The Radixact™ System Experience at Miami Cancer Institute

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Disclosure

• An honorarium is provided by Accuray for this presentation

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- Usha Robins, MS
Topics

• Introduction to Miami Cancer Institute (MCI)
• What is new on “Radixact™ System”?
• Acceptance tests procedure and commissioning at MCI: Overview & Results
• IROC auditory results
• Machine performance
• Clinical utilization of “Radixact™ System”
• Conclusions
Miami Cancer Institute Statistics

- 440,000 square feet, $430 million
- 7 state-of-the-art photon therapy machines
- 3 gantry pencil beam scanning proton therapy center
- State of the art imaging
  - 2 dual source CT’s; Wide Bore CT; 2 PET/CT; 2 MRI’s; 4 Ultrasounds; 2 Mammography; 2 Stereotactic Tables; SPECT/CT; X-Ray
- >5,000 new pieces of medical equipment
- $25 million on IT related systems and hardware
  - New electronic medical records system
  - New patient treatment planning systems
- 113 Patient friendly exam rooms; 60 infusion rooms / 8 infusion beds
Grand Opening: January 16, 2017
The only center with ALL radiotherapy modalities under one roof

- Varian® TrueBeam™
- CyberKnife® M6™
- Radixact™
- GammaKnife® Icon™
- Viewray® MRIdian™ Linac
- High Dose Rate Brachytherapy
- Pencil Beam Scanning Proton Therapy
Radixact™ System Increases Treatment Delivery Efficiency

• **Faster image acquisition**
  - 10 rpm gantry rotation increased from 6 rpm

• **40% shorter scan time**
  - 6 second beam-on warm up decreased from 10 sec

• **15% reduced treatment delivery time**
  - 1000 MU/min dose rate increased from 850 MU/min
Radixact™ Couch Improvements

- Easier patient setup
  - x-, y-, and z-axes move independently

- Reduced sag
  - A pallet support has been added to the rear of the Radixact™ Couch to support the weight of the couch as it enters the bore
The Accuray Precision™ Treatment Planning System
Software Improvements

• **High resolution planning** calculations occur at native resolution: No more down-sampling to 256 x 256 resolution on import

• PET and MR images can be loaded as **secondary datasets**

• **Deformable registration** of secondary MR to primary CT images

• Advanced **auto-segmentation** tools
The Accuray Precision™ Treatment Planning System Software Improvements

- **Faster treatment plan optimization.**
  - Optimization is performed now “locally”

- **Faster treatment plan review**
  - Up to 4 plans on each planning computer
  - Compare 2 plans calculated on the same planning image

- **New PreciseART™ Adaptive Radiation Therapy option “automated” module**

- **Streamlined workflow**
  - For sharing patients across multiple machines on the same database
ATP procedures and commissioning at MCI

• Previous experience with the Tomotherapy® H™ Series (since 2004).
• ATP procedures and commissioning for Radixact™ basically are the same as for the previous Tomotherapy® H™ Series machines.
• The commissioning followed the Report of the AAPM Task Group 148: “QA for helical tomotherapy”. Daily, quarterly and annual procedures were established.
ATP procedures and commissioning at MCI

- Besides the TG-148 recommendations, we implemented recommendations stated in the “Physics Essentials Guide” (document PEG 1050223-ENG B)

- It was extensively used the “TQA™ Total Quality Assurance” software (document 1050230-ENG C). TQA is a very important component in our Quality Assurance Program.

  Highly recommended!
Intended used of the TQA™ Software

The TQA™ Software application is intended to support the customer monitoring changes in system performance that may provide early indications for maintenance or dosimetric validation. In addition, the TQA™ Software application may be appropriately used to assist in daily quality assurance checks to ensure the correct dosimetric performance of the system for patient treatment.
TQA™ Software results example
The documentation provided by Accuray is extensive and elaborate. The technical support is excellent.

Accuray does NOT provide with Radixact™ System the film software package for patients QA. It is provided the RIT film analysis package for tomotherapy (for mechanical tests analysis).

