Purpose: To investigate the effect of the dose grid resolution variability on the spinal cord dose for spinal SBRT treatments.

Method: 10 CyberKnife plans were selected for the proximity of the PTV to the spinal cord. All dose distributions were calculated with Monte Carlo using high spatial resolution and minimal relative uncertainty. The plans were renormalized to a 16 Gy prescription dose and to ensure a target coverage > 95% in order to compare the calculated dose distributions. Each dose matrix was resampled 12 times, covering a grid resolution range of 0.95 mm to 13.52 mm. The spinal cord DVHs were generated for each resampled dose grid. The variations of the maximum point dose (DmaxCord) and dose-coverage to partial volumes (D[V]) up to 5 cc were investigated against the grid resolution.

Results: The mean variation of DmaxCord with grid resolution is characterized by an inverse power law, with a sharp initial decrease leading to potentially large underestimates of DmaxCord (24%, 40% and 55% at resolutions of 2 mm, 4 mm and 8 mm). The variability of mean D[V] values decreases from smaller to larger grid resolutions, however large disparities are observed between patient plans. We introduced the variability threshold volume (Vth) as a constraint to express the dose coverage independently from the grid resolution. For resolutions up to 8 mm, the mean Vth value is (0.96±0.10) cc with a corresponding dose coverage of (26±12) % relative to the initial DmaxCord value.

Conclusions: Dose distributions calculated with grid resolutions larger than 2 mm could result in significant underestimates of DmaxCord. Furthermore, the sensitivity of the dose coverage to grid resolution variability is patient dependent. Consequently, a specified cord dose tolerance should be quoted at a particular grid resolution uniformly adopted between institutions; 2 mm or less is an appropriate value.