Thesis Project Portfolio

Redesigning and Prototyping a Micro Scissor for Micro-Anastomosis Post-Mastectomy
(Technical Report)

Impacts of the Exclusion of Gender as a Consideration in Healthcare Funding, Diagnosis, and Treatment

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia - Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Gabrielle Hope Gilpin

Spring, 2024

Department of Biomedical Engineering

Table of Contents

Sociotechnical Synthesis

In the realm of healthcare, two distinct yet interconnected challenges emerge: the equitable treatment of diverse patient populations and the advancement of surgical techniques to optimize patient outcomes. Gender-sensitive health care practices address disparities in access and quality of care, acknowledging the multifaceted impact of gender on health outcomes. Concurrently, innovations in surgical instrumentation, such as micro scissors, underscore the quest for precision and efficacy in medical procedures. While seemingly disparate, these two areas converge at the intersection of patient-centered care and surgical innovation. My technical project focuses on the design and development of micro scissors with a sinusoidal blade to optimize anastomosis with a coupler. The creation of this tool has the potential to increase the success of breast reconstruction procedures for patients post-mastectomy. My STS research is centered around the gender disparities in healthcare and how a system built on male physiology affects women through funding disparities, misdiagnosis, and mistreatment.

Breast reconstruction surgeries post-mastectomy are common procedures aiming to restore the shape, appearance, and size of the breast. Autologous tissue flap reconstruction, a technique involving the transplant of harvested tissue from the patient's body to the breast cavity through micro-anastomosis, presents advantages such as reduced infection rates but is hindered by risk of thrombosis and necrosis. This study focuses on redesigning straight blade micro scissors used in autologous procedures to mitigate these risks. Using computer-aided design (CAD) software, 3D printing, and stereolithography (SLA) additive manufacturing, prototypes with sinusoidal blades were developed as an alternative to straight blades to improve cutting ability and maximize usable tissue of the vein. The sinusoidal blade was tested on cooked pasta and analyzed using ImageJ software and statistical analysis. The ImageJ and statistical analysis showed the sinusoidal blade's cutting ability to be comparable to the straight blade, with improved available area through reduced ridges. Clinical testing using cadaverous veins was proposed to further validate the design's efficacy. This novel and innovative approach addresses a critical need in microsurgery, potentially enhancing patient safety, expanding the landscape of current surgical tools, and improving surgical outcomes.

The exclusion of gender as a variable in healthcare has perpetuated biases across medical research, diagnosis, and treatment. Historically, women were often omitted from clinical trials, resulting in a skewed understanding of health, rooted in male physiology. This oversight extends to social and hormonal factors, exacerbating disparities in disease recognition and funding allocation. Misdiagnosis, exemplified by the "Yentl Syndrome," underscores the consequences of neglecting gender differences in disease presentation, particularly evident in conditions like ischemic heart disease. Women often experience delayed diagnoses and higher mortality rates due to symptoms differing from the male norm. Moreover, disparities in drug development and dosing pose significant risks to women's health. Despite evidence of differing drug responses between genders, sex-specific pharmacokinetics are often ignored, leading to suboptimal treatment outcomes. Addressing these disparities demands a paradigm shift in healthcare, prioritizing inclusivity and gender sensitivity across research and practice. Collaboration among policymakers, healthcare providers, researchers, and industry stakeholders is crucial to integrating gender as a critical variable in study design, clinical trials, and treatment protocols. Only through concerted efforts can healthcare systems strive to provide equitable and effective care for all individuals, regardless of gender.

As a biomedical engineer, it is my goal to improve the quality of care that patients receive whether that be through the optimization of tools used to conduct surgery or analyzing the healthcare system to ensure that all patients are properly cared for. My technical project of redesigning a micro scissor blade used specifically for breast reconstruction surgery for patients who have overcome breast cancer led me to take a closer look into the gender breakdown of various diseases. This inspired my STS research once I discovered that a gender disparity exists not just for specific diseases but within the healthcare system as a whole.