VALGUS LOADING CAUSES INCREASED IN VITRO ACL STRAIN IN SIMULATED JUMP LANDING

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INTRODUCTION
Anterior cruciate ligament (ACL) injury has been associated with abrupt deceleration while running, cutting or landing.

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Anterior cruciate ligament (ACL) injury has been associated with abrupt deceleration while running, cutting or landing. Videotape analyses of these injuries has implicated valgus configuration of the lower extremity as a potential injury risk factor. The previous experimental studies that have examined this injury mechanism have done so using sub-physiologic loading magnitudes and rates.

METHODS
Ten fresh cadaveric limbs were studied [mean (SD): 70.3 (15.4) years; 4 males; 6 females; ages 45 to 89]. Specimens were cut 15 cm proximal and distal to the knee joint and potted using polymethylmethacrylate. A testing apparatus was constructed to simulate the position of a single extremity as it strikes the ground while landing from a jump or during a run/stop maneuver (Figure 1). Pre-impact muscle precontractions of the quadriceps, medial and lateral hamstrings, and medial and lateral gastrocnemius muscle-equivalents were achieved by pretensioning 7 kN/mm springs across all specimens, while the mean (SD) ACL strain when loaded by a ‘Flexion only’ impact moment was 1.00 (0.32). The pretensioned muscle-equivalent springs gave an immediate rise in tension upon stretch, similar to a lengthening contraction condition in vivo. Any test order effect that may have been present was minimal because there was no significant difference in the peak strains measured under the two ‘Flexion only’ conditions.

RESULTS AND DISCUSSION
The mean (SD) peak impact force rose to 1,670 (390) N over a 30 ms time course, thus confirming the physiologic nature of the test. The impact forces did not differ between the ‘Valgus + Flexion’ and ‘Flexion only’ tests [1,620 (390) vs. 1,790 (380) N, respectively]. The mean (SD) relative strain during the ‘Valgus + Flexion’ loading was 4.3 (2.7%), whereas the corresponding ACL strain measured 3.5 (2.8%) during the ‘Flexion only’ moment impact. Thus, we rejected the null hypothesis because the peak normalized relative ACL strain in the Valgus + Flexion configuration was significantly higher than that in both the initial ‘Flexion only’ configuration (p=0.04) and final ‘Flexion only’ (p=0.02) conditions. Mean (SD) peak normalized ACL strain when the joint was loaded in ‘Valgus + Flexion’ was 1.28 (0.38) [non-dimensional units] across all specimens, while the mean (SD) ACL strain when loaded by a ‘Flexion only’ impact moment was 1.00 (0.32). The pretensioned muscle-equivalent springs gave an immediate rise in tension upon stretch, similar to a lengthening contraction condition in vivo. Any test order effect that may have been present was minimal because there was no significant difference in the peak strains measured under the two ‘Flexion only’ conditions.

CONCLUSIONS
In the slightly flexed knee, preloaded by quadriceps, hamstring and gastrocnemius muscle forces, relative ACL strain was significantly higher under a valgus + flexion impact loading than under a flexion-only impact loading.

REFERENCES

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