Seminar/Talk

Why do surgeons sleep better with plasticity in their knots?

Pedro M. Reis
École polytechnique fédérale de Lausanne

Host: Scott Waitukaitis

Knots, the weakest link in a suture, are central to surgical procedures, where they are used as ligatures to bind surgical threads during suturing. Massive bleeding may occur when the suture loop surrounding a vessel becomes untied or breaks. In high-tension closures, such as tendon repairs, knot unraveling rates can be as high as 86%. Even if the need for mechanical analysis of knots has long been recognized in the medical profession, established guidelines for best practices rely primarily on empirical knowledge, not on structural analysis. More broadly, physical knots are complex functional structures involving the coupling of a nontrivial set of ingredients: topology, geometry, elasticity, contact, friction, and plasticity. In this talk, we will present results from an investigation on surgical knots' operational and safety limits, highlighting the previously overlooked but crucial effect of plastic deformation. We analyze the sutures produced by an experienced surgeon in a model system. The relevant range of applied tensions and geometric features are characterized through mechanical testing and X-ray tomographic imaging. From a thorough analysis where we vary the tying tension and the number of throws in the system, we find a clear relationship between the number of half-hitches and the necessary untying tension of the suture. Our unprecedented experimental data from surgeon-tied sutures and model systems, combined with finite element simulations, enable us to rationalize the primary ingredients dictating the mechanical performance of surgical knots. These findings could have potential applications in the training of surgeons and control of robotic-assisted surgical devices.

Tuesday, November 21, 2023 10:00am - 11:00am
Moonstone, Ground floor, Seminar Room F

This invitation is valid as a ticket for the ISTA Shuttle from and to Heiligenstadt Station.
Please find a schedule of the ISTA Shuttle on our webpage:
https://ista.ac.at/en/campus/how-to-get-here/ The ISTA Shuttle bus is marked ISTA Shuttle (#142) and has the Institute Logo printed on the side.