Are static and dynamic squatting activities comparable?

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Introduction

3D kinematics, 3D kinetics, and EMG of the lower limb have been extensively analyzed during squatting activities. Various squatting conditions were studied: static squatting positions (Julot, 2005) and dynamic squatting movements (Moro-oka, 2008).

But are static and dynamic squatting activities comparable?

Two studies have compared 3D kinematics of the knee during static and dynamic squatting activities, but their findings are inconsistent. D’Entremont et al. (2002) analyzed squatting conditions in supine position, and Ma et al. (2011) compared two different groups of subjects. Moreover, dynamic activities were conducted at low speeds (1°/s IV/s) and no information was available on kinetics or EMG.

The purpose of this study was to compare simultaneous recording of 3D kinematics, 3D kinetics and EMG of the lower limb during static and dynamic squats.

Materials and methods

Ten subjects were recruited: 5 women, 5 men, 51±17 years, 170±11 cm, 83±4±18.5 kg, 5 healthy subjects, and 5 OA subjects.

3D knee kinematics was recorded with the KnoKEM™ (Emovi Inc, Laval, QC, Canada) (Fig. 1C–D) and 12 optoelectronic cameras (VICON, Oxford, UK, 200 Hz) (Fig. 1F).

3D kinetics, i.e. forces, torques, and center of pressure, was recorded with a force plate (AMTI, Watertown, MA, USA, 2000 Hz) (Fig. 1B).

EMG activity of lower limb was recorded with surface electrodes placed on 8 muscles (Dolys Inc., Boston, MA, USA, 2000 Hz) (Fig. 1E).

Static squat: 5 positions of knee flexion (0°-70°) for 5 s.

Fast dynamic squats: as many cycles (0°-70°-0°) as possible in 10 s.

Standardization: positioning in jiff and foot wedges (Fig. 1A).

Comparison: the 5 positions where static and dynamic flexion angles were similar.

Statistics: Wilcoxon signed-rank test (p=0.05).

Results

Mean knee flexion angles achieved during static squats were 3.0±7.2°, 57.1±19.2°, 46.6±18.5°, 55.2±16.6°, and 71.8±10.6°.

Mean knee flexion speed achieved during fast dynamic squats was 57.3±17.5°/s (4 full cycles).

Data acquired on one healthy subject during static and fast dynamic squats are shown in Fig. 2.

![Image](image_url)

Figure 2: Black curves show evolution of knee flexion in statics (A), knee internal–external rotation (B), vertical ground reaction force (C), and vastus medialis EMG activity (D) during fast dynamic squat of one healthy subject (41 years, 183 cm, 72 kg).

The squares, diamonds, triangles, crosses, and circles represent the 5 knee flexion angles achieved during static squats. Dashed and dotted grey lines define the flexion and extension phases of the fast dynamic squats.

Mean internal tibial rotation was 1.3±3.6° during the static squat and 1.8±3.7° during the fast dynamic squats (Fig. 3). A significant difference (p=0.049) was found at 37.1° of knee flexion (Fig. 3).

Mean anterior tibial translation was 7.8±4.4 mm during the static squat and 5.1±5.4 mm during the fast dynamic squats (Fig. 4). A significant difference (p=0.049) was found at 30° of knee flexion (Fig. 4).

![Image](image_url)

Figure 3: Mean internal tibial rotation during static and fast dynamic squats (SD). Black squares represent static data and grey rounds data. Black stars indicate significant differences (p<0.05).

The EMG activities of the 8 muscles recorded during the static squat were less than those recorded during the fast dynamic squats, and several differences were significant (Fig. 6). Differences between static and dynamic EMG activities represented 10.0±5.7% of the dynamic data.

![Image](image_url)

Figure 4: Mean anterior tibial translation during static and fast dynamic squats (SD). Black squares represent static data and grey rounds data. Black stars indicate significant differences (p<0.05).

Mean absolute differences between static and fast dynamic squats were 1.5±1.3° for rotations, 1.9±2.1 mm for translations, 17.5±24.9 N for forces, 6.6±1.9 Nm for torques, 11.2±10.5 mm for center of pressure, and 7.6±1.8 µV for the EMG activities. 68.6% of the compared data were equivalent.

Conclusions

This study show for the first time that static and fast dynamic squats are comparable in terms of 3D kinematics, 3D kinetics, and EMG of the lower limb. Few significant differences were found, and they remain small.

Kinematic differences correspond to those found by Mu et al. (2011).

Studies investigating static and dynamic squatting activities can be considered with equal confidence because they produce the same kind of results, if realized in similar conditions.

References


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Further information

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