

Algorithmic LCL Pie-Crusting for Soft Tissue Balancing in Valgus Total Knee Arthroplasty

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INTRODUCTION: The valgus knee deformity results from imbalance in tension between medial and lateral soft tissue compartments (**Figure 1**). This deformity poses challenges when attempting to restore proper alignment during total knee arthroplasty (TKA). Many soft tissue release techniques have been described for addressing valgus deformity during TKA, but a lack of consensus on the optimal approach remains. The pie-crusting technique consists of performing a series of horizontal incisions in tight structures surrounding the knee, leading to progressive release and restoration of alignment. We hypothesize that pie-crusting of the LCL will allow for controlled lengthening of the lateral compartment of the knee without increasing instability.

METHODS: IRB approval was obtained. 10 fresh-frozen human cadaver knees were dissected leaving the femur and fibula connected by an isolated LCL with bone cuts made as performed during primary TKA. The specimens were preloaded with a tensile load of 2-5 Newtons (N) until the desired level of stretching was achieved. The LCL was tested with an 80N load. A 12-hole grid with 4mm x 3mm spacing between holes was devised and laid over the LCL. The LCL was released at the joint line with the pie-crusting technique using an 18-gauge needle (**Figure 2**). Two horizontal in-out perforations were made 3 mm apart. Length and stiffness of the LCL were collected after every 2 perforations for a total of 8 per knee. The measurements were averaged, and a regression analysis was performed.

RESULTS SECTION: A total of 6 cadaver knees were tested. Mean LCL length before pie-crusting was 4.188 ± 0.828 mm and the mean stiffness was 30.368 ± 5.755 N/mm. After 8 perforations, the mean LCL length increased to 4.733 ± 1.02 mm and the mean stiffness decreased to 25.8 ± 5.835 N/mm. These values were statistically significant ($p = 0.0318$ and $p = 0.0004$, respectively) (**Figure 3**). There were no LCL failures.

DISCUSSION: Pie-crusting of the LCL led to gradual lengthening and decreased stiffness as the number of perforations increased without sacrificing the integrity of the ligament. Several limitations exist within our study. The sample size was small with only 6 knees tested. The pre-existing alignment of the knees was unknown, making it difficult to assess the efficacy of this technique specifically on valgus deformed knees. Furthermore, pie-crusting of only the LCL differs from currently utilized techniques for soft tissue release during TKA. Ultimately, the proposed pie-crusting of the LCL may be useful in restoring knee alignment during TKA. The safety and simplicity inherent in the needle pie-crusting technique validate its routine application for addressing valgus deformities.

SIGNIFICANCE/CLINICAL RELEVANCE: (1-2 sentences): Our proposed technique may serve as a valuable piece in the soft tissue release toolkit when performing TKA on valgus deformed knees. It may also prove useful in widening the lateral joint space during arthroscopy, allowing for better visualization and increased workspace.

References: [1] Moorman CT III, LaPrade RF: Anatomy and biomechanics of the posterolateral corner of the knee. J Knee Surg 2005;18(2): 137-145.

IMAGES AND TABLES:

Figure 1. Valgus knee deformity and cadaveric knee specimen highlighting the LCL.¹ **Figure 2.** 3D printed template used to guide pie-crusting technique.

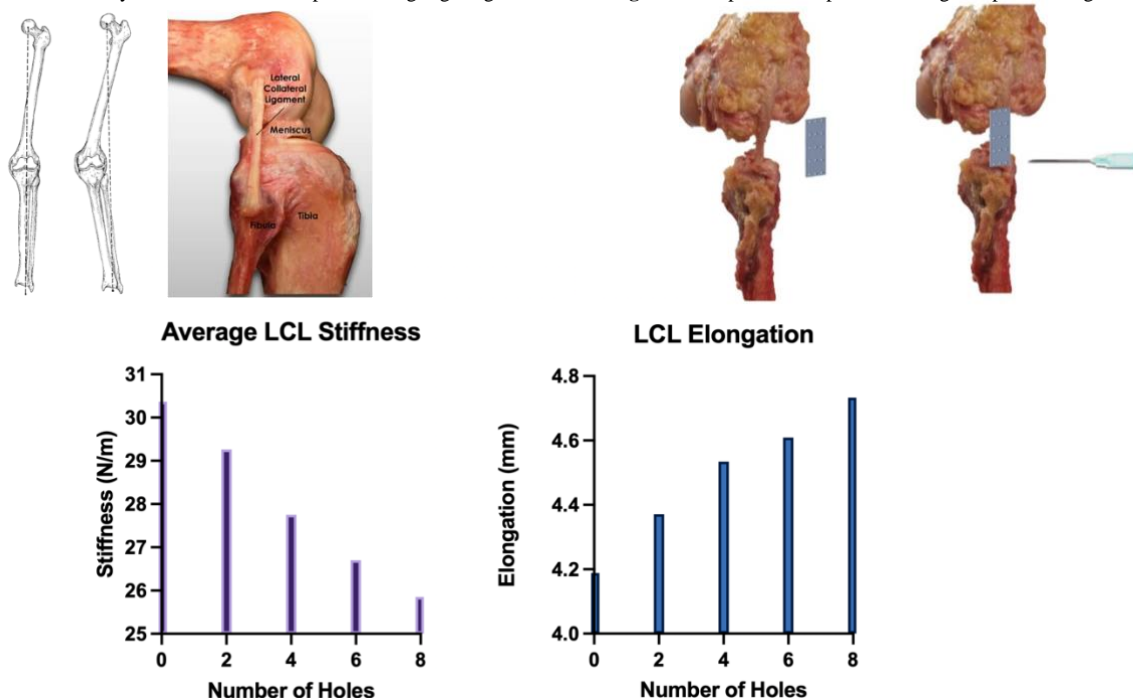


Figure 3: Mean LCL stiffness and elongation with progression of pie-crusting.