

Standard of Care Total Body Irradiation for Scleroderma: Duke Institutional Implementation

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PURPOSE

We present our institution's experience to assist other centers in starting up their own TBI for scleroderma program.

INTRODUCTION

Systemic Sclerosis/Scleroderma is an autoimmune disease with **considerable morbidity and mortality**. It causes excessive collagen production leading to thickening and tightening of skin as well as damage to internal organs such as kidneys and lungs. The estimated incidence rate is approximately 20 cases per million per year.

Recently, **Total Body Irradiation (TBI) conditioning** as part of an autologous hematopoietic stem-cell transplantation has become standard of care per the outcome of the randomized phase II study The Scleroderma: Cyclophosphamide (CY) or Transplantation (SCOT) Trial.

Prescription: 200 cGy x 4 fractions
Lung/Kidney Limits: 50 cGy x 4 fractions

Our group's previous work as part of the SCOT trial has been previously published [1]. This includes kidney block design for improved dosimetry. TBI for scleroderma involves **coordination** between multiple departments and individuals making it a **challenging** technique in terms of physics as well as practical aspects.

These challenges have impeded its widespread implementation.

METHODS

Coordination with BMT Program

Challenges:

- Machine Scheduling for
 - Simulation (CT, MV on Linac, US)
 - Treatment

- Physics Department Coverage

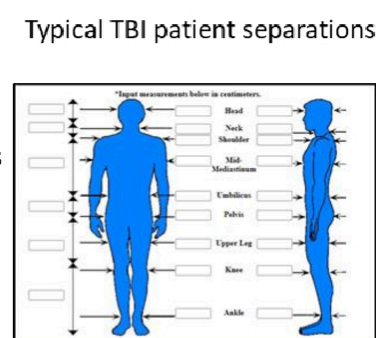
Radiation Oncologist Consult

Challenges:

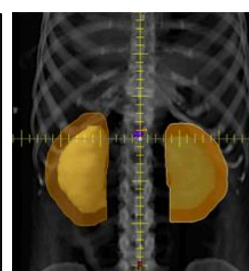
- Physics consulted if patient in poor condition e.g. difficulty bending arms
- Potential adjustment or modifications to TBI stand e.g. adjustment of handholds
- The earlier these issues are addressed, the more efficiently the treatment can be simulated, planned, and delivered.

Simulation

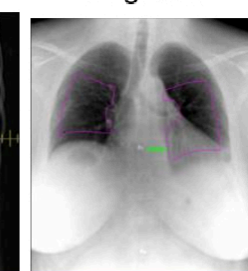
Patient dimensions measured



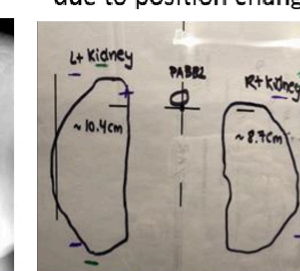
CT (head to knee)
For kidney block



MV Chest
Radiograph for lung block



Ultrasound:
Establish kidney size & location due to position change

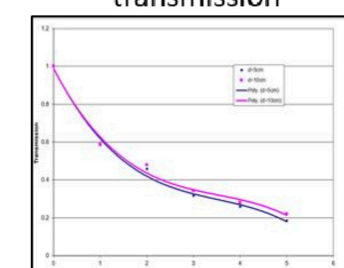


Challenges:

- To ensure accurate positioning: Reference 3 BBs are placed on anterior and posterior patient surface at known distances; BB locations tattooed
- Supine Kidney positions contoured used as guide for US Kidney location/size
- MV: Account for magnification from lung midline to imager
- US: Acquire both prone and sitting US to evaluate kidney size and potential shifts due to breathing or positional (change from prone, supine → sitting (treatment position))

