INTRODUCTION

Knee hyperextension, an underrepresented and insidious condition mainly seen in women [1-4], can contribute to abnormal accumulated knee stressors resulting in pathology. Movement of the knee into hyperextension of more than five degrees, is associated with a ground reaction force vector that acts anterior to the knee joint[5]. The anterior location of the ground reaction force vector places increased contact stress on the tibiofemoral cartilage [6] and considerable tension stress on the passive restraining structures that resist further knee extension (e.g. posterior knee capsule and Anterior Cruciate Ligament)[5]. Chronic hyperextension may stress connective tissues resulting in adaptive lengthening of the structures that resist knee hyperextension and consequently contribute to a more unstable joint. The purpose of this study was to investigate joint laxity in women with and without knee hyperextension. We hypothesized that knee laxity, measured by the anterior displacements at specific loadings and the stiffness changes in the knee joint, were different among women with and without hyperextension.

METHODS

Healthy female, 18-39 years of age, with and without knee hyperextension greater than 5° at rest were invited to participate. Participants were screened for: knee extension passive range of motion (PROM); lower limb muscular strength; and general joint laxity using the Beighton and Horan Joint Mobility Index (BHJMI). To determine leg dominance, participants were instructed to kick a ball. The knee ligament arthrometer KT-2000 (MedMetric Co., San Diego, CA, USA) was used to evaluate knee laxity by measuring anterior displacement of the knee joint. Participants were placed in a supine position. KT-2000 device was placed on participant’s lower leg and knee was positioned in 30° of flexion. EMG electrodes were attached to selected lower limb muscles to ensure participant’s complete relaxation during the KT-2000 testing. Three successful trials of laxity were obtained to calculate the mean value of anterior displacement bilaterally. Data was collected on knee joint laxity in anterior direction applying 45, 67, 89, and 134 N. The applied force and corresponding displacement data were continuously recorded into a computer via an acquisition card (DaqCard 216b, IOtech, USA) at 1,000 Hz. Intra and inter-session tester reliability was determined (ICC=0.9) prior to data collection.

The recorded force and displacement output data were analyzed using Excel to identify the anterior displacement in millimeters (mm) at each load for further analysis. Stiffness was defined as the ratio of the force to the displacement. The initial stiffness was the stiffness calculated in the initial loading phase (45-67N) and the terminal stiffness was in the terminal loading phase (89-134N). All statistical testing was performed using SAS 9.3 (SAS Institute Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

Figure 1: The dominant leg of women with hyperextension showed greater displacement.
Twenty two healthy women: twelve women (mean + SD age, 20.4 ± 2; mass, 59 ± 6 kg; height, 1.6 ± 0.1 m) with knee hyperextension greater than five degrees at PROM and ten women (mean + SD age, 21 ± 3; mass, 59.3 ± 10 kg; height, 1.7 ± 0.1 m) took part in this study. Mean + SD knee passive range of motion was 8.5º± 1.7º (range 6º to 11º) and 3.4º± 1.5º (range 0º to 5º) in women with and without knee hyperextension, respectively.

The results of this study showed that the dominant side of the hyperextension group had significant greater anterior displacement that that of the no-hyperextension group (p< 0.05) (Figure 1). No significant difference was found in the non-dominant side. Pearson correlation coefficients (Figure 2) showed a moderate correlation between the degree of knee extension at PROM and anterior displacement. The dominant side of the hyperextension group had significantly smaller initial stiffness than that of the non-hyperextension group (Figure 3).

**Figure 2:** There was a weak correlation between PROM and anterior displacement in the dominant leg across in both groups.

**CONCLUSIONS**

The results of this study seem to indicate that knee hyperextension places the posterior capsule of the knee joint and Anterior Cruciate Ligament under considerable tension stress. Chronic knee hyperextension may stress connective tissues resulting in adaptive lengthening of the structures that resist knee hyperextension and consequently contribute to a more unstable joint. These findings may explain why hyperextension knees are at greater risk of injury. Further investigation on knee mechanics in women with knee hyperextension should be performed.

**Figure 3:** The dominant leg of women with hyperextension had significantly smaller initial stiffness.

**REFERENCES**