SBRT: Technical Issues for Clinical Implementation of an SBRT Program

Presented by
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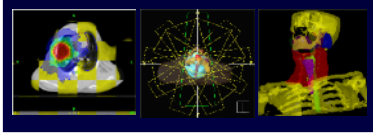

Hapless drifting barges…

SBRT versus Barge Technology

Comparison	SBRT	Barges
1. Years in Development	15	>1000
2. Established Guidelines	YES	Apparently NOT
3. Assigned responsibilities	YES	Apparently NOT
4. Sophisticated Delivery/ R&V	YES	NOT
5. Pursuit of Excellence	YES	NOT

Establishing Guidelines and Recommendations for SBRT

- Our professional societies have a long history of establishing policies and procedures for high quality patient care and billing.
- ASTRO and ACR developed guidelines in 2004 for SBRT (Presented by Dr. Louis Potters).
- AAPM is establishing complementary guidelines via the Task Group process…. TG101

AAPM Task Group 101:
Stereotactic Body Radiation Therapy

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Stereotactic Body Radiation Therapy

The AAPM RTC approved the following charges of the task group:

- **Charge (1): To review the literature and identify the range of historical experiences, reported clinical findings and expected outcomes**
- **Charge (2): To review the relevant commercial products and associated clinical findings for an assessment of system capabilities, technology limitations, and patient related expectations and outcomes.**
- **Charge (3): Determine required criteria for setting-up and establishing an SBRT facility, including protocols, equipment, resources, and QA procedures.**
- **Charge (4): Develop consistent documentation for prescribing, reporting, and recording SBRT treatment delivery.**

SBRT TG101 Members

- **Brian Kavanagh, MD, MPH - U. Colorado**
- **Robert Timmerman, MD – UTSW, Dallas**
- **Volker Stieber, MD, Wake Forest University**
- **Danny Song, MD, Johns Hopkins University**

- **Stanley H. Benedict, PhD – UVa, TG101 Chairman**
- **James Galvin, PhD - Thomas Jefferson University**
- **William Hinson, PhD - Wake Forest Univ., NC**
- **Michael Lovelock, PhD - MSKCC**
- **Wang Lu, Ph.D. Fox Chase Cancer Center**
- **Sanford Meeks, PhD - M.D. Anderson Cancer Center - Orlando**
- **Lech Papiez, PhD, UTSW, Dallas**
- **Thomas Purdie, PhD, Princess Margaret Hospital, Toronto, Canada**
- **Ramaswamy Sadagopan, M.S., University of Texas MDACC**
- **Bill Salter, PhD – University of Utah**
- **Mike Schell, PhD – Univeristy of Rochester**
- **Almon S. Shiu, PhD, MD. Anderson Cancer Center**
- **Timothy Solberg, PhD – University of Nebraska**
- **Wolfgang Tome, University Of Wisconsin**
- **Dirk Verellen, PhD - Brussels, Belgium**
- **Kamil M. Yenice, Ph.D., University Of Chicago**
- *** FF-Yin- Duke University (TG102) & P. Keall – Stanford (TG78)**

AAPM TG 101: SBRT –
A brief overview of the Table of Contents:

1. **Clinical Rationale for SBRT**
2. **Review of Clinical History and Current Status of SBRT**
3. **Patient Immobilization, Repositioning, and Relocalization/Verification**
4. **Simulation, Treatment Planning, and Reporting**
5. **Special Dosimetry Considerations**
6. **SBRT Treatment Delivery Systems**
7. **Clinical Implementation of SBRT**
8. **Future directions**

AAPM TG 101: SBRT - Table of Contents:

1. Clinical Rationale for SBRT
2. Review of Clinical History and Current Use of SBRT

+ The TG authors recommend clinical protocols and Internal Review Board (IRB) Process.

+ Treatments should be developed in a multi-disciplinary fashion so as to provide the best individualization of treatment, foster collegiality, and direct interaction among specialities, which will demonstrate to the IRB that patient safety and clinical relevance are top priorities.

+ The ideal sequencing with chemotherapy remains to be established.

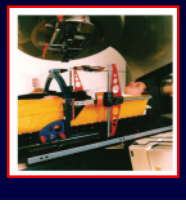
AAPM TG 101: SBRT - Table of Contents:

3. Patient Immobilization, Repositioning, and Relocalization/Verification
3.1 Requirements and limitations of patient positioning in SBRT
3.2 Immobilization
Commercial and Non-commercial Frames
3.3 Repositioning
External fiducial based systems
3.4 Relocalization
IGRT, US, Implanted fiducials
Rigid implants
Frameless/tracking technologies (Video, IR)
3.5 Respiratory motion management
Target expansion, Abdominal compression, Breath-hold, Gating

•Highlights:
•Not vendor specific; aim to delineate specifications/limitations
•IGRT is required, and may include US, MV, and KV imaging (TG102)
•Not advising relocalization based on external fiducial system alone
•Must initiate a respiratory management program (TG78)
•Repeat CT may provide the best 3D confirmation of target relocalization

Frames and Body Molds for SBRT

- *Patient comfort is most important*
  - Individual treatment can last 30+ minutes
- Should have repositioning accuracy of approx 5 mm or less
  - Compare to H & N cancer IMRT
  - Note—frameless SBRT is also feasible



Repositioning & Relocalization

Current paradigm:

The immobilization of the patient serves in Repositioning the body as reproducibly as possible in order to…

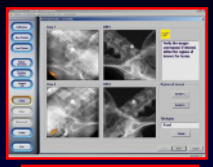
Relocalize the target as reproducibly as possible.

