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Wearable Sensor-Based classification of ACL reconstructed limbs during exercise in male & female patients.

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Purpose: Early identification of subtle, sub-clinical, aberrant motion characteristics in patients with ACL reconstructed knees can inform rehabilitation and return to sports decision making. Wearable sensors enable characterization of movement in native sport and activity environment. The purpose of the study was the ability of a machine learning algorithm to accurately classify male and female participants' reconstructed limb from the contralateral healthy limb using inter-limb movement variability from sensor data during walking and jogging.

Methods: We evaluated 109 patients with primary, unilateral and uncomplicated ACLR at approximately 6 months from index surgery. All participants walked for 5 minutes at 3 mph and jogged for 3 minutes at 6mph on a treadmill. Subjects were fitted with 5 wireless sensors (Shimmer3 IMU Unit, Dublin, Ireland) secured bilaterally on the wrists and ankles and around the waist at the sacrum. Accelerations from the sensors were continuously monitored during the walking and jogging trials. The multi-dimensional time-varying biomechanical data captured by the sensors were processed to generate a graphical model and matrixes to represent the cause-and-effect relationship in inter-limb movement. The matrixes extracted from the sensor data were used to train machine learning algorithms and then these trained algorithms were evaluated to classify participants' ACLR limb from their contralateral healthy limb. The performance of these trained algorithms was calculated to generate the individual classification accuracy.

Results: While walking, the trained algorithms were able to classify the ACLR limb in males with 81.5% accuracy and females with 73.7% accuracy. While jogging, ACLR limbs were classified with 76.7% accuracy in males and 83.0% accuracy in females.

Conclusion: Cause-and-effect analysis of inter-limb movement variability demonstrated a high level of accuracy in classifying an injured ACLR limb from a healthy contralateral limb during exercise. The accuracy of classification may be influenced by gait speed and sex.