
Prostate IGRT with gold markers and 2D imaging

- DRR-s
- kV X-ray images
- fused images
Prostate IGRT with gold markers and 3D imaging
Simultaneous integrated boost (SIB) technique

Prostate gland: 70 Gy  28 x 2.5 Gy
Vesicula seminalis: 57.4 Gy  28 x 2.05 Gy
Simultan integrated boost (SIB) technique

2 full rotation with RapidArc

RapidArc technique

dose distribution
Stereotactic Body Radiotherapy (SBRT)

- 4D CT with Anzai belt system (slow CT with respiratory curve)
- GTV delineations on CT series reconstructed in 7 phases
- ITV creation with union of GTVs followed by CTV/PTV definition
- RapidArc treatment plan for PTV with 2 partial arcs
- Treatment delivery with 6 MV FFF (8 x 7.5 Gy)
- IGRT with kV-CBCT before each fraction
- On-line correction with 6DoF table

Irradiation time: < 2 min
Treatment time: ~12 min
4D imaging for SBRT

4D CT with Anzai belt

evaluation of target movement
Definition of ITV

GTV contours in each phase

ITV includes all GTV contours
Irradiation with RapidArc technique

Treatment with two partial arcs
Conformal dose distribution in 3D
Static dose distribution with moving target
IGRT with daily kV-CBCT
planning PET and kV-CBCT
Stereotactic radiosurgery

Head fixation with invasive frame  Treatment with four non-coplanar beams
Dynamic conformal arc irradiation

Beam aperture continuously conforms to the shape of the PTV
Dose distribution in transversal and sagittal planes
Verification with kV-CBCT
Accelerated partial breast irradiation (APBI)

Beam arrangements for APBI (5-6 co-planar IMRT beams with sliding window)
IMRT with sliding window technique

At fix gantry angle the MLC-s are moving while the beam is on
Dose distributions in transversal and coronal planes

Prescribed dose: 9 x 4.1 Gy
IGRT with kV-CBCT using the clip positions
Setup errors without corrections

Online OBI Match Results
(Difference of final online matched position and initial couch position) (Isocentric Standard, IEC61217, 6DoF)
Total skin irradiation

- large source – skin distance (430 cm)
- 6 MeV HDTSE – 2500 MU/min
- 6 patient positions (3 + 3 in two days)
- 2 gantry angles (106.5° and 73.5 °) for each position
User’s statements about TrueBeam

- Versatile equipment for all needs in radiation oncology
  (simple and complex treatments for cancer anywhere in the body)
- Flawless integration with treatment planning and R&V system
- Fast imaging and accurate dose delivery
- Automated workflow with optimized patient throughput
- Very reliable with high uptime (> 98%) – good service
- Extensive training and continuous support from the company
Thank you for your attention!