Purpose:A new method, based on the Finite Element (FE) modeling, has been introduced for dosimetric assessment of the brachytherapy sources with mobile internal component.

Methods:Dosimetric characteristic of a commercially available brachytherapy source, Best Double-Wall Model 2335 103Pd seed, were calculated by Monte Carlo (MC) simulation using the MCNP4c2 and MCNP5 codes according to the updated AAPM Task Group 43 (TG43U1) protocol, following finite element (FE) modeling to predict displacements of the seed's internal radioactive components in different orientations of the seed encountered in clinical practice (4D dosimetry). The complete seed geometry and materials together with a published 103Pd spectrum were used to perform finite-element modeling using ABAQUS v.6.8.1 software and dosimetric characterization of the source using MCNP4c2 and MCNP5 codes.

Results:Using FE modeling, change of seed orientation resulted in displacements of the seed's internal components. For the case of the Model 2335 103Pd seed, this has a negligible effect on the dose rate constant and radial dose function (<1%) but the consequences on the 2D anisotropy function was greater (up to 16.2% at small angles).

Conclusions:There are no clinically significant variations in the dose rate constant and radial dose function due to the uncertainty of the internal position of the structures for the Model 2335 103Pd seed. However, the uncertainty in the 2D anisotropy function at smaller angles is larger than what has been reported, due to the motion of the internal components. Using this 4D dosimetry method is suggested to determine the dosimetric characteristics of each new brachytherapy seed with mobile internal components.

Keywords: Palladium-103, Brachytherapy, Monte Carlo simulation, Finite Element modeling, TG43U1