

# Total Marrow with Lymphoid Irradiation (TMLI) as a conditioning regimen using VMAT technique: Planning and dosimetry validation



Reena Devi Phurailatpam,<sup>a</sup> Kishore Joshi <sup>a</sup>, Supratip Kapat <sup>a</sup>, Ann Christy Saju <sup>b</sup>, Jayant S. Goda <sup>a</sup>, Chandrashekhar Tambe<sup>c</sup>, Rajesh A Kinshikar<sup>c</sup>, Siddharth S Laskar<sup>b</sup>

<sup>a</sup> Department of Radiation Oncology, ACTREC, Tata Memorial Centre, Homi Bhabha National institute, Kharghar, Navi Mumbai <sup>b</sup> Department of Radiation Oncology, Tata Memorial Hospital, Tata Memorial Centre, Homi Bhabha National institute, Mumbai, <sup>c</sup> Department of Medical Physics, Tata Memorial Hospital, Tata Memorial Centre, Homi Bhabha National institute, Mumbai

\* Corresponding author: [reena.ph@gmail.com](mailto:reena.ph@gmail.com)

## Background and Objective

To study the planning and dosimetric feasibility of implementing TMLI (Total Marrow with lymphoid Irradiation) using Volumetric modulated arc therapy (VMAT) as a conditioning for bone marrow transplant.

## Methods

- Four patients who were planned to receive cyclophosphamide- TMLI based conditioning for allogeneic transplant were accrued in the present study after institutional ethics committee approval.
- VMAT plans on TrueBeam Linac (Varian Medical Systems, USA) using Eclipse treatment planning system (TPS version 13.5).
- Dosimetrically validated using Lithium fluoride thermoluminescent dosimeters (LiF TLD), Ionization chambers and ArcCHECK phantom (M/S SUN NUCLEAR CORPORATION).
- PTV-TMLI encompassed the entire CTV TMI and CTV TLI and the sanctuary sites of brain and Testis. Organs at risk (OAR) to be spared : lungs, heart, liver, kidneys, eyes, oral cavity, thyroid, parotids and bowels.
- Dose prescription was 13.2Gy/8# , 1.65 Gy delivered twice daily.
- VMAT plans were generated using 8 overlapping 360° coplanar arcs optimized simultaneously. 6MV photon FF at dose rate 600MU/min.(Fig 1)
- The isocentre was placed at the overlapping area between the two adjacent arcs which was 4 cm and to eliminate the uncertainty in matching the two planes. Four isocentres were selected to encompass the entire PTV with asymmetric jaw settings .The collimator was set to 90° and field width (Y direction) of 40 cm, and field length (X direction, i.e. the direction of movement of leaves) ranged from 15 to 16 cm to allow maximal modulation. (1)

## Dosimetric validation

TLD and Ionization chambers : A thorax phantom and a rectangular phantom(density 1.03 g/cm<sup>3</sup>) were strapped together to make a phantom of length 100cm.(Fig 2) 25 TLDs along with 3 ionization chambers(0.125cc PTW) were placed at different places of the phantom.

**Planar dose validation:** Arc check phantom was used for planar dose verification.(2) It is a commercial diode array designed specifically for rotational measurements. Planar dose for each arc of individual plans were verified. Dose distributions were analyzed using gamma criteria of 3% dose and 3 mm distance to agreement

## Results and Discussion

The mean volume of PTV encompassed by 95 % Isodose line was 92 % of the PTV volume and D2 (mean dose of 2cc volume of PTV) was 104% of prescribed dose. Conformity and homogeneity index were 0.90 and 0.21 respectively. OAR doses are given in the table 1.

Percentage variation in point dose measurements with Ionization chambers were found to be within 5%. The mean TLDs reading was within 7% of the TPS calculated dose. Planer dose verification was passed within 99% of gamma index with 3%-3 mm criteria.(Fig 3)

**Conclusions:** Although resource intensive, the favorable dosimetry of VMAT based TMLI and its validation using two independent methods makes this technique robust enough to potentially replace the conventional TBI technique with adequate PTV coverage and better OAR sparing effect.

