Guidewire Reproducibilty and Modeling

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The number of minimally invasive vascular interventions is increasing, and the device most frequently used is a guidewire, along which devices are delivered to the intervention site. Procedural failure can occur due to improper guidewire and/or device selection. To facilitate guidewire and device guidance, we investigated the reproducibility of guidewire paths in vessel phantoms. Several trained users repeatedly passed guidewires of different flexibility through the phantoms under pulsatile flow conditions. Afterwards, the 3D paths were reconstructed and compared. In addition, the 3D paths were calculated using graph representation techniques. Points in the vessel lumen in planes perpendicular to the vessel centerline were generated. All points in adjacent planes were joined generating a vector set in a graph representation in which the edge weights were functions of the angle between contiguous vectors. The optimal path through this weighted directed graph was then determined using a Dijkstra's (shortest path) algorithm. The guidewire paths appear reproducible across users but not across materials. The average RMS difference of repeated placements was 0.17 ± 0.02 mm (plastic-coated guidewire), 0.73 ± 0.55 mm (steel guidewire) and 1.15 ± 0.65 mm (steel vs plastic-coated). For the guidewire modeling, the average RMS distance between the actual and simulated guidewire path was 0.7 mm; computation time was 3 s. For a given guidewire, these results indicate that the guidewire path is relatively reproducible in shape and position. The ability to predict the guidewire path inside vessels may facilitate calculation of vessel-branch access and force estimation.