Clinical Implementation and Preliminary Patient Outcomes of Flattening Filter Free Irradiation at an Extended Distance for Total Body Irradiation (FIRE-TBI)

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Objectives
To implement a flattening filter free (FFF) total body irradiation (TBI) technique that uses a higher dose rate (FIRE-TBI), and determine if it reduces treatment time.
To prospectively track TBI patient outcomes to ensure technique safety.

Background
A. TBI Technique at the Tom Baker Cancer Centre
- Extended SSD delivery with AP/PA patient orientation using a custom couch
- Sweeping arcs between 310° and 60/70° (short/tall patients)
- Dose homogeneity achieved using inverse-square-law-based control point weighting and VMAT optimization
- Beam spoiler to increase surface dose
- Most common prescription is 400 cGy delivered in two fractions BID

B. FIRE-TBI Technique
- Same patient setup and equipment but with 6 MV FFF substituted
- Nominal dose rate 1400 MU/min vs 600 MU/min for standard technique
- FIRE-TBI requires pre-set multi-leaf collimator (MLC) leaves based on height and anteroposterior (AP) width (Frederick et al. 2020)
- Treatment planning facilitated by the Eclipse scripting application programming interface (ESAPI) (Frederick et al. 2023)

Methods
Randomized Prospective Study Design

- RO Consult
  Study introduction (REB approved)
  Criteria: fulfill general transplant/TBI eligibility, first transplant, no previous irradiation, age ≥18 years, Rx 4 Gy/2 fx
  Block randomization to FIRE-TBI or standard TBI technique

- Day -1
  Both TBI fractions timed with stopwatch

- Day 0
  Post-treatment questionnaire on treatment satisfaction completed

- Inpatient Follow Up
  Chart review: Stomatitis severity over time (WHO Oral Toxicity scale) (WHO 1979)
  Narcotic usage over time

- Outpatient Follow Up
  Chart review and transplant physician contact:
  Non-infectious pneumonitis (any grade) at 3 and 6 months (Panoskaltsis-Mortari et al. 2011)
  OS and RFS at 6 months

13 patients accrued between Mar and Dec 2022 (6 FIRE-TBI, 7 standard TBI)

TBI, 7 standard TBI

Results

Acute and Sub-Acute Outcomes

- No difference in duration of severe or ulcerative stomatitis
- Total PCA dose higher in standard TBI cohort, but duration of use not different
- No cases of non-infectious pneumonitis with median follow up of 12.2 months
- No significant differences in OS or RFS

Conclusions
Institutional experience with higher dose rate low-dose TBI (FIRE-TBI) was well received and well tolerated, with significantly reduced treatment time and no apparent increase in acute or pulmonary complications. A larger sample size is needed to confirm these results.

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References