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Comparing countermovement jump force production after anterior cruciate ligament reconstruction to pre-injury performance using statistical parametric mapping

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INTRODUCTION:
Force-time analysis of a bilateral countermovement jump (CMJ) is used to detect neuromuscular deficits after anterior cruciate ligament reconstruction (ACLR). The uninvolved contralateral limb is often used to benchmark recovery along with discrete force and impulse metrics. Both practices may be incomplete indicators of recovery as injury affects strength in the contralateral limb, and discrete variable analysis may exclude force production over the full range of motion in jumping. This study addresses these gaps by investigating changes in CMJ force production after ACLR compared to a pre-injury baseline and inclusion of statistical parametric mapping (SPM) as well as discrete variable analysis.
METHODS:
Ground reaction forces were recorded for 12 (male n = 6, female n = 6, age = 21.6 ± 3.7 years) elite multisport athletes on dual force plates (1500Hz) during routine CMJ testing pre-injury (T0), and at 24 ± 3 weeks (T1) after ACLR. Raw force-time data were processed and analysed in the Shiny Vertical Jump Analysis app (https://github.com/mattsams89/shiny-vertical-jump) in Rstudio for the unweighting, braking and propulsive phases of the CMJ. Paired t-tests, asymmetry index and SPM were used to compare the involved limb and uninvolved limb after ACLR, and compared to T0.
RESULTS:
At T1, peak force was reduced on the involved limb (T1: 6.4 ± 1.6 N/kg; T0: 7.7 ± 1.4 N/kg, p = 0.002), with greater inter-limb asymmetry for peak force (T1: 7.3 ± 11.1%; T0: -1.1 ± 6.1%, p = 0.039) and propulsive impulse (T1: 12.3 ± 13.3%; T0: -0.2 ± 4.8%, p = 0.011). Propulsive impulse of the uninvolved limb increased from T0 (1.33 ± 0.11 N.s/kg) to T1 (1.58 ± 0.55 N.s/kg, p = 0.037). Propulsive impulse was significantly lower for the involved versus the uninvolved limb at T1 (p = 0.021). SPM showed lower vertical force production for the involved limb when comparing T0 to T1 (p<0.001) from 92% to 99% of the entire CMJ movement; and for the involved versus uninvolved limb (p = 0.009) from 72% to 76% of the entire CMJ movement at T1.
CONCLUSION:
Both the discrete variable analysis and SPM revealed a reduction in the involved limb force and impulse production, resulting in elevated inter-limb asymmetry six months after ACLR compared to pre-injury. However, SPM analysis identified additional temporal force-time deficits compared to discrete time point analysis. This highlights the need to consider post-surgery knee function across all phases of centre of mass acceleration and lower limb joint position. Greater propulsive force production of the uninvolved limb post-surgery versus pre-injury may indicate a training effect of the uninvolved limb, or an adjustment in movement strategy. Utilising pre-injury baseline and assessing the shape of the force-time waveform and timing of peak force rather than relying only on discrete or phase-specific metrics may be more useful to assess force production after ACLR to better inform rehabilitative programs and guide return to play.

Topic: **Biomechanics**

Presentation **Oral**