Improved Organ Sparing with VMAT Total Body Irradiation

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Background
- Total body irradiation (TBI) is a conditioning regimen used in bone marrow or stem cell transplantation during which the whole body is irradiated with the intention of eliminating malignant cells and preventing the rejection of donor cells through immunosuppression.
- TBI is associated with significant pulmonary toxicity and infertility, which have a paramount influence on the patient’s quality of life.

Objectives/Aims
- To evaluate the dosimetric differences between VMAT and 2D AP/PA Conventional TBI Techniques.

Methods
- Ten pediatric patients treated with VMAT TBI technique on C-arm Linac from November 2019 to August 2020 were included in this study.
- VMAT TBI plans were generated using the in-house developed autoplanning script.
- For each VMAT TBI plan a corresponding 2D AP/PA plan was created replicating institution’s current clinical setup with the patient positioned at extended SSD with a compensator to account for differences in patient thickness, 50% transmission daily lung blocks and electron chest-wall boosts prescribed to 50% of AP/PA photon prescription.
- Clinically relevant metrics, global Dmax, PTV V110%, lungs and lungs-1cm Dmean were analyzed and compared between VMAT and 2D plans. For patients on non-myeloablative regimen, the gonads were spared with VMAT TBI and the dosimetric indices for Dmax and Dmean were copared between 2D and VMAT plans.
- All dosimetric comparisons between VMAT and 2D plans were made with the dose expressed as a percentage of the prescription dose (2Gy or 12Gy) and the volume expressed as a percentage of the PTV volume. Paired t-test was used to compare the dosimetric indices between VMAT and 2D TBI plans.

Results
- All VMAT TBI plans achieved D90% ≥ 100% of prescription, PTV coverage, D90%, was reduced significantly (-6.2%± 2.4%, p < 0.001) with 2D plans, whereas no significant differences were observed between the 2D and VMAT global Dmax (p < 0.226) and PTV V110% (p < 0.444), Table 2.
- Compared to 2D plans, VMAT TBI plans produced significant decrease in the Dmean to the lungs and lungs-1cm volumes of -25.6% ± 11.5% (p < 0.001) and -34.1% ± 10.1% (p < 0.001), respectively. In addition to lungs, VMAT TBI technique provided sparing to other organs: for 12 Gy prescription, kidneys Dmean of 64.7% ± 3.3%, for 2 Gy prescription, testes/ovaries Dmean of 31.6% ± 10.7%, brain Dmean of 74.8% ± 1.6% and thyroid Dmean of 72.5 ± 3.5%.

Conclusions
- Superior lung sparing with the superior target coverage and similar global Dmax were observed with the VMAT plans as compared to 2D plans.
- In addition, VMAT TBI plans provided great dose reductions in gonads, kidneys, brain and thyroid.

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References