Alternative tools for patients QA used at MCI: RIT software for film analysis using the “Cheese” Phantom and the “ArcCheck” device.
Transition from TomoTherapy® H™ series to Radixact™ System

• For previous users the time needed to learn and become familiar with the new Radixact™ System TDC is relatively short.

• Accuray Precision™ Treatment Planning System interface is completely different. Some time will be needed to learn it. The planning process is similar.
The new TDC Radixact™ System user interface
A TP procedures and commissioning at M CI

- Dosimetric characteristics and stability of the new Radixact™ System

- Performance of the new Accuray Precision™ Treatment Planning System

- Evaluation of the stability of the MVCT imaging system
Study of Basic Dosimetric Beam Characteristics of the New TomoTherapy® Delivery System Radixact™.

T Romaguera, J Bennouna, U Robins, N Thakur, AN Gutierrez

• PURPOSE:
  • Study of basic dosimetric beam’s characteristics of the new TomoTherapy® delivery system Radixact™ compared to its predecessor TomoTherapy® H™-series beam model.

• METHODS:
  • The tests according to the TG-148 where established and performed during the commissioning process and repeated twice in a 6 months period.

  • The beam quality, output, longitudinal and transverse profiles were measured for all field sizes and have been followed closely for 6 months using the TQA software and by independent methods.
• RESULTS:
  • The initial beam was adjusted to match the quality of the golden standard \([\text{PDD (20,10) = 0.523}]\). The \(\gamma\) parameter to assess the match between the measured profiles and the gold standard increased in some regions of the longitudinal profiles as result of this adjustment, but still it was within the specifications.
  • The daily output measurement showed fluctuations within 2%. The quality of the beam measured weekly reported changes below 1%.
  • The beam stability, important factor during the delivery of long procedures like TBI, was in the order of 2%.
CONCLUSION:

This work indicates that the Radixact™ Systems can be twinned using the actual gold model developed for the previous TomoTherapy® Systems within the manufacturer specifications.

The daily output, the beam quality and the stability in delivering long procedures and complex IMRT having short LOT met the technical specifications. The multileaf collimator (MLC), a very important component in the profiles definition, performed at the same level as the LINAC.
Other dosimetric tests results...

• A long helical procedure of 40 min was created and ran weekly. Chamber measurements were carried out to assess the machine stability.

• The chamber measurements for the procedure with short LOT was consistent during the time of this study.

• Verification of the stability of plans with “Static” beams.
Performance Study of the New Delivery System Radixact™ Using as Benchmark Clinical Plans Generated for TomoTherapy® HDA™
T Romaguera, J Bennouna, A Gutierrez, U Robins, G Luciani, C Kozarek, N Jafari, R Vaden

• **Purpose:** To compare the performance of the Accuray Precision™ Treatment Planning System using as benchmark clinical plans generated for TomoTherapy® HDA™ system.

• **Methods:**
  - The Accuray Precision™ Treatment Planning System was commissioned according to the TG-53 recommendations.
  - 10 patients plans were developed to be treated on TomoTherapy® HDA™ system using VoLO™. The plans were optimized until the Dose Volume Histograms (DVH) and the dose distribution assessed every slice met the clinical objectives.
  - Same 10 patients were replanned for with Precision™ Treatment Planning System for comparison. The plans were optimized until the DVHs and the dose distributions closely matched those obtained previously.

• **Results:** The Accuray Precision™ Treatment Planning System produced optimized plans **substantially faster** than its predecessor. The reduction in “on-beam” time for the new plans was 20-50%.

• **Conclusion:** In comparison with its predecessor, the Radixact™ **planning process was faster** and the **treatment beam-on time was reduced up to 50% due the increase in output (1000 cGy/min at isocenter) and optimization in the gantry speed**
Initial Clinical Evaluation of the Stability of the Radixact™ MVCT Image Quality

Usha Robins, Tino Romaguera, Vivek Mishra, Alonso Gutierrez

• PURPOSE:
  • To characterize the image quality and assess the stability of Radixact MVCT scans.