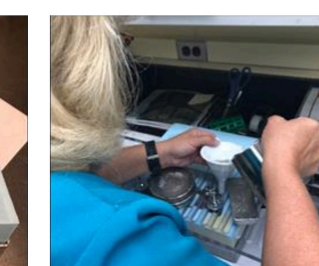
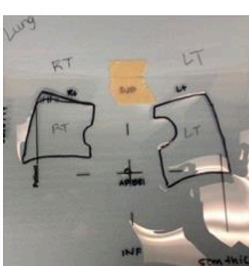
Planning

TBI dose calculation using MU hand calculation



Commissioning Block transmission

Patient-specific block generation



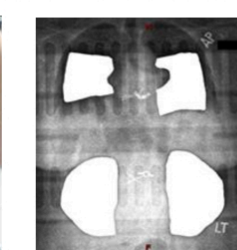
Challenges:

- Physics determination of appropriate kidney block shape and location based on CT → US variation
- Physician draws and approves lung/kidney blocks
- Planning: Block thickness determination
- Block generation time-consuming, training intensive process
- Physics physical inspection of blocks important: no air bubbles, cracks; enough room on block tray to adjust position of blocks

Treatment

Delivery
Physics
Therapists
Physicians

Dry-run:
Initial set-up, Marking Block positions, CR verification



Treatment Fractions 1 – 4:

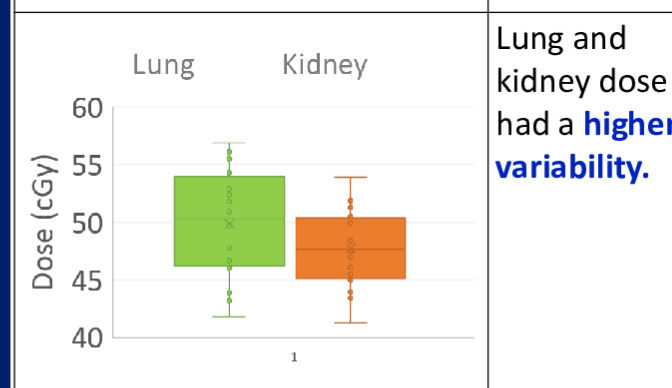
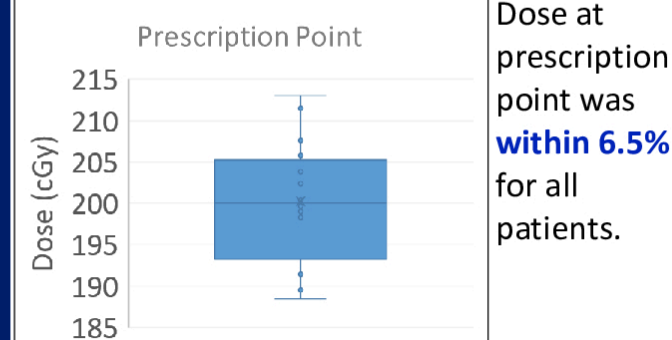
- Fx 1: OSLDs for Prescription point, lung, kidney
- AM fx 1 & 3: Based on Initial set-up and Block positions, CR verification
- PM fx 2 & 4: Based on initial set-up and marked block positions

Challenges:

- Patient compliance strongly depends on patient's condition and support from staff in BMT program.
- 3rd fraction (2nd day AM), patient typically more exhausted due to ATG infusions and extensive monitoring
- Dry run time slot up to 2 hrs
- Treatment fraction time slots approximately 1-1.5 hrs

RESULTS

Sixteen patients from 8/2018 to 5/2020 were treated since TBI for Scleroderma became standard of care.



CONCLUSIONS

With TBI conditioning pre-transplantation becoming the new standard of care for scleroderma, careful implementation of not just physics but also practical aspects can achieve satisfactory dosimetry.

REFERENCES

[1] Craciunescu, O. I. et al. (2011). Renal shielding and dosimetry for patients with severe systemic sclerosis receiving immunoablation with total body irradiation in the scleroderma: cyclophosphamide or transplantation trial. *International Journal of Radiation Oncology* Biology* Physics*, 79(4), 1248-1255.

CONTACT INFORMATION

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