Soft-Tissue ACL Graft Study: A Comparison Study of Femoral Cross-Pin Fixation with Tibial Interference Screw vs.Tibial Cross-Pin Fixation with Femoral Interference Screw

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Introduction

The anterior cruciate ligament (ACL) in the knee is frequently torn in athletes, affecting up to 400,000 people every year (1). The success of ACL reparation surgery is related to sound initial biomechanical strength of fixation. There are many different fixation methods for soft tissue grafts. These include interference fixation, sutures over a post, and femoral cross-pin fixation. With current procedures, the tibial side interference screw has been shown to slip with the cross-pin fixation (2). The purpose of this study was to test two different hypotheses. First, we hypothesize that a tibial cross-pin performs as well as the clinically proven femoral cross-pin. Secondly, we hypothesize the interference screw will perform better on a femur than on a tibia. We designed a new surgical procedure to see whether it will exhibit superior strength and efficiency in comparison to the traditional, accepted practice that utilizes the femoral cross-pin fixation.

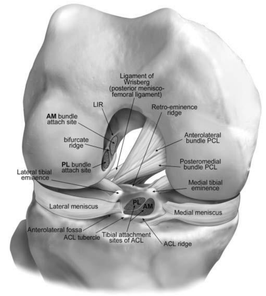

Figure 1

Methods

We performed a graft fixation procedure on porcine femur and tibia bones using bovine extensor digitorum communis tendons (Fig. 1). The specimens were divided into four groups, one for each combination of bone and TransFix cross-pin/soft-tissue interference screw. Once this was done, we tested the integrity of the graft using an apparatus to directly pull the graft parallel to the graft axis (Fig. 2). We then compared femoral vs. tibial fixation strength of the cross-pin and interference screw fixation, as well as the cross-pin vs. interference screw fixation in each bone.

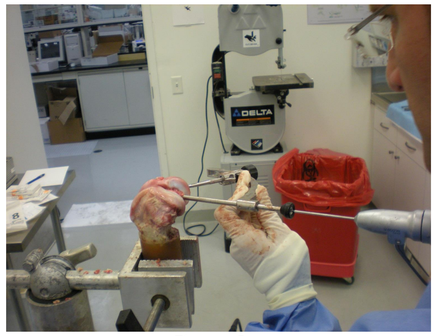

Figure 2

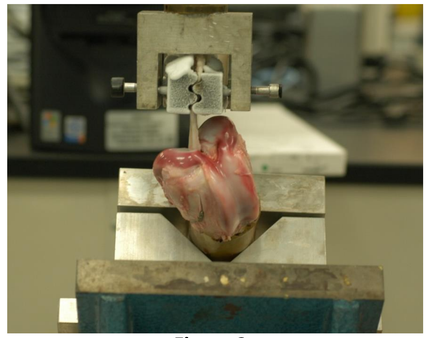

Figure 3

Results

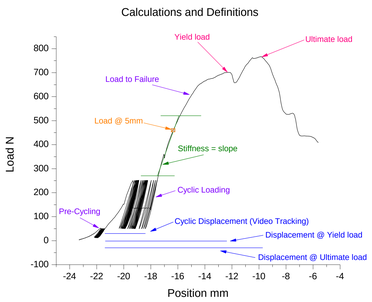

Figure 4

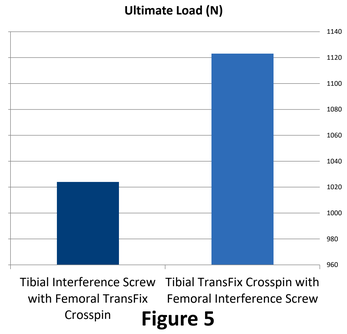

Figure 5

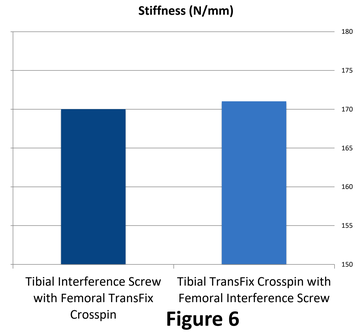

Figure 6

Results (cont.)

