A Biomechanical Comparison of Fan-Folded, Single-Looped Fascia Lata with Other Allograft Tissues as a Suitable Substitute for Anterior Cruciate Ligament Reconstruction

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INTRODUCTION:

Allograft anterior cruciate ligament reconstruction has become increasingly popular over the past decade. Proponents of the use of allograft tissue cite numerous studies showing the clinical efficacy of this procedure with results equivalent to autograft tissue in most series. In addition, the use of allograft tissue obviates concerns about donor site morbidity that are associated with autograft harvest. With advances in soft tissue fixation techniques and devices, other allograft tissues such as Achilles and tibialis anterior tendon are being used with success as well. As the number of allograft anterior cruciate ligament reconstructions performed annually continues to increase, demand on tissue banks for allograft tissue is becoming a concern. As such, viable alternatives to traditional allograft tissue such as bone-patellar tendon-bone are necessary.

HYPOTHESIS:

The hypothesis of this study is that a single-loop construct of fan-folded fascia lata allograft tissue has initial biomechanical properties comparable to other allograft tissues currently used in anterior cruciate reconstruction.

METHODS:

Eighteen fascia lata specimens were harvested from 11 donors and fanfolded using a proprietary process. A sheet of fascia lata (typically 22 cm x 4 cm), harvested from the mid-thigh where tissue thickness is most uniform, was laid onto an accordion-like folding template. This facilitated the creation of a bundle of tissue 8-10 layers thick that was secured with sutures. Bone-patellar tendon-bone (BPTB), tibialis anterior, tibialis posterior, and peroneus longus tendons were harvested from four additional donors. All soft tissue grafts were tested to failure on an MTS machine in a single-looped / double stranded fashion after securing both ends in freeze grips, leaving 5 cm of unfrozen free length for tensile testing at 100% strain/sec. The bone plugs from BPTB grafts were similarly clamped in freeze grips. The ultimate load to failure and stiffness were calculated for each graft type tested.

RESULTS:

The mean ultimate load to failure was 3,266 N and stiffness was 414 N/mm for the double-stranded fascia lata grafts (n=18), with graft diameters ranging from 7 to 10 mm. There was no statistically significant difference for either ultimate load to failure or stiffness between the fascia lata and tibialis anterior (3012 N, 342 N/mm), tibialis posterior (3,666 N, 392 N/mm), and peroneus longus tendons (3,050 N, 346 N/mm). The fascia lata grafts performed significantly better than the tested BPTB grafts (1,404 N, 224 N/mm). Excluding the three 7 mm diameter fascia lata grafts from the analysis (using only 8-10 mm grafts which were more consistent with graft sizes of the other allograft tissues), the mean ultimate load to failure increased to 3,524 N and stiffness increased to 445 N/mm but this did not alter any of the statistical measurements.

Table 1: Comparing measures of allograft materials

Graft type	Average Diameter	Ultimate Load, in N		Stiffness, in N/mm	
	in mm	mean	SD	mean	SD
Fascia Lata	8.4	3,266	987	414	151
BPTB	10.0	1,403	511	224	71
Tibialis Anterior	9.0	3,012	794	343	97
Tibialis Posterior	9.9	3,666	782	391	27
Peroneus Longus	8.4	3,050	684	347	91

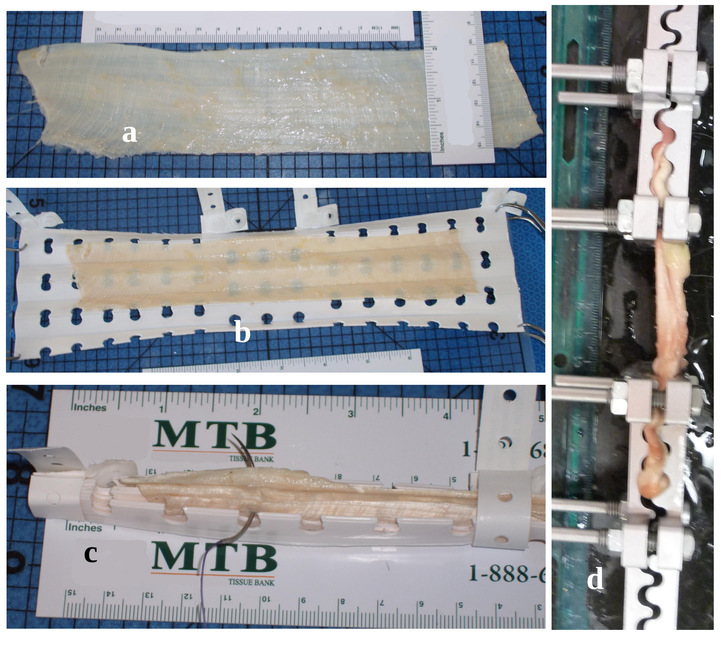

Figure 1 – Fascia lata material is cut to about 22 cm X 5 cm sheets, a, then fan folded into 8 layers, b, and then sutured, c. Specimens were held in freeze grips with 5 cm of free length for testing, d.

DISCUSSION & CONCLUSION:

Many factors ultimately contribute to the success or failure of an allograft reconstruction, including graft preparation at the time of surgery, tunnel placement, graft fixation, postoperative rehabilitation protocol, and allograft incorporation and remodeling. Despite this, laboratory values for ultimate tensile strength and stiffness provide at least an initial indicator of how an allograft might perform in vivo. The values for both ultimate tensile strength and stiffness of the fascia lata graft in this study compared favorably with the other graft tissues.

One in vivo theoretical advantage of the fascia lata construct is potentially the decreased time to biologic incorporation. Since allograft tissue incorporates from the periphery, it is conceivable that a graft construct with numerous pleats and a large exposed surface area would incorporate faster than a solid tubular graft. Another consideration is cost and availability of allograft tissue. BPTB allografts are generally more expensive than soft tissue tendon allografts. A sheet of fascia lata large enough to produce a double strand graft is typically less expensive than a tendon allograft. In addition, depending on the size of the donor, up to four fascia lata sheets of adequate size can be harvested from each donor We believe that the use of fascia lata is an economically viable and readily abundant alternative when selecting an allograft for ACL reconstruction.

This study does have several limitations with respect to the performance of the fascia lata graft. As this was an in vitro biomechanical study, no conclusions can be drawn as to performance with regard to pullout strength after fixation, potential elongation over time, biologic incorporation, or clinical function. In addition, all the grafts used in this study were tested immediately after thawing without any preloading or cycling. Finally, all grafts were fresh-frozen specimens without am further processing such as gamma irradiation or the use of sterilizing solutions, both of which may have an effect on tissue quality. Despite these factors, the single-loop double-strand fascia lata allograft has shown initial promise with biomechanical properties equal to or exceeding any other allograft tissue being used today. In addition, the relative abundance and low cost should make it an attractive alternative when selecting an allograft tissue for ACL reconstruction

ACKNOWLEDGMENTS & DISCLOSURES:
This work was supported in part by the Max Biedermann Institute for Biomechanics and the University of Miami Tissue Bank