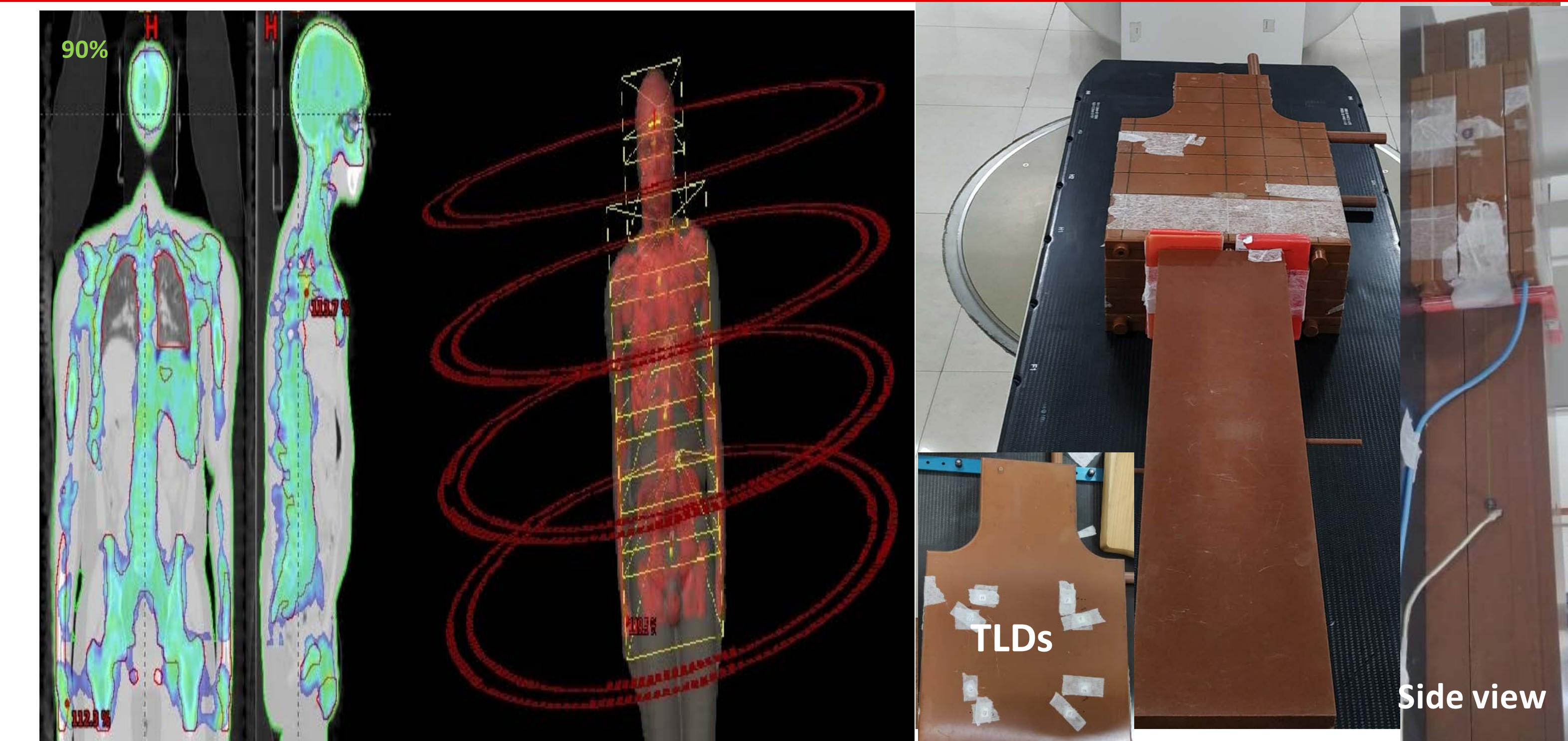


Fig1. Dose distribution and Beam arrangement

| OAR           | Mean Dose Gy(Std deviation) |
|---------------|-----------------------------|
| Right Eyeball | 7.95(1.13)                  |
| Left Eyeball  | 7.80(1.14)                  |
| Oral cavity   | 6.9(1.32)                   |
| Lt Parotid    | 7.27(0.77)                  |
| Rt Parotid    | 7.03(0.61)                  |
| Thyroid       | 12.65(0.87)                 |
| Heart         | 6.9(0.77)                   |
| Left lung     | 8.25(0.82)                  |
| Right lung    | 8.63(0.95)                  |
| Liver         | 9.01(1.01)                  |
| Left Kidney   | 6.08(1.45)                  |
| Right Kidney  | 6.64(0.96)                  |
| Bowel         | 9.57(1.47)                  |

