

Kinematic Analysis of the Calf Raise Test Using a Mobile iOS Application: Validation of the Calf Raise Application

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Abstract : Objectives: The calf raise test (CRT) is used in rehabilitation and sports medicine to evaluate calf muscle function. For testing, individuals stand on one leg and go up on their toes and back down to volitional fatigue. The newly developed Calf Raise application (CRapp) for iOS uses computer-vision algorithms enabling objective measurement of CRT outcomes. We aimed to validate the CRapp by examining its concurrent validity and agreement levels against laboratory-based equipment and establishing its intra- and inter-rater reliability. Methods: CRT outcomes (i.e., repetitions, positive work, total height, peak height, fatigue index, and peak power) were assessed in thirteen healthy individuals (6 males, 7 females) on three occasions and both legs using the CRapp, 3D motion capture, and force plate technologies simultaneously. Data were extracted from two markers: one placed immediately below the lateral malleolus and another on the heel. Concurrent validity and agreement measures were determined using intraclass correlation coefficients ($ICC_{3,k}$), typical errors expressed as coefficient of variations (CV), and Bland-Altman methods to assess biases and precision. Reliability was assessed using ICC_{3,1} and CV values. Results: Validity of CRapp outcomes was good to excellent across measures for both markers (mean $ICC \geq 0.878$), with precision plots showing good agreement and precision. CV ranged from 0% (repetitions) to 33.3% (fatigue index) and were, on average better for the lateral malleolus marker. Additionally, inter- and intra-rater reliability were excellent (mean $ICC \geq 0.949$, $CV \leq 5.6\%$). Conclusion: These results confirm the CRapp is valid and reliable within and between users for measuring CRT outcomes in healthy adults. The CRapp provides a tool to objectivise CRT outcomes in research and practice, aligning with recent advances in mobile technologies and their increased use in healthcare.

Keywords : calf raise test, mobile application, validity, reliability

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