IMRT and other conformal techniques in Russia

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Medical physicists in Russia

- About 500 medical physicists
- About 150 oncological clinics
- About 200 linacs that can realize 3D and other conformal techniques
- Association of Medical Physicists in Russia with its president Valeriy Kostylev
- N.N.Blokhin Russian Cancer Research Center is the biggest clinical oncology institution on the territory of the CIS with one of the most powerful radiotherapy facilities
- International Training Center on medical physics, radiation oncology and nuclear medicine
N.N. Blokhin Russian Cancer Research Center

- 4 Varian Clinac iX (MLC 120, OBI, EPID, IMRT, RapidArc, Respiratory Gating)
- 2 Varian Clinac 600CD (MLC 120, EPID, IMRT, Respiratory Gating)
- 1 CyberKnife VSI (private)
- 1 Philips SL 75-5
- 2 Varian Acuity simulators;
- CT GE Lightspeed 16
- MRI, PET and SPECT are available in diagnostic departments
N.N. Blokhin Russian Cancer Research Center
Are we ready for IMRT?

- Availability of equipment
- Do we have adequate immobilization devices for performing IMRT?
- What tests and protocols are we going to conduct during commissioning?
- How are we going to verify the treatment plans?
- What MLC test will be included in QA programme?
- Dose constraints
IMRT Commissioning of Delivery System: MLC tests results

MLC Position Accuracy:
“Picket fence” test

“Spoke shot” test

For sliding window IMRT:
leaf position & speed accuracy

• MLC leakage is measured annually with a detector large enough to provide an average value
IMRT Commissioning of Treatment Planning System

- CIRS Thorax and Head & Neck Phantoms
- Ionization chamber Semiflex PTW
- TG-119 IMRT Commissioning Tests
Patient specific QA

- Octavius phantom 729
- Gamma analysis criteria 3%/3mm 90% of dots is acceptable
- Total distribution check
- Gantry angles are the same as in treatment plan

Number of analyzed plans:
Total: 397
IMRT: 243
RapidArc: 154
Results of IMRT plan verifications

Percent of patients, %

Percent of points that passed criteria
Results of VMAT plan verifications

- Percent of points that passed criteria
- Percent of patients, %

- 90-95: 10%
- 95-100: 90%

Graph showing the distribution of points that passed criteria, with a significant majority in the 95-100 range.
Analysis of verified plans
Dependence of IMRT plan verification results on tumor site

- Head & neck: >90% of the points passed
- Brain: >90% of the points passed
- Prostate: >90% of the points passed
- Lungs: >90% of the points passed
Introduction of intended errors in the “template” treatment plans

Plans were developed from recommendation AAPM TG 119

1) «Speed test»
2) «Several targets»
3) «Prostate»
4) «Head and neck»
5) «C-shape»
Introduced errors

- MLC transmission factor = 0.00, MLC leaf gap = 0.00 cm
- MLC transmission factor = 0.05, MLC leaf gap = 0.50 cm
- Collimator angle = 2° (instead of 0°)
- Error in absolute dose value = 2% (simulation of error in linac calibration)
- Table shift = 5 mm (separately in three different directions)

Example of correct values:
Results of verification with Octavius

% of points not passing 3%/3mm criteria

- Speed test
- Several targets
- Prostate
- Head&Heck
- C-shape

Errors

- without error
- MLC (0,0)
- MLC(0.05, 0.5)
- Colimator
- Calibration
- Table shift
Statistics of 3D CRT, IMRT and VMAT plans per year
Immobilization devices that are used in RCRC
INTRODUCTORY PAPER

QUANTITATIVE ANALYSES OF NORMAL TISSUE EFFECTS IN THE CLINIC (QUANTEC): AN INTRODUCTION TO THE SCIENTIFIC ISSUES

SØREN M. BENTZEN, PH.D., D.SC.,* LOUIS S. CONSTINE, M.D.,† JOSEF J. O. DEASY, PH.D.,‡ AVI EISBACH, M.D., § ANDREW JACKSON, PH.D., ¶ LAWRENCE B. KARAN, M.D., ‡ RANDEL D. H. HAKEN, PH.D., § AND LAUREN DE FORKE, PH.D. ¶

From the *Departments of Human Oncology, Medical Physics, Biostatistics, and Medical Informatics, University of Wisconsin School of Medicine and Public Health, Madison, WI; †Department of Radiation Oncology, University of Rochester Medical Center, Rochester, NY; ‡Department of Radiation Oncology, Washington University, St. Louis, MO; §Department of Radiation Oncology, University of Michigan, Ann Arbor, MI; ¶Department of Medical Physics and Radiation Oncology, Sloan-Kettering Cancer Center, New York, NY; ‡Department of Radiation Oncology, University of North Carolina at Chapel Hill, NC.