Table 1: OAR DOSES

Fig 2.100 cm Phantom for dosimetry With TLD and Ionization chambers

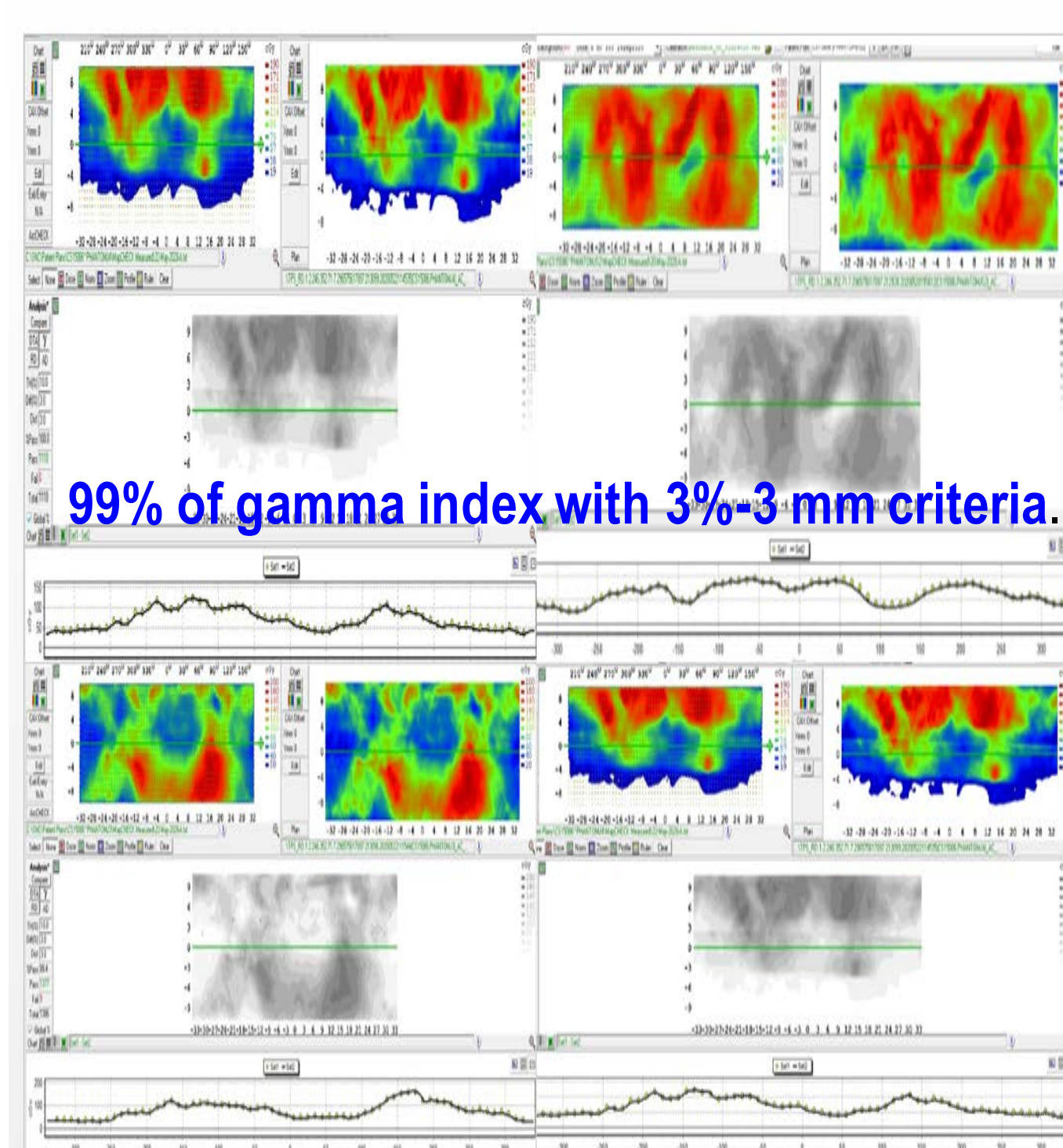


Fig 3.Dose analysis ARC CHECK