Purpose:
This study develops treatment planning and a comprehensive dosimetry verification procedure for volumetric modulated arc therapy(VMAT) based total marrow irradiation(TMI), a form of targeted total body irradiation(TBI).

Methods:
The simulation CT of 3 patients treated with TBI were used. Planning was done with Eclipse treatment planning system(Varian Medical Systems, CA). Planning volume(PTV) was defined as skeletal bone, rib, and sternum, with 3mm margin, from head to mid-femur. In total marrow and lymphoid irradiation(TMLI), PTV is expanded to include spleen and major lymph nodes. The mandible, maxillary bones and forearms were excluded. The dose prescription was 12Gy in 6 fractions. The PTV is divided into head-and-neck(H&N), chest and pelvis regions. Correspondingly, there is separate plan for each region, composed of 2~3 arcs/fields with multiple isocenters along patient axial direction. The 2D dosimetry verification was conducted with EBT2 Gafchromic film(International Specialty Products, NJ) for gamma evaluation and ion chamber for absolute point dose measurement, using a IMRT phantom(Computerized Imaging Reference Systems, VA) and RIT software(Radiological Imaging Technology, CO), with emphasis of junction area between neighboring plans for hot/cold spots. We further conduct volumetric dose verification with electronic portal imaging devices and DosimetryCheck program(Math resolutions, MD). The gamma evaluation criteria were 5% absolute point dose difference and 3mm distance to agreement.

Results:
More than 90% of PTV is covered by 100% of prescribed dose. Compared to TBI, average dose reduction on critical organs are: lung(10%), kidney(53%), liver(48%), Eyes(69%), and heart(51%). Junction areas show average 98% gamma passing rate and 3% absolute dose difference; volumetric portal dosimetry show average 91% gamma passing rate and 2% absolute dose difference, compared to plan dose.

Conclusions:
Adequate target dose coverage and reduced normal organ dose are observed. A comprehensive dosimetry verification procedure is developed. The initial results are encouraging and warrant further investigation towards clinical implementation.

Funding Support, Disclosures, and Conflict of Interest:

There is no conflict of interest.