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Development of a 3D-Printed Biodegradable Polymeric Ureteral Stent

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Abstract

Abstract— Traditional ureteral stents, commonly made from non-biodegradable polymers or metals, are associated with several complications such as infection, encrustation, migration, and the necessity for secondary surgical removal. To overcome these limitations, this project focuses on the development of a biodegradable polymeric ureteral stent that can degrade safely within the urinary tract after fulfilling its function.
The primary objective was to design and fabricate a stent that provides temporary internal support for urinary drainage while minimizing patient discomfort and eliminating the need for retrieval procedures. Polylactic Acid (PLA) was selected as the base material due to its biocompatibility and degradability, reinforced with magnesium and zinc nanoparticles to enhance mechanical strength and control the degradation rate. Chitosan and hyaluronic acid coatings were applied to impart antimicrobial and anti-inflammatory properties.
The stent was modeled using Fusion 360, structurally analyzed through Finite Element Analysis (FEA) in ANSYS, and fabricated via 3D printing. Surface coatings were applied post-fabrication using a controlled dipping method.
Simulation and fabrication results confirmed the structural viability, dimensional accuracy, and effective surface coating of the stent. The proposed design presents a promising biodegradable alternative to conventional stents, potentially improving patient outcomes and reducing healthcare costs.