Future paradigm:

IGART: Adaptation of the TP on a daily basis

Tumor relocalization methods

- CT based
  - Near real-time 3D imagery
- kV image-based (right)
  - Landmarks or fiducials indexed to known tumor position
  - TG 102 / F-F Yin
- Ultrasound-based
- Optical
- Implanted RF signaling device



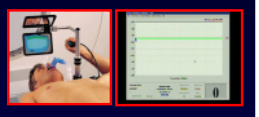
Respiratory management

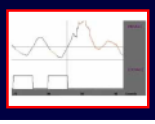
Strategies to control tumor motion during treatment and improve patient relocalization

(TG78 Paul Keall, Presented in the respiratory management sessions)

Respiratory control for SBRT

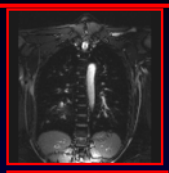
- Abdominal compression
  - Forces shallow breathing
- Controlled breath-hold
  - Stabilizes tumor within the respiratory cycle
  - Can be device-assisted
- Tumor tracking
  - Implanted fiducials
- Gated beam-on devices
  - Treatment only given when tumor located within the beam
  - Respiratory tracing used

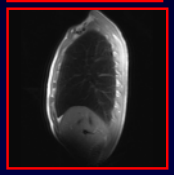




3. Patient Immobilization, Repositioning, and Relocalization/Verification: Summary

- Immobilization
  - Frames and custom body molds
- Tumor relocalization
  - Image-guidance (IGRT)
    - CT, kV, ultrasound, optical, MRI, etc
- Respiratory control
  - Abdominal compression
  - Controlled breath-hold
  - Gated beam-on devices





cineMRI courtesy of Dr. Paul Read, Univ. of Virginia

AAPM TG 101: SBRT - Table of Contents:

4. Simulation, Treatment Planning, and Reporting
   - 4.1 Patient data acquisition
   - 4.2 Treatment Planning
   - 4.3 Treatment Report
   - 4.4 Bio-effective based treatment planning

Highlights of 4.2 Treatment Planning

+On tumor volumes and margins (Clinical History and ICRU 50 and 62)
+On hot spots within target volumes (Negative margins increase hot spots)
+On dose fall-off away from the target (Beam geometry, resolution, etc))
+On the selection of beam direction (Collision free options are reduced)
+On dose-calculation algorithms and heterogeneity corrections
+On calculation grid size (4mm vs. 2mm)
+On tolerance doses of critical structures (Preliminary data provided)
+On plan analysis (Suggested volume ratios and Dose fall off at 2 cm, etc)
+3D-conformal, Arc, and IMRT techniques (Minimize MLC segments)

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Highlights of 4.3 Treatment Report

Dose report contents and nomenclature……..
Incorporation of setup uncertainties in dose calculations
Patient shifts……..
Delivery data report…..……
Statistical analysis of delivery data ……

AAPM TG 101: SBRT - Table of Contents:

- 5. Special Dosimetry Considerations
  - 5.1 Problems associated with dosimetry of small/narrow field geometry
  - 5.2 Problems associated with small field inhomogeneity calculations
  - 5.3 Dose verification and in-vivo dosimetry strategies
  - 5.4 Energy selection, heterogeneity corrections

•Highlights:
•References/synopsis for small field dosimetry (intra-cranial)
•Unlike cranial SRT, tissue inhomgeneity is a greater concern with SBRT
•Energy selection considerations, particularly for lung, and at inhomogenous interfaces is presented (<10MV preferred).

AAPM TG 101: SBRT - Table of Contents:

6. SBRT Treatment Delivery Systems
   - 6.1 Dedicated SRS machines
   - 6.2 Mini/micro-MLC accessories
   - 6.3 Use of conventional linear accelerators

Highlights of treatment delivery devices

Overview of specifications/limitations of dedicated machines such as Cyberknife, Tomotherapy, Novalis
•Overview of conventional linear accelerators – which pioneered this field
•Overview of specialized accessories: micro-mlc

AAPM TG 101: SBRT - Table of Contents:

7. **Clinical Implementation of SBRT**
   - 7.1 **Recommended commissioning and acceptance-testing procedures**
   - 7.2.1 **QA procedures: Periodic QA protocol for equipment, devices, and system**
   - 7.2.2 **QA, Verification, and Recording procedures for clinical procedure**
   - 7.3 **Estimates of the resources needed for establishing an SBRT program, including protocol development, SOP development, equipment commissioning, personnel training, and on-going QA processes**

Highlight:

•Most common questions I get are…

"What do we need to do to start an SBRT program??

"Will I be compliant with CPT billing codes?"...

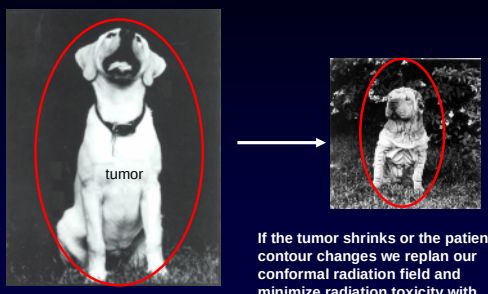
Categories of Availability of Physicists:

-General: Available for communication (ie phone)

-Direct: In the department, available at initiation**

-Personal: At machine (similar to HDR delivery)

7.0 Future Paradigm: Adaptive Radiation Therapy



If the tumor shrinks or the patient contour changes we replan our conformal radiation field and minimize radiation toxicity with similar local control rates.

Slide courtesy of Paul Read, U. Virginia

Conclusion
AAPM Guidelines on SBRT

SBRT has great potential but must be executed with care and caution.

Let's learn from each other….

...not from the guys floating barges down river.

Thanks to the Task Group members!