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Characterization of Precurved Needles for Use in Distal Tip Manipulation Mechanisms

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Precurved needles are used in a variety of medical applications for both passive and active control of instrument position. In one application, the deployment of a precurved stylet from a concentric outer cannula can be used to achieve lateral positioning of the distal tip of the stylet. This paper outlines how the material and geometry of the stylet can be chosen to ensure that it will not yield and thus repeatedly return to its precurved shape when deployed from a cannula. Using this methodology, we calculate the maximum strain for a range of stylet geometries and show that nitinol is required for the stylet material so that it will not plastically deform. Then, 16 stylets of varying diameters (0.508 mm, 0.635 mm, 0.838 mm, and 0.990 mm) and radii of curvature (10 mm, 20 mm, 30 mm, and 40 mm) were manufactured. Experiments were performed with four different diameter cannulas (20, 18, 16, and 14 gauges) to measure the forces required to deploy the stylets from and retract them back inside the cannulas. Retraction forces were measured between 0.3 N and 13.9 N, and deployment forces were measured between 0.2 N and 7.0 N. For a given cannula, it was found that force increases as the stylet diameter increases and as the bend radius decreases.

Numerical and Experimental Simulations as Symbiotic Tools for Solving Complex Biothermal Problems

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In the design of medical devices, the use of numerical simulation, either with or without complementary experimentation, may lead to a more competent product. The experimentation in question may either be performed in vitro or in vivo. This paper conveys a case study in which the two methodologies, numerical simulation and in vitro experimentation used in tandem, enabled the evaluation of safety issues related to a heat-generating implant. The numerical simulation was implemented by means of ANSYS finite-element software employed in the transient mode. The experimental work provided information necessary for the execution of the simulation and, therefore, was performed as the first phase of the research. The implant is of the type that is equipped with a short-lived battery that requires intermittent recharging. The recharging is accomplished by means of an antenna that is externally mounted on the skin surface. The antenna is the primary of a transformer, and the implant contains the secondary of the transformer. During the recharging period of the battery, heat is generated in both the antenna and the implant. By the symbiotic use of the experimental results and the numerical simulation, time-dependent temperatures were determined in the tissue that is situated in the neighborhood of the implant and the antenna. These temperatures were evaluated from the standpoint of possible tissue damage.

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