# The Development of the One-Handed Knee Aspiration Mechanism to Aid in Arthrocentesis

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### Abstract

Knee effusions are commonly encountered in Orthopeadic and Rheumatologic practices. These occur in multiple etiologies from septic joints, to post-operative effusions which can impair rehabilitation. Knee effusions require removal of the excess synovial fluid through arthrocentesis which can be diagnostic and therapeutic for patients. The current method of arthrocentesis is poses difficulties in when performed by a single user both for the clinician and discomfort for patients. Clinicians must use only one hand to retract the plunger of the syringe and a second hand to alternate between providing counter force to the retraction of the plunger and manipulating the fluid to an area within the knee, from which it can be accessed and withdrawn. In response, our research team proposed the creation of a novel medical device to simply the task, allowing for single handed retraction of the syringe while allowing dedication of the second hand to manipulating the knee. The device was designed to be retrofitted to a standard 60cc syringe. The device gripped in the users palm and the plunger retracted by sliding the thumb rearward, which articulated with an arm connected to the plunger of the syringe. This device development centered around various 3D printed models and allows for one-handed aspiration with ergonomic hand positioning. Several prototypes of the device were built before establishing a current design. The first iteration satisfied the requirement of one-handed control of the syringe; however, this design was bulky and difficult to use based on digit positioning. The second iteration transitioned to a skeletonized model, decreasing both cost of the design for production and bulk, but the design remained lacking from an ergonomics standpoint. Our current iteration was fully skeletonized while improving upon ergonomics, providing natural hand positioning and comfortable aspiration for a wider range of hand sizes. The efficacy of the mechanism was tested in a “dry run” setting where the mechanism was tested both with an empty syringe, and withdrawing fluid to simulate the resistance imparted by synovial fluid. In this study, the device achieved improved ease of use and comfort when compared to aspiration with the syringe only ($p=0.00024$, $p=0.00003$). Qualitative feedback also indicated general satisfaction with the mechanism when utilized in simulated practice. This device, we feel, is highly marketable to ease the awkward task of performing an arthrocentesis, adding little cost to the procedure based on the economical design materials and lends itself to a multitude of clinical environments, all while causing less discomfort to patients due to the stability it yeilds. Future work includes testing the device in a clinical setting, performing a subsequent iteration based on the feedback obtained from testing, obtaining a provisional patent for copyright protection and marketing the device to syringe manufacturing companies.