Clinical Implementation of Intraoperative Radiotherapy
10-year experience

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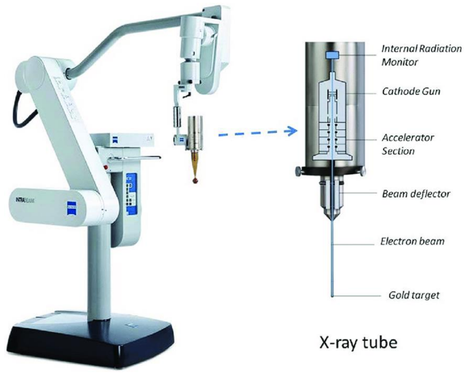
Purpose

- We present strategies and challenges of clinical implementation of intraoperative radiotherapy (IORT) with Zeiss INTRABEAM in a large radiotherapy program
- IORT program with INTRABEAM was developed and implemented at MUHC in November 2013 with Zeiss INTREABEAM
- To date the methodology was used to treat 61 early-stage breast cancer patients successfully
- Subsequent implementation was successfully completed at the Montreal Neurological Hospital for IORT of GBM tumors

INTRABEAM System



Intrabeam Floor Stand

X-ray tube

- 50 kVp x-rays
- Spherical applicators
  - 1.5 cm - 5 cm diameter
- Low dose-rate
  - 20 Gy at applicator surface in 15-40 minutes, depending on applicator size

Quality Assurance

Pre-treatment checks:

- Mechanical checks on the probe straightness
- Isotropy of the source at 4 cardinal angles
- Dose output

Periodic checks

- Depth dose curve in water
- Isotropy in water
- Applicatory integrity on CT scan

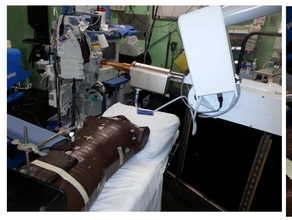
Clinical Implementation

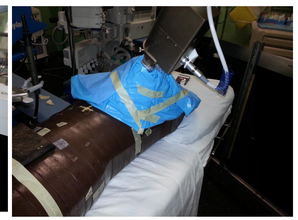
- Workflows for IORT, before the surgery (to flag the patient for adequate radiation oncologist and medical physics presence and equipment availability, immediately prior to surgery and during radiotherapy
- Sterilization-safe sizers and applicator-specific boxes were designed and fabricated to limit unnecessary sterilization cycles and extend lifetime of Zeiss spherical applicators

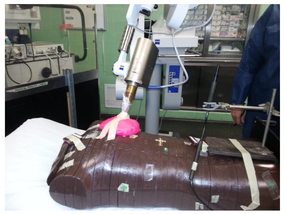
Patent: US 2016/0287901 A1(2016)

- On-site radiation safety training for operating room staff
- On-site user training for radiation oncologists, surgeons and medical physicists
- Failure modes were explored
- Adequate staffing was planned, and subsequent cross-training took place
- Procedures put in place:
  - Sterilization procedure
  - Contact list
  - Equipment checklist and calibration due dates
  - Emergency stop/restart procedure
  - Second check procedure for the physicist

Radiation Protection





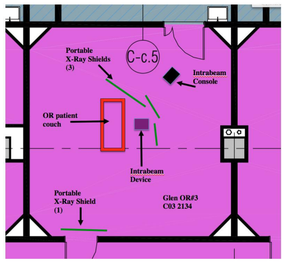


Radiation surveys involved extensive in-air and in-phantom measurements, with and without lead shielding

Operating rooms with sufficient shielding were identified.

The rooms most used for breast surgeries require additional portable shielding

(portable lead glass)



Additional safety measures were implemented:

- Remote pause button
- Remote patient monitoring from the hallway
- X-ray signs on the doors
- Supply area (rear) door blocked during procedure
- Procedure-specific OSLD carried by medical physicist
- Photographs of shields and room setup stored for each procedure for documentation

Discussion and future direction

- Generally positive clinical outcomes, in line with published clinical trial outcomes
- Reliable radiation delivery system, with minimal downtime
- Robust system engineering and quality components
- Manufacturer monitoring and maintenance (full support contract)
- Prescription dose of 20Gy at the surface of the applicator was determined to be inaccurate by modern dose measurement methods. Watson *et al* and others reported that this prescription may underestimate the delivered dose to water by between 32% and 25% at the surface of applicators of 1.5 cm to 5 cm, respectively.
- Newer INTRABEAM operating systems allow the user to toggle between dose calculation algorithms, but most clinicians continue with the old formalism for clinical consistency in treatment and current lack of clinical experience with alternate dose prescriptions.
- NIST-traceability provides a foundation of accuracy and reliability in dose measurements. Watson *et al* [private communication] is developing NIST-traceability pathway for detectors and measurement procedures for the INTRABEAM source. This will align the INTRABEAM source calibration with that of Xxoft Accent.
- Ayala Alvarez *et al* and others have developed Monte Carlo-based algorithms to calculate INTRABEAM dose to tissue on patient CT images. This will provide more accurate OAR doses from IORT and dose summation of IORT dose with external-beam radiotherapy dose.
- Recommendations for electronic brachytherapy dosimetry are currently being developed for this source and others by the AAPM TG-292.

References:

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