Thesis Project Portfolio

A Patient-Specific Computational Model for Optimizing Surgical Planning to Treat Patellar Instability

(Technical Report)

Examining the Current Debate Over Antidepressant Overprescription and its Impact on Patients' Beliefs and Behaviors

(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

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Spring, 2023

Department of Biomedical Engineering

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Executive Summary

The technical and STS research papers that compose this portfolio are not closely related, but both address how to best administer care for a prevalent medical condition. The technical research was centered around a condition known as patellar instability that affects 6 out of every 100,000 people, and is especially prevalent in young athletes. Patients experiencing this condition suffer from recurrent dislocations of their kneecap and often undergo surgery to adjust their knee anatomy. Studies have reported that between 25% and 70% of patellar instability patients who receive surgical intervention have a recurrence of the condition and must get further treatment. This project sought to create a personalized computational model of the knee in order to assess the forces acting on the patella and provide metrics to guide surgical planning. In theory, this would improve planning methods and result in more successful surgical outcomes to improve patient care. The STS research was related to clinical depression, which is a mental illness that affects over 8% of the population in the US each year. One of the most common treatments for this condition is medication with antidepressants. Scholars and physicians debate whether or not these medications are overprescribed, with compelling evidence being presented by both sides. This research sought to examine both arguments in order to characterize the rhetoric being used and analyze its effects on patients seeking treatment for this condition. Strengthening the understanding of this system can inform how physicians should approach treating patients in order to provide the best care possible.

Patellar instability is an orthopedic disorder characterized by the patella sliding out of its intended position within the femur's trochlear groove. Over 25% of patients who receive surgical treatment for patellar instability experience a recurrence of the condition, which is attributed to the lack of quantitative metrics being used in surgical planning. In order to address this issue, this

project aimed to create a patient specific computational model of the knee to then quantify the force vector acting on the patella. MRI images were segmented to obtain the patient's bone and muscle geometries. Anatomical landmarks were placed on the quadricep muscles, patellar tendon, and MPFL in nmsBuilder software to create the paths along which each body acts on the patella. Within OpenSim software, the force acting on the patella in the coronal plane was found for knee angles ranging from full extension to 180 degrees flexion. The force at full extension and 30 degrees flexion is of particular interest as it is most relevant in dislocation. It was found that the only instance that the force vector was in the lateral direction instead of the medial direction was in the pathological patient model within the range of interest. This is significant because it is consistent with expected results and is an indication that the model is accurately able to describe the force vector. Future work would include modeling a larger patient population in order to validate the accuracy of the model before its application in clinical settings.

Clinical depression is an incredibly common condition that affects the livelihood and well-being of many across the globe, making its treatment of great concern for health care entities and personnel. In addition to talk therapy, a common form of treatment is medication with antidepressants. Some physicians and researchers believe them to be great tools for treating depression, while others argue that they are grossly overprescribed and as not as effective as once believed. A literature review was conducted in order to analyze how each group made their argument in order to gain an unbiased understanding of the larger debate and assess the nature of the rhetoric being used. The group arguing that these drugs are not overprescribed tends to appeal to the sensibilities of health care providers by discussing the importance of treating depression and the abilities of doctors to appropriately prescribe medication. The latter group incidentally appeals more to patients through their emphasis of wanting lasting change for

patients and acknowledging the side effects that patients suffer from. As a result of its relatability and potential for interesting headlines, this argument has entered the mainstream media. Patients who access this media are more likely to question the efficacy of their medication and cease treatment. In this way, the scholarly debate surrounding antidepressants has a large influence on patient beliefs and behaviors. Understanding this relationship can help inform how physicians interact with and treat their patients in order to offer them the best care possible.

Overall, this research provides physicians more information to guide their approaches to patient care. The technical research offers a novel way to plan surgical interventions by giving insights into patient anatomy and biomechanics. It could be built upon and validated in the future, which would allow for it to be applied clinically and improve outcomes for many patients. The STS research offers insight into currently available literature in the psychiatric field and how it may be impacting the success of clinical depression treatment. An understanding of the debate and what aspects of it are being presented to patients is important in developing new treatment plans. Strengthening this understanding will help continue to advance care for depression and offer patients the best treatment possible. Both components were able to successfully identify an aspect of medical care that needed improvement and provide information or tools with the potential to ameliorate the problem.