Comparison of VMAT vs Arc treatment plans for patients undergoing SBRT of early-stage Non-Small Cell Lung Cancer (NSCLC)

INTRODUCTION
Recently, VMAT (Volume Modulated Arc Therapy) treatment planning techniques are being increasingly used for treatment planning of cancer patients. The VMAT delivery is supposed to significantly reduce treatment time compared with traditional IMRT, and potentially achieve better accuracy and sparing of the organs at risk. The purpose of this work is to analyze the dosimetric implications of using VMAT treatment planning techniques compared to traditional Arc therapy methods for patients undergoing SBRT (Stereotactic Body Radiation Therapy) for early-stage Non-Small Cell Lung Cancer (NSCLC).

METHODS AND MATERIALS
Ten NSCLC patients are planned using the Pinnacle$^3$ treatment planning system version 9.0 (Philips Medical Systems, Cleveland, Inc.) with both VMAT and Arc treatment planning techniques. Nine patients are prescribed 12 Gy per fraction (fx) for a total of 4 or 5 fx and one is prescribed 20 Gy per fraction for 3 fx. VMAT plans are created using the integrated SmartArc inverse planning module that generate dynamic arc beams which deliver optimized IMRT plans during gantry rotation around patient. For Arc planning we use seven 30 degree angle coplanar arcs around the tumor. At the Arc control points, MLC leaves conform to a block structure that is specifically chosen to optimize the 3D dose distribution of the planning target volume (PTV) and spare the organs at risk (OAR). In our current clinical practice, the ITV (internal target volume) is generated from the GTV (gross target volume) drawn by the physician by adding lung tumor motion margins calculated from a prior 4D CBCT patient simulation scan. The PTV is usually created by adding a 3 mm 3D isotropic margin to the ITV to account for treatment setup errors. The quantitative evaluation of both SBRT treatment plans was performed by analyzing several Dose–Volume Histogram (DVH) indicators such as: mean, maximum and minimum doses for GTV, ITV, PTV, OAR (lungs, spinal cord, chest wall, esophagus, blood vessels, heart), and V95 (volume receiving at least 95% of the prescribed dose) for PTV.

RESULTS and DISCUSSION
The GTV tumor volumes for the ten SBRT patients range between 0.2 cm$^3$ to 16.2 cm$^3$, with eight patients having GTV volumes less than 10 cm$^3$. The corresponding PTV volumes range between 1.9 cm$^3$ to 50.1 cm$^3$. The physician chose VMAT for seven patients and the Arc technique for the rest. Arc technique is preferred for rounded and small targets, the mean GTV and PTV volumes being 2.4 cm$^3$ respectively 7.1 cm$^3$. On average VMAT plans require for treatment delivery 16.6 ± 20.2 % more monitor units (MU) than the traditional Arc plans. The average PTV minimum, maximum and mean doses as a percentage of prescribed dose are 94.5 ± 3.9 %, 114.1 ± 3.3 % and 106.6 ± 1.6 % for VMAT and 91.6 ± 4.4 %, 119.5 ± 5.3 % and 109.5 ± 2.5 % for the Arc technique. The average V95 PTV coverage for VMAT plans is 99.7 % ranging from 99.4 % to 100 %, compared with a mean of 99 % ranging from 96.8 % to 100 % for the Arc plans. The maximum dose received by the lungs, spinal cord and chest wall show on average significant increases for Arc plans as opposed to VMAT plans (5.7 ± 6 % increase for lungs, 4.4 ± 9.2 % for cord and 2.4 ± 6.3 % for chest wall ). The average mean doses and minimum doses for the OAR are similar for both techniques.

CONCLUSION
The comparison of VMAT vs Arc techniques for SBRT of NSCLC treatments is subject to many variables, including GTV and PTV volume sizes, shape and proximity relative to the OAR. The presentation will incorporate a comprehensive quantitative evaluation using additional dosimetric measures and more lung SBRT patient data (about 100 patient database).