

THE INFLUENCE OF DONOR FACTORS ON THE MECHANICAL PROPERTIES OF PRE-SHAPED BONE-PATELLAR TENDON-BONE ALLOGRAFTS

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INTRODUCTION

In 1963, Jones popularized an open reconstruction technique using the patellar tendon (Jones, 1963). Since then, ligament reconstruction has seen significant advances. The bone-patellar tendon-bone (BTB) graft has become the most commonly implanted graft for several reasons - ease of graft fixation using interference screws, accessibility of the patellar tendon for autograft recovery, and strength of the patellar tendon (Clancy, 1982; Kurosaka, 1987; Noyes, 1984).

Regeneration Technologies, Inc. has recently introduced a patellar tendon allograft that is pre-shaped to precise dimensions. This graft contains cylindrical bone plugs and pre-drilled suture holes that were designed to maximize biomechanical properties by optimizing the bone block geometry and its contact in the tunnel. The success of anterior cruciate ligament (ACL) reconstruction can hinge on many factors including the biomechanical properties of the graft. It is commonly reported in the literature that for most activities, the reconstructed (ACL) must withstand at least a 454N load (Noyes, 1984). The purpose of this study was to determine the effects of donor age and method of preservation on pre-shaped allograft BTB strength.

METHODS

All pre-shaped BTBs consisted of 2 pre-sized bone plugs, one from the proximal

tibia and the other from the patella. Each bone block was 10mm in diameter, 25–30 mm in length, and contained 2 drill holes to accommodate #5 braided suture. Each specimen was allowed to thaw to room temperature and then hydrated in saline prior to testing.

In this study, a total of 142 pre-shaped frozen allograft BTBs from 54 different donors 18-96 years of age, were tested. Table 1 shows the distribution of age and gender for the samples tested. In addition, a similar set of 21 rehydrated, freeze-dried, pre-shaped patellar tendons from 11 different donors, 24-62 years of age, were also tested.

Table 1: Age range and characteristics of the pre-shaped BTBs tested in this study.

Age Range	Total BTBs	Males	Females
<35 years	22	5	3
36-50	27	8	1
51-65	21	6	2
66-75	23	5	4
76-85	39	11	4
86+	10	4	1
Freeze-dried	21	9	2

Specimens were tested on an MTS Bionix 858 serohydraulic mechanical test apparatus using a custom collet system. The collet assembly was chosen to reproduce a clinically applicable “interference” fit. Each specimen was tested with a load cell calibrated to $\pm 2500\text{N}$. Initially a pre-conditioning cycle was run between 10 and 250N in load control at a rate of 0.5 Hz for 5

cycles. The BTB was then tested to failure in displacement control at a rate of 50 mm/min. For each test, the maximum load and mode of failure was recorded. Stiffness of the allograft was calculated from the linear portion (between 10 and 250N) of the load displacement curve.

The types of failure were defined to be: (a) failure of the patellar bone by visual evidence of a cracked bone block, (b) failure of the tibial bone by visual evidence of a cracked bone block, (c) failure of the tendon (either tearing off the bone block or rupture between the bone blocks), or (e) slippage from the collet. The data was analyzed within each age interval by ANOVA and Newman-Keuls multiple comparison test. A significant difference was defined by $p < 0.05$.

RESULTS AND DISCUSSION

Donors younger than 35 years were found to carry significantly higher load and have significantly higher stiffness than all the other age groups. No significant difference in stiffness was observed among the rest of the age groups. BTBs from donors 36-50 and 51-65 years had insignificant difference in load. BTBs from the three age groups older than 65 were identified to be similar but carried significantly less load than the younger age groups.

With the exception of one age group, most failures occurred in the tendon. In the 76-85 year old age group however, the failures were equally distributed between the patellar bone block, tibial bone block, and the tendon. Tendon failure appeared to initiate at the attachment of the bone block, the tendon was never observed to rupture between the bone blocks. There was no significant effect of freeze-drying and/or rehydration on the strength or stiffness.

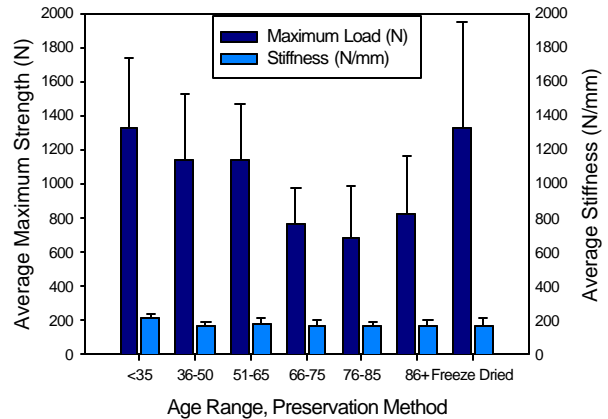


Figure 1: Average maximum strength (N) and Average Stiffness (N/mm) of the pre-shaped BTBs as a function of age and preservation method.

SUMMARY

The data indicates that freeze-drying and rehydration do not significantly reduce the tensile load of the BTB. Pre-shaped BTBs from donors younger than 35 years were found to carry significantly higher load than all other age groups, and BTBs in the age groups older than 65 carried significantly lower loads than the younger age groups. However, the 95% confidence interval for pre-shaped BTBs across all age ranges falls above the clinically recommended strength (450N) of ACL reconstruction materials.

REFERENCES

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