55 Use of body worn sensors to predict ankle injuries using screening tools

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51 LATERAL ANKLE COMPLEX RESPONSE TO REPEATED MECHANICAL LAXITY ASSESSMENT

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Background Tissue response to repeated loading of the lateral ankle during arthrometer testing is unknown, and may be affected by number of trials and rate of loading.
Objective To determine tissue response changes from repeated anterior displacement testing in those with and without chronic ankle instability (CAI).
Design Cross-Sectional.
Setting Biomechanics laboratory.
Participants Of 53 volunteers; 36 recreationally active individuals participated (17 males, 19 females; age = 21.9 ± 2.7 years, body mass = 67.2 ± 12.5 kg, height = 168.8 ± 10.4 cm). Eighteen participants were designated as CAI and reported repeated sprains and Cumberland Ankle Instability Tool (CAIT) scores ≤24; 18 controls reported no ankle sprains with CAIT scores ≥ 28.
Interventions Three trials of anterior displacement to 150 N (LigMaster, version 1.26, Sport Tech, Inc., Charlottesville, VA, USA) were applied, then unloaded past 0 N until displacement was measured at 0 mm.
Main outcome measurements Displacement from 0 mm at 0 N during unloading and rate of unloading were determined for each trial. Repeated measures ANOVA and post-hoc comparisons were used to determine differences in unloading rates and displacement across 3 trials for each group and across all participants.
Results Rate of unloading was not significantly different across trials ($p > 0.05$), nor was displacement across 3 trials between controls (5.4 ± 4.2 mm) and CAI (6.0 ± 4.2 mm) individuals ($p = 0.87$, $\eta_p^2 = 0.0$). Across all participants, the displacement of trial 1 (6.7 ± 3.4 mm) was significantly greater than trial 3 (4.7 ± 2.5 mm, $p = 0.001$, $\eta_p^2 = 0.17$).
Conclusions The significant difference between trials 1 and 3, but not between successive trials, may indicate fluid removal from the ligament over repeated trials, allowing for the isolation of the collagen matrix. The influence of repeated loading and unloading should be considered in arthrometer assessment, as the number of trials explained only 17% of the variance. Further research is needed to determine the optimal number of pre-conditioning cycles for a stable tissue response.

52 THE ASSOCIATION BETWEEN FACTORS FROM ANAMNESIS AND PHYSICAL EXAMINATION AND EARLY SIGNS OF OSTEOARTHRITIS IN PATIENTS WITH PERSISTENT SYMPTOMS AFTER AN ANKLE SPRAIN: A CROSS-SECTIONAL STUDY IN GENERAL PRACTICE

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Background Structural abnormalities on MRI are frequently found after a lateral ankle sprain.
Objective To determine the possible associations between patient's history, physical examination and early signs of osteoarthritis in patients with a previous ankle sprain.
Design Cross-sectional.
Setting General practice.
Patients Ninety-eight patients who consulted their general practitioner, 6 to 12 months prior to inclusion, with a lateral ankle sprain and reported persistent complaints were selected for the present study. Of these, 94 patients underwent a physical examination and MRI and were included for the present study.
Assessment of risk factors A standardised questionnaire and a standardised physical examination, including the assessment of swelling, hind foot position, range of motion, anterior drawer test and talar tilt test, were applied. All patients underwent a MRI.
Main outcome measurements On MRI the presence of osteochondral lesions, cartilage loss, bone oedema and any sign of osteoarthritis were scored by a radiologist. Univariate and multivariate analyses were used to test the association between patients' history and anamnesis and early signs of osteoarthritis as seen on MRI.
Results Cartilage loss in the talonavicular joint (17.3%); osteochondral lesions (6.1%) and bone oedema in the talocrural joint (25.%) and early signs of osteoarthritis (48%) were found on MRI. Multivariable analyses showed that pain at the end stage of dorsiflexion or plantar flexion was associated with cartilage loss in the talonavicular joint (with OR 0.56; 95% CI 0.13–2.43). No other significant associations were found.
Conclusions We found only one significant association between patient related factors from history taking and physical examination and early signs of osteoarthritis in patients with persistent complaints after a lateral ankle sprain. More studies with enough power are needed to investigate the association between potential predictors and the detection of early osteoarthritis after a lateral ankle sprain.

53 USING INERTIAL SENSORS TO QUANTIFY EXERCISE PERFORMANCE IN ANKLE REHABILITATION: A CASE REPORT

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Background Neuromuscular training programmes have demonstrated success in the rehabilitation of ankle joint injuries, as well having proven success in reducing the risk of injury recurrence. However athlete motivation to do these exercises can be poor, with many athletes performing their exercises incorrectly when they are not supervised by their trainer/therapist.
Objective The objective of this study was to investigate whether inertial sensors on the leg can be used to track exercise performance, and therefore be used to provide feedback on exercise performance.
Design A single case study.
Setting University research laboratory.
Participants A healthy (no injuries/conditions that would affect postural stability/proprioception) adult male (age = 25 years, body mass = 75 kg, height = 189 cm) participated in this study.
Assessment The participant performed ten repetitions of a single leg squat exercise (SLS). Skeleton and video data were recorded using a Microsoft Kinect for post-labelling of exercise

performance. An inertial sensor (Shimmer, Dublin, Ireland) was secured to the participant's left shank. The sensor contained a tri-axial accelerometer, gyroscope and magnetometer sampling at 51.2 Hz.