• METHODS:
  • Cheese Phantom with known density plug inserts and high contrast resolution plug was used
  • Scans were obtained with 3 different pitches: fine, normal, coarse
  • Image quality analysis was performed in the ImageJ software platform (noise level, uniformity, spatial resolution, HU stability)
Initial Clinical Evaluation of the Stability of the Radixact™ MVCT Image Quality
Usha Robins, Tino Romaguera, Vivek Mishra, Alonso Gutierrez

• RESULTS:
  • All image parameters showed good stability
  • Image noise and uniformity were consistent over time and within the 3 scan types

• CONCLUSION:
  • Radixact™ System MVCT has no significant statistical variation in the noise, uniformity, and HU stability over the 3 month evaluation period.


“E2E” Test

• Result of the IROC for the irradiation of Head and Neck Phantom

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<th>IROC-H vs. Inst.</th>
<th>Criteria</th>
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<td>1.01</td>
<td>0.93 – 1.07</td>
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<th>Gamma Index*</th>
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<td>≥85%</td>
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</tr>
<tr>
<td>Sagittal</td>
<td>97%</td>
<td>≥85%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Percentage of points meeting gamma-index criteria of 7% and 4 mm.
MCI: Down time

The mean reasons were,

- Loss of communications between the IDMS and the TDC
- Loss of communication with the gantry after software upgrade (in March)
Service and support

• The technical support and the communication with Accuray has been excellent. Very receptive to our suggestions.

• The efficient work of the Accuray service engineer performing the system maintenance and the closely follow up according to the TG-148 ensured an optimal system performance

Recommendation:

Be proactive! (At MCI the detector assembly was replaced)
Radixact™ System Utilization at MCI

- Complex cases with targets in close proximity to OARs
  - Head and neck
  - Breast (comprehensive nodal irradiation)
  - Prostate
- Extended fields
  - Pelvic/para-aortic
  - CSI
- Special cases
  - Spine tumors
  - Pediatric cancers
Performance of the Radixact™ System in the clinic

• Integration with the ARIA® oncology information system (OIS), Version 13.7
  • Radixact™ System is fully integrated in the departmental workflow. Patient are scheduled and managed by the OIS

  • Radixact™ System send the information about the delivered dose, which is recorded by the OIS. If needed, it is now possible to perform manual dose correction

  • Treatment summary and plan information is possible to be sent and store in pdf format in ARIA.

  • Registration images can be sent to ARIA, but they cannot be manipulated in off-line review (work in progress)
Example of MVCT registration (H & N case)
Example of MVCT registration
Radixact™ System Case 1, H & N

- 51 year old male
- Painless left neck mass and left ear pain
- Excisional biopsy revealed squamous cell carcinoma
- PET/CT revealed a 1.7 cm lesion in the left base of tongue, right retropharyngeal lymph node
- T1N2bM0
- Definitive chemoradiotherapy
  - 70/63/56 Gy in 35 fractions
- Treatment time: 5.4 mins
Case 1
Case 2, Reconstructed Breast
Case 3, Bilateral Breast
Case 4, Gyn
Case 5, Pediatric

• 11 year old with abdominal mass
• High risk neuroblastoma (MYCN amplified)
• 90% tumor resected
• PTV1: 21.6 Gy in 12 fractions
  • CTV1 = preop GTV + 1.5 cm
• PTV2: 14.4 Gy in 8 fractions
  • CTV2 = residual GTV + 1 cm
• Treatment time:
Case 5, Pediatric
Conclusions

• Radixact™ System
  • Is prioritized for treatment of our most complex cases despite having the option to use other radiation technologies
  • Has improved our planning and treatment delivery workflow
  • Has been stable and reliable over nearly 6 months of high-volume operation
  • A “workhorse” in our department, routinely treating 25-35 patients per day
Thank you!