A Revised ACL Tibial Tunnel Guide for Improved Tunnel Placement During Reconstruction

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Background

Anterior Cruciate Ligament (ACL) injuries are among common in the US, with and annual incidence between 100K to 200K cases undergoing reconstruction surgery annually. The project was to design a tibial guide for ACL reconstruction surgery in order to reduce variability in the location of the drilled bone tunnels and improve postoperative knee stability and decrease reconstruction failure. Currently utilized guides are placed based on anatomical landmarks during arthroscopy; however, this yields inconsistent tunnel locations[1]. We aimed to create a guide design that utilizes pre operative imaging to allow for quantitative placement during reconstruction[2]. We created mechanisms to incorporate to this new ACL tibial while maintaining clinical usability of the device by comparison to current models, namely the Arthrex AR-1510T[3]. The main goal of this project was to create a device that would allow the surgeon to accurately replicate placement of the tibial tunnel based on the preoperative images at the 33-40% distance of the tibial plateau AP distance.

Methods

We utilized current ACL tibial guides to establish basic dimensions for the redesigned device. We then created 3D CAD models with additions that allowed for reliance on external landmarks. Based on the current practice of placement of the tibial tunnel guide through the anteromedial portal, we redesigned the device with additional adjustable braces to lay against the tibial tubercle and crest and allowed the guide to be placed through a transpatellar portal, which is often accessible thought the harvest of the patellar Bone tendon Bone ACL harvest. Measurements based off MRIs were determined to understand the excursion needed on the stoppers to accommodate variations in crest and tubercle morphology. We then tested these models in the dry lab and made additional adjustments to fit variability in anatomy and to allow for additional ease of use. The finalized proof was utilized in the dry lab and accuracy measuring the A to P distance of the guidewire exit point was assessed.

Results

Based on the 25 trials of simulated use on tibias, we were able establish our tunnel within .39mm of the calculated ideal distance from our pre-determined A to P dimension. This was simulated on both left and right knees, with the device meeting all parameters for adjustment for to accommodate anterior shin morphology.

Discussion

Based on the results from this project, we have established a device that predictably allow for accurate and objective placement of the tibial bone tunnel for ACL reconstruction. Tunnel malposition is the most common reason for revision surgery, and the device allows for placement tunnel based on the standard pre-operative knee X-rays with the exception of having a marker ball commonly utilized in arthroplasty present in the Xray for calibration. We met our goal from a design perspective with promising results for the next phase of testing in the wet lab, comparing this device against traditional testing of tibial tunnel placement based on internal anatomical landmarks. This may yield additional modifications from the design.