Electron beam dose calculation evaluation using Pinnacle pencil beam and Monaco Monte Carlo methods: A retrospective study

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Purpose

Electron pencil beam dose calculation algorithms are used by multiple treatment planning systems for electron therapy treatments. Recently, more TPS's have implemented Monte Carlo dose calculation algorithms instead. The purpose of this work was to retrospectively evaluate potential dosimetric differences between pencil beam and Monte Carlo calculations.

Methods

Twenty previously treated patients with electrons were included in this study. The electron energies used for the treatment ranged from 6 MeV to 15 MeV. The treatment sites included sinuses, ears, testicles, skin, and IMNs. All patient treatment plans were initially created using the Pinnacle TPS with 3D electron dose calculation algorithm. The plans were then recalculated using the Monaco TPS. The differences in dose distributions and DVH's were evaluated.

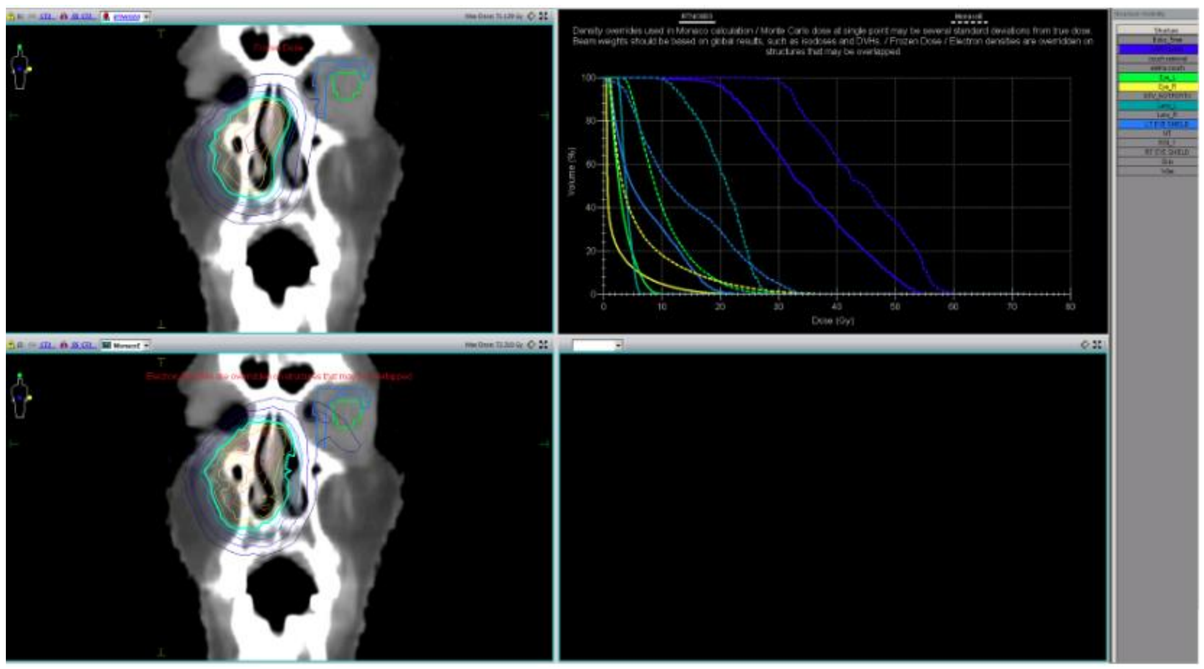

Figure 1. Isodose distributions (Top: Pinnacle (Pencil beam) and bottom: Monaco (MC)) and DVH variations

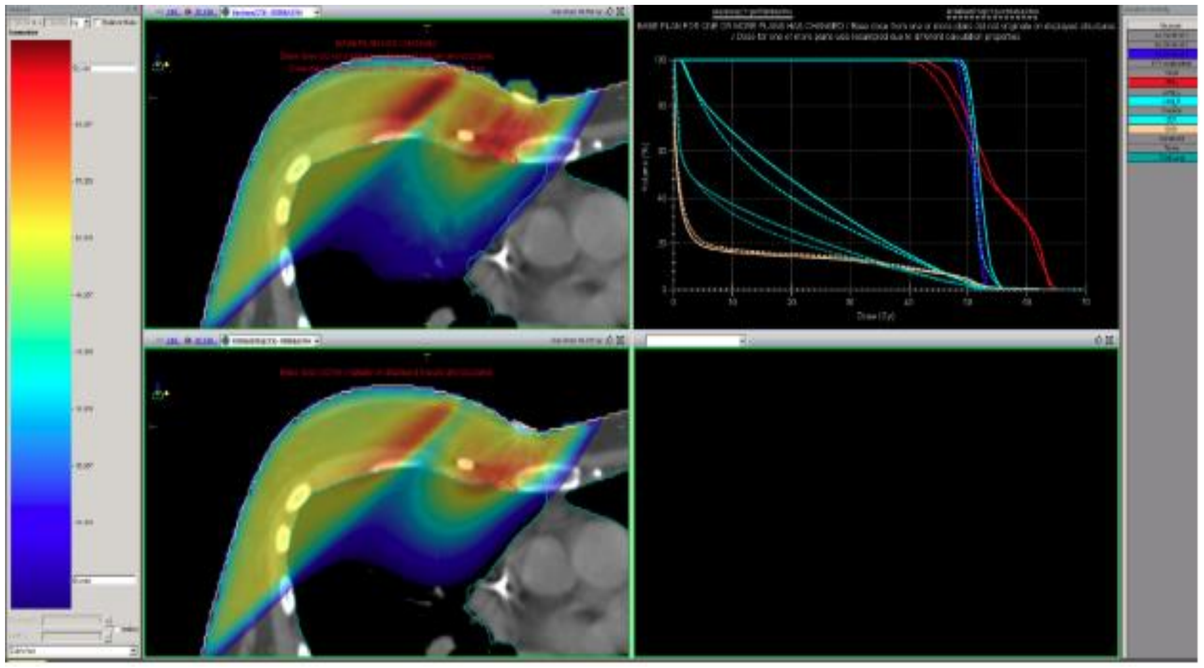

Figure 2. Isodose distributions (Top: Pinnacle (Pencil beam) and bottom: Monaco (MC)) and DVH variations

Results

Differences between the dose calculation algorithms were observed for the majority of cases. They were within 1% for cases with minimal tissue inhomogeneities (breast, skin, testicles). Differences of 3% or more were observed with the presence of inhomogeneities (sinus, skin folds, lung. The DVH analysis showed higher doses, as well as broader and deeper dose distributions for critical structures when calculated with Monaco. In cases of photon-electron beam matching, the dose on the photon side increased by 2-5%.

Conclusion

It is important to carefully consider the electron dose calculation accuracy when the treatment site has tissue inhomogeneities, as in the case of air-bone-tissue interfaces. When photon beams and electron beams are matched, consideration should be given to the hotspot in the photon side and if necessary dose verification measurements should be made.

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