INTRODUCTION

The one leg squat and wall squat exercises are used in both athletic training and during knee rehabilitation programs. However, it is currently unknown how patellofemoral forces and stresses change among one leg and wall squat exercises and knee angles. The purpose of this study was to compare patellofemoral forces and stresses as a function of these squat exercises and knee angles. It was hypothesized that patellofemoral forces and stresses would increase as knee flexion increased and would be greater in the wall squat short (feet closer to wall) compared to the wall squat long (feet further from wall) and the one leg squat.

METHODS

Eighteen subjects (9 males and 9 females) were used with an average age, mass, and height of 29±7 y, 77±9 kg, & 177±6 cm for males and 25±2 y, 60±4 kg, & 164±6 cm for females. Each subject performed the wall squat long (knees over ankles at the bottom position) and the wall squat short (knees beyond toes at bottom position). A one leg squat was also performed. Intensity was normalized for each exercise by having each subject their 12 repetition maximum intensity, which were 55±9 kg for males and 36±9 kg for females for the wall squat and 15±3 kg for males and 10±3 kg for females for the one leg squat. Surface electrodes were placed over the vasti muscles, rectus femoris, medial and lateral hamstrings, and gastrocnemius. Reflective markers were positioned over landmarks on the foot, ankle, knee, hip, and shoulder.

Patellofemoral forces & stresses were calculated using a biomechanical knee model (Zheng et al., 1998; Salsich et al., 2003) with input variables consisting of resultant knee forces and moments, patellofemoral contact areas, and the muscle force function $F_m(i) = k_i A_i \sigma_{m(i)} [EMG_i/MVIC_i]$, where $k_i$ was a muscle force-length variable, $A_i$ was physiological cross sectional area (PCSA) per muscle, $\sigma_{m(i)}$ was MVIC force per unit PCSA, EMG_i and MVIC_i were EMG window averages, and $c_i$ was a weight factor adjusted in a computer optimization program. Patellofemoral forces and stresses as a function of exercise and knee angle were assessed by a two-way repeated measures analysis of variance (p < 0.05).

RESULTS AND DISCUSSION

Patellofemoral forces and stresses are shown in Figures 1 and 2. Both patellofemoral forces and stresses increased progressively as knee flexion increased. Both patellofemoral forces and stresses were significantly greater in the one leg squat compared to the wall squat short between 50-90° of the descent, while both the wall squat short and long were significantly greater than the one leg squat between 50-90° of the ascent.

SUMMARY/CONCLUSIONS

Performing variations of the squat exercise does affect the magnitude of patellofemoral forces and stresses during both the descent and ascent.
phases. In addition, both forces and stresses increased with knee flexion.

REFERENCES
Salsich et al. (2003), *Clinical Orthopaedics*, 417, 277-284.

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Figure 1. Mean (SD) patellofemoral compressive force during the one leg squat and the wall squat.

Figure 2. Mean (SD) patellofemoral stress during the one leg squat and the wall squat.