Main outcome measurements The following signals were obtained from the sensor during the SLS; acceleration magnitude, pitch, roll and yaw. The skeleton and video data were labelled by a physiotherapist. The sensor signals were then inspected to determine if the various labels of SLS performance could be discriminated.

Results The following sensors signals from the left shank can discriminate between the various labels of SLS performance; Acceleration magnitude, roll, pitch and accelerometer Z.

Conclusions This preliminary analysis reveals that variations in SLS performance, which may indicate poor neuromuscular control of the ankle joint can be identified with an inertial sensors on the shin. While the results of this case study are encouraging further quantitative analyses of the data are required.

54 INVESTIGATING NORMAL DAY TO DAY VARIATIONS IN POSTURAL CONTROL IN A HEALTHY YOUNG POPULATION (AGE 18–40) USING WII BALANCE BOARDS

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Background Objective measurements of postural control are frequently used to examine the causes of, features associated with, and therapeutic interventions for ankle instability. However, researchers have typically used single-session measures to represent postural control at one point in time. Recent studies in a healthy elderly population demonstrated significant variations in day-to-day postural control and suggest that single-session measurement may not truly reflect postural control. We need to investigate patterns of day-to-day variation in postural control in a younger population, the typical age profile included in ankle instability studies.

Objective Investigate the variations between continuous day-to-day clinical measurements of postural control within subjects, and the associations between once-off and continuous daily measurements, in a healthy young population. It was hypothesised that variations exist and a once-off clinical measure may not be representative of an individual's true postural control.

Design Observational longitudinal cohort study.

Setting University motion capture laboratory.

Participants 24 healthy young adults (9 female, 15 male) aged 18–40 years.

Independent variables Age, time of day (08:00–10:00), duration (40 s) and testing condition (eyes-open versus eyes-closed).

Main outcome measurements Lifestyle questionnaire and 40 s eyes-open/eyes-closed static Wii Balance Board balance tests, on 20 consecutive weekdays

Results Coefficient of variation demonstrated substantial inter-subject differences from 10–131% (eyes-open) and 10–112% (eyes-closed) across variables. Minimal detectable change percentage showed that 22/30 parameters demonstrated acceptable measurement error (<30%). Across mean COP distance, mean sway length, mean sway frequency and sway area, 16/24 (eyes-open) and 11/24 participants (eyes-closed) exhibited statistically significant differences ($p < 0.05$) between the once-off and the daily measures.

Conclusion Variations in postural control exist in a healthy young population. Depending on testing conditions and specific variables, a once-off measure is not indicative of an individual's true functional state. Therefore, when investigating subtle changes in postural control, long-term monitoring proves to be a superior assessment tool.

55 USE OF BODY WORN SENSORS TO PREDICT ANKLE INJURIES USING SCREENING TOOLS

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Background The Single Leg Squat (SLS) is an important screening tool in predicting those at an increased risk of ankle injuries as it relates to landing, running and cutting tasks. However, clinical analysis of this exercise is often completed visually with relatively poor intra-rater reliability. More detailed analysis of SLS completed in biomechanics laboratories is time-consuming and costly. Recent developments in body worn sensors may allow for quick assessments that produce valid and reliable data.

Objective To explore a model for leveraging data obtained from wearable sensors to aid in ankle injury risk factor screening.

Design A single case study design, with qualitative analysis of quantitative data.

Setting University research laboratory.

Participants A single participant (female, age = 24 years; height = 158 cm, body mass = 47 kg) was chosen. The participant was familiar with the SLS exercise and had completed it as part of their exercise routine for the past year.

Interventions The participant completed 10 left SLS repetitions. These were recorded using the sensors and repetitions where the participant lost balance were noted. Loss of balance was defined as when the subject was unable to maintain single leg stance during the downward or upward phase of the movement and placed their other foot on the ground for support.

Main outcome measurements Visual analysis showed signals from the wearable sensors (accelerometer Y and gyroscope Z) were altered when the participant lost their balance compared to signals obtained when the participant maintained balance.

Conclusions These preliminary results indicate that body worn sensors may be able to automatize screening tools such as the SLS. An automated system for characterising and quantifying deviations from good form could be developed to aid clinicians and researchers. Such a system would provide objective and reliable data to clinicians and allow researchers to analyse movements quicker and in a more naturalistic setting.

56 PEAK PLANTAR PRESSURES DURING WALKING IN CHRONIC ANKLE INSTABILITY AND HEALTHY PATIENTS

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Background Due to the prevalence of ankle instability in active individuals, it is important to understand what characteristics patients with ankle instability exhibit during dynamic tasks.