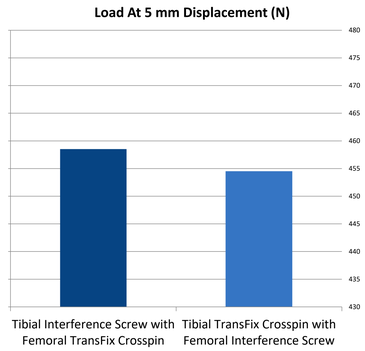

Figure 7

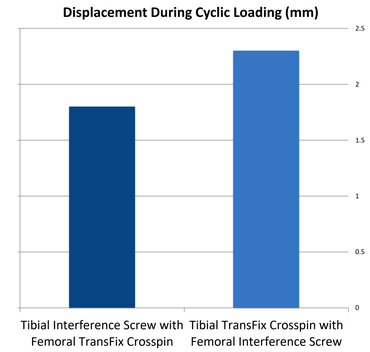

Figure 8

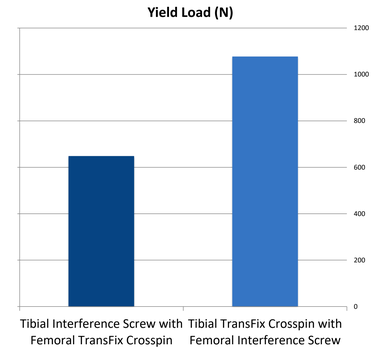

Figure 9

Conclusion

Changing the cross-pin to the tibia and interference screw to the femur can be considered advantageous according to our results. When considering yield load, the tibial cross-pin is better than the femoral cross-pin, the femoral interference screw is better than the tibial interference screw, the tibial cross-pin is better than the tibial interference screw, and there is no significant difference between the femoral cross-pin and the femoral interference screw. The yield load was also significantly higher with the combination of tibial cross-pin and femoral interference screw than with the traditional way of femoral cross-pin and tibial interference screw (Fig. 9). Regarding cyclic displacement and ultimate load, the femur is better than the tibia with both fixations, and the cross-pin is better than the interference screw. The femur has better bone quality compared to the tibia, especially in regards to the interference screw. The cross-pin proves to be stronger because the graft's looped end wraps around it while the cross-pin is embedded in bone. Due to the graft having both a looped and free end, both a cross-pin and an interference screw are necessary. Therefore, we recommend to have the interference screw in the femur and the cross-pin in the tibia based on biomechanical properties (Fig. 5 and Fig. 8).
In addition to the biomechanical advantages, there are also clinical advantages to a tibial cross-pin and femoral interference screw. Placing the cross-pin in the tibia is less invasive because it is relatively subcutaneous. This decreases the risk for painful prominent hardware on the tibia, and decreases the risk for deep infection of hardware and the graft at the tibial wound. Tibial cross-pin fixation also allows the surgeon additional benefits of all-epiphyseal fixation on the tibia in skeletally immature cases and increased ease in graft tensioning during final graft fixation because no additional hand is needed to manually reduce the tibia.
Using a tibial cross-pin and femoral interference screw is preferred to a femoral cross-pin and tibial interference screw for anterior cruciate ligament repair surgery.

References

(1) Haus BM, Mastrangelo AN, Murray MM. Effect of anterior cruciate healing on the uninjured ligament insertion site. *Journal of Orthopaedic Research*. 2011; 1-9.
(2) Weiler A, Richter M, Schmidmaier CMG, Kandziora F, Sudkamp NP. The EndoPearl device increases fixation strength and eliminates construct slippage of hamstring tendon grafts with interference screw fixation. *Arthroscopy*. 2001; 17: 353-359.

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