Advances in dose–volume–outcome (or normal tissue complication probability, NTCP) modeling since the seminal Emami paper from 1981 are described. There has been some progress with an increasing number of studies on large patient samples with three-dimensional dosimetry. Nevertheless, NTCP models are not ideal. Issues related to the grading of side effects, selection of appropriate statistical methods, testing of internal and external model validity, and quantification of predictive power and statistical uncertainty, all limit the usefulness of much of the published literature. Synthesis (meta-analysis) of data from multiple studies is often impossible because of suboptimal primary analysis, insufficient reporting and variations in the models and predictors analyzed. Clinical limitations to the current knowledge base include the need for more data on the effect of patient-related cofactors, interactions between dose distribution and cytotoxic or molecular targeted agents, and the effect of dose fractions and overall treatment time in relation to nonuniform dose distributions. Research priorities for the next 5–10 years are also proposed. © 2010 Elsevier Inc.
Dose constraints for SBRT

Dose tolerance limits and dose volume histogram evaluation for stereotactic body radiotherapy

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Table 1: Dose constraints for SBRT

RTOG 0611, heart/pericardium

Note: All values are in Gy (Gray).
Sites for which we use IMRT or VMAT technique
Head & Neck

Patient D. T4N2M0 (laryngeal cancer)

PTV1 – 2 Gy×25 fx;
PTV2 – 2 Gy×30 fx;
PTV3 – 2 Gy×35 fx;
Patient D. T4N2M0 (laryngeal cancer)

PTV1 – 2 Gy×25 fx; 2 arcs (135º - 225º) clockwise and counterclockwise

PTV2 – 2 Gy×30 fx; 7 field IMRT

PTV3 – 2 Gy×35 fx; 7 field IMRT
Prostate

Hypofractionated salvage radiotherapy with simultaneous integrated boost after radical prostatectomy

Patient O. Lymph nodes+ region of relapse +fossa = 1.8 Gy * 26 fx;
Fossa = 2.35 Gy *26 fx; Region of relapse = 2.5 Gy*26 fx
Hypofractionated salvage radiotherapy with simultaneous integrated boost after radical prostatectomy

Patient O. Lymph nodes+ region of relapse +fossa = 1.8 Gy * 26 fx; Fossa = 2.35 Gy *26 fx; Region of relapse = 2.5 Gy*26 fx

2 full arcs;
Patient M. NSCL cancer (primary tumor)
Contouring was made on 4D CT scan (+information from PET)
PTV – 10 Gy*5 fx
Patient M. NSCL cancer (primary tumor)
Contouring was made on 4D CT scan (+information from PET)
PTV – 10 Gy*5 fx IMRT, 6 fields
Brain

Patient B. Diagnosed with glioblastoma
PTV1 – 2 Gy*22 fx; PTV2 – 2 Gy*30 fx
Patient B. Diagnosed with glioblastoma
PTV1 – 2 Gy*22 fx; PTV2 – 2 Gy*30 fx
6 fields IMRT technique.
Management of motion during SBRT of liver metastases

CT scan and treatment for deep inspiration breath-hold using RPM system
SBRT of liver metastasis

Patient V. PTV- 12 Gy*3 fx
SBRT of liver metastasis

Patient V. PTV- 12 Gy*3 fx
6 field IMRT
CyberKnife experience in Russia
Number of CK machines in Russia

- Moscow – 5
- Chelyabinsk – 1
- Saint Petersburg – 1
- Voronezh – 1
- Ufa – 1

6% of all conformal treatment machines
Reference Center for Russia

Memorandum of Collaboration

Accuray is honored to have signed a 1-year collaboration agreement* with
The Center of Radiotherapy Oncostop
making them Accuray Reference Center for Russia.

*starting November 2015

ACURAY®
Patient number
Our patients: treatment sites

- intra-cranial
- extra-cranial
Our patients: treatment sites

- Nasopharynx
- Liver
- Lymph node
- Lung
- Pancreas
- Prostate
- Other
Our QA program: periodical and patient-specific

- **Daily:**
  - Absolute dose to a point

- **Weekly:**
  - Automatic Quality Assurance test

- **Annual:**
  - Symmetry and Flatness
  - Percent Depth Dose and Profiles
  - End-to-End tests
Our QA program: Daily

NO measurements in BirdCage

Single beam phantom plan, with Farmer or semiflex chamber and Stereotactic Dose Verification Phantom. So we verify:

- Absolute dose to a point
- Accuracy of dose delivery
- Communication between computers in CK network
Our QA program: Weekly

- Standard AQA test results, mm

- AX-BX
- AY-BY
Our QA program: Quarterly

End-to-End tests for:

- 6DScul (and before EVERY trigeminal patient)
- Fiducial
- XSpine
- Synchrony
- XLung
Our QA program: Quarterly

- Graphs for PDD and profiles
- PTW MP3 phantom, Tandem, 2 diodes E
Patient specific QA

Every plan with PTV ≥ 0.015 cc
Try to measure before the treatment
Patient specific QA: results

% of plans vs. Standard deviation

-3%  -2%  -1%  0%  1%  2%  3%
Technical problems

Long shipping time of spare parts
Summary

- Established successful IMRT program
- 9 CyberKnife machines
- Increasing percent of patients with IMRT and CK treatment
Thank you for your attention