

Judging return-to-sport after ACL reconstruction using acyclic as well as cyclic neuromuscular performance tests

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Aims and Objectives: Most athletes expect to return to their pre-injury sport without restrictions after a reconstruction of their torn anterior cruciate ligament (ACLR). Different indicators for a safe and successful return to sport have been identified. Very recent results revealed that indicators of absolute performance were superior to e.g. limb symmetry. Thus, the primary aim of this investigation was to compare neuromuscular performance of athletes returned to sport after ACLR with uninjured athletes. The secondary aim was to relate overall performance to symmetry in both groups.

Materials and Methods: Eighty-four athletes (age: 24 (SD 5) years; 21 women; handball: 33, soccer: 25, volleyball: 15, ice hockey: 5, track and field: 3, judo: 2, swimming: 1) participated in this cross-sectional design. The sample consisted of 17 patients after primary ACL reconstruction (ACLR, 5 women) eleven (6-23) months after return to sport clearance. Participants performed acyclic as well as cyclic neuromuscular tests on a SpeedCourt device (GlobalSpeed GmbH). Unilaterally performed squat jump (SJ) and drop jump (DJ) heights were measured as an indicator of lower extremity explosive or reactive strength under acyclic concentric or fast stretch-shortening muscle action conditions, respectively. The 15 s vertical foot tapping (FT) test was applied to measure cyclic lower extremity performance. The results of each test were converted into z-scores. Z-scores indicate how many standard deviations an individual's score is away from the mean. Accordingly, a z-score of zero equals the sample's mean. Athlete's z-scores were summed up, resulting in the performance score (PS) which indicates overall performance. The participants were ranked based on their PS. Further, for the unilaterally performed tests (SJ, DJ) limb symmetry indices (LSIs) were calculated by dividing the smaller by the larger value and multiplying by 100. LSIs were related to the PS separately for the whole sample as well as for the ACLR subgroup. Effect size is given as Cohen's *d*.

Results: Uninjured athletes revealed higher values for the PS ($t(82) = 3.5$, $p < 0.001$; $d > 0.9$) and for the LSIs ($t(82) > 5.1$, $p < 0.001$; $d > 1.4$) as compared to ACLR athletes. For the subgroup of uninjured athletes, no significant relationship was found between the overall performance and the LSIs (SJ: $r = -0.2$, $p = 0.15$; DJ: $r = -0.1$, $p = 0.43$) as well as within both LSIs ($r = 0.1$, $p = 0.41$). In athletes after ACLR, in contrast, the LSIs between SJ and DJ showed a strong and significant association ($r > 0.73$, $p < 0.001$). Interestingly, neither the overall performance nor the LSIs could be related to the time after injury ($0.17 < r < 0.37$, $p > 0.14$).

Conclusion: Based on the tests utilized in this study, the ACLR athletes underperformed the uninjured group. Independent from time since injury or surgery, function was not reestablished. Results of functional tests should be an integrative part of the return-to-sport decision process.

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