Thesis Project Portfolio

Quantitative ACL Tibial Guide: Improving Clinical Outcomes of ACL Reconstruction Surgery

(Technical Report)

Ideal ACL Treatment According to Post-Treatment Activities and Financial Capability

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

My technical research and STS research topics are closely tied to each other as they both aim to provide an improved solution to patients with anterior cruciate ligament (ACL) tear injuries. ACL reconstruction surgery is the most common treatment for these patients and is most commonly performed on young athletes due to their high prevalence of this injury. During the surgery, an ACL tibial guide is used to drill a bone tunnel across the tibia. Surgeons will then be able to replace the torn ACL with a graft tendon, which is usually taken from another part of the patient's knee or a human donor, through the bone tunnel. My technical research focuses on redesigning the ACL tibial guide by adding measuring and targeting components that allow for more consistent and accurate bone tunnel placement. My STS research aims to evaluate different treatment options and determine an optimal choice for patients by taking into account the cost of the treatment, the patient's socioeconomic status, and their planned activities post-surgery.

Project Summaries

The technical portion of my thesis produced a redesigned tibial guide with enhanced accuracy and consistency of bone tunnel placement during ACL reconstruction surgery. By creating a tibial guide with an adjustable targeting mechanism, we expect to improve clinical outcomes and increase the success rate of ACL reconstruction surgery. We implemented three specific aims to accomplish these goals. Measuring the total AP distance across the tibial plateau for each reconstruction surgery will allow us to better understand the surgical site and define the best tunnel location for each patient (Aim 1). The adjustable target arm will allow the surgeon to accurately position the tunnel location to the predetermined percentage of the AP distance without the variability of reliance on a landmark and surgical experience (Aim 2). Through iterative designs and testing, we expect to assemble a device that will produce consistent

measurements and tunnel placements (Aim 3). In total, we used computer aided design (CAD) software to design, and 3D printed three (3) prototypes for the project.

In my STS research, I found that the shortcomings of the current ACL reconstruction surgery methods cause significant financial strain to patients undergoing the treatment process. With the high incidence rate of 100,000 to 200,000 ACL tears per year and 11.5% chance of subsequent ACL injury, there is significance in finding the best treatment for patients of different socioeconomic backgrounds. The unreliability of current surgery methods is one main contribution to the low surgery success rate, which leads to the need for additional treatments post operation. With the newly designed ACL tibial guide from the technical portion of my thesis, patients can expect to reduce the needs of subsequent treatments. Research showed that ACL reconstruction is more cost-effective than non-operative treatments with merely rehabilitation. Considering the treatment cost and the patient's socioeconomic status, ACL reconstruction surgery is predominantly the best option for patients. This result is especially true if the patient is an athlete who wishes to return to their professional level of sport. The modifications on the current surgical tool are expected to make the ACL reconstruction surgery a more financially affordable option for patients with ACL injuries and to improve their treatment outcomes.

Conclusion

From both my technical and STS research projects, I learned that ACL tears occur a lot more commonly than I expected. For such a prevalent injury, it was a surprise to me to learn that the ACL reconstruction surgery has such a high failure rate, which again emphasizes the significance of my research projects. In the beginning of my STS project, I evaluated the financial impact of each treatment individually but failed to take into account the costs associated

with additional treatments post operation, including sometimes the need for a repeated surgery. My technical project aims to increase the accuracy and consistency of the current ACL reconstruction surgery methods, which is expected to reduce patients' need for further treatment after operation. This guided me to consider the opportunity cost of each treatment for my STS research evaluation. Overall, in both projects I not only learned in depth about the importance and impact of ACL injuries, but I also learned to think critically and to dive deeper into details that might not be obviously presented initially.

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