# Drop Vertical Testing after Quadriceps, Hamstring, and Bone-Patellar Tendon-Bone Autografts in Anterior Cruciate Ligament Reconstruction in Adolescent Athletes

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INTRODUCTION: Historically**,** hamstring and bone-patellar tendon-bone grafts have been used in the majority of anterior cruciate ligament autograft reconstructions (ACLRs). Over the past few years, there has been an increased interest in the use of the quadriceps tendon autograft, with recent literature suggesting biomechanical and clinical advantages. However, there is little evidence related to performance during gait lab-based functional testing and seldom has the quadriceps autograft been directly compared to the hamstring and bone-patellar tendon-bone autograft in this setting. The purpose of this retrospective chart review is to compare the functional outcomes as measured by three-dimensional motion analysis during the drop vertical test between quadriceps autograft with bone block (QB), quadriceps autograft without bone block (Q), hamstring autograft (HS), and bone-patellar tendon-bone (BTB) at six months postoperatively in an adolescent population.

METHODS:

This IRB-approved retrospective chart review included patients aged 8-18 who underwent ACLR at our institution. Patients with previous ipsilateral knee surgery were excluded. The data collected for this study included kinematic and kinetic data during the drop vertical test in a formal gait lab using a computerized video-based system (Motion Analysis Corp. CORTEX software). The Kruskal Wallis test and subsequent pairwise comparisons were carried out for each studied parameter.

RESULTS:

We had a total of 54, 40, 35, and 26 patients in HS, QB, Q, and BTB groups respectively. There were no significant differences in terms of age, height, weight, or body mass index between the groups. Athletes in this study were from a variety of competitive sports including soccer (37), basketball (34), and American football (30). The QB group had smaller knee extension moments maximums (-0.97 N/kg vs. -0.35 N/kg, $p = 0.0323$) and smaller knee extension moment averages (-0.12 vs. -0.03, $p = 0.265$) as compared to the HS group. Analysis of the remaining primary outcomes revealed no difference in transverse plane hip power, hip internal rotation moments, or knee valgus angles between any of the groups.

Analysis of secondary outcomes revealed that the QB group demonstrated lower hip abduction moments (0.04 N*m/kg vs. 0.30 N*m/kg, $p = 0.0426$) and larger knee external rotation moments (0.02 N*m/kg vs -0.02 N*m/kg, $p = 0.0206$) as compared to the HS group. The Q group demonstrated smaller knee extension moments (-0.13 N*m/kg vs. -0.03 N*m/kg, $p = 0.459$) and smaller knee valgus angles (-0.35° vs 0.28°, $p = 0.0254$) as compared to the HS group. No other secondary outcomes were statistically significant between any of the groups.

DISCUSSION AND CONCLUSION:

The quadriceps autograft with bone block may be associated with smaller knee extension moments, decreased hip abduction moments, and larger external rotation moments than the hamstring graft where as the quadriceps autograft without bone block may be associated with smaller knee extension moments and smaller knee valgus angles.[1] With regards to the remaining established biomechanical parameters associated with return-to-sport and failure (primary outcomes), the four graft types studied appeared to be equivalent. However, our study did demonstrate smaller hip abduction moments and increased knee external rotation moments in the QB graft when compared to the HS, which have been shown to play a role in first-time ACL injury risk. Further clinical studies may be useful in demonstrating whether these biomechanical outcomes are associated with reinjury rates.

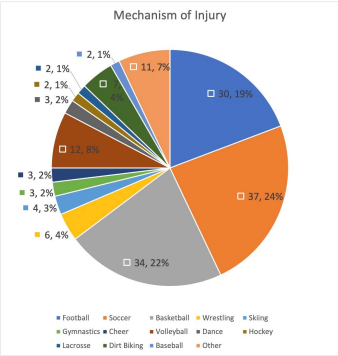


**Figure 1**: A depiction of the mechanism of injuries in our population of 156 adolescent patients. The 'Other' category consisted of: one track and field injury, one taek wondo injury, one jiu jitsu injury, two flag football injuries, one roller skating injury, one kickball injury, one injury while playing tag, one injury while jumping on a trampoline, and one softball injury.

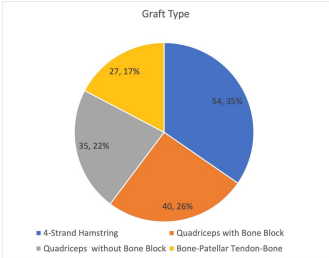


**Figure 2**: A schematic of the graft choice in our population of 156 adolescent patients undergoing ACL-R.