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# Computational modelling of the mechanical performance of Nitinol guidewires


Guidewires are long, slender, flexible wires with a metal core for navigating through complex networks of blood vessels to guide the placement of larger medical devices. In some instances, Nitinol guidewires can exhibit undesirable phenomena such as "lag" and "whip", where the movement input by the surgeon proximally is not transferred to the distal end of the device during a procedure. The relationship between material properties and these wire phenomena which are explored in this study are poorly understood.

In this work, we demonstrate how dissipative material phenomena such as plasticity in steels and phase transformation in Nickel Titanium superelastic alloys are linked to this behaviour. We demonstrate how lag accumulates in the wire in various geometries and compare these observations to experimental data. A parameter study of key superelastic properties such as plateau stresses and transformation strains reveals how lag and whip occur in wires in different tortuous paths. a perfectly elastic material with no hysteresis and is the fundamental mechanism behind lag and whip. Results further show that the performance of the guidewire material can be related to a single metric that is given in terms of the energy dissipated during transformation, i.e., the area of the hysteresis loop. The combination of torsion and the bending of the wire in the curved path are critically important in the generation of lag and whip and these results provide a fundamental mechanistic understanding of the lag and whip phenomena.