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BIOFEEDBACK IN PARTIAL WEIGHT BEARING: VALIDITY OF THREE DIFFERENT DEVICES

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Background: Partial weight bearing is frequently instructed in patients with lower-limb fractures by physiotherapists, and controlled for by using tactile feedback or bathroom scales. A limitation in using these methods is that they do not represent weight bearing during dynamic activities (e.g., walking), resulting in difficulties for patients to comply with weight bearing instructions in daily living. Recent technological advances have resulted in portable biofeedback devices that are capable of offering continuous feedback on weight bearing during walking. Although these devices seem promising to improve training and compliance to weight-bearing instructions, the validity of available devices remains unclear.

Purpose: To investigate criterion validity of three biofeedback devices on partial weight bearing applied in different weight bearing categories in healthy participants.

Methods: Criterion validity was investigated in three biofeedback devices on partial weight bearing (two commercially available and one prototype device):

(1) Smartstep TM;
(2) SensiStep;
(3) OpenGo Science.

A convenience sample of 55 healthy adults was recruited at Fontys University of Applied Sciences. Participants were instructed to walk at a self-selected speed with crutches under four different weight bearing conditions expressed in percentages of body weight: 1–20%; >20–50%; >50–75%; >75–100%.

Peak force data on partial weight bearing of a single step in each weight-bearing category as measured with the biofeedback devices was compared with an embedded force plate (AMTI OR 6–7), which served as the gold standard. Criterion validity was estimated using regression based Bland Altman 95% limits of agreement based on linear mixed model statistics. To evaluate agreement of classification within instructed weight bearing categories between the biofeedback devices and the gold standard weighted kappas were calculated over five categories (<1%; 1–20%; >20–50%; >50–75%; >75–100%).

Results: Fifty-five healthy adults (58% male), mean age 32 years (sd = 15.6) participated in the study. Absolute agreement with the gold standard is low for all instruments, however for the purpose of giving feedback using predefined ranges of weight bearing ranges, the Bland Altman plots show acceptable agreement for Smartstep in all weight bearing categories. For SensiStep, in all weight bearing categories a large underestimation of peak forces is shown, especially in weight bearing category 1–20% SensiStep measured no force in 90% of participants. Although OpenGo Science shows acceptable agreement in the lower weight bearing categories, differences compared to the gold standard in peak force values show increasing deviation in successive weight bearing categories. Weighted kappas for Smartstep, SensiStep and OpenGo Science are respectively 0.8, 0.2 and 0.6.

Conclusion(s): Absolute peak force agreement between the Biofeedback devices and the gold standard is low for all devices. However, Smartstep seems an acceptable device for the purpose of giving feedback on weight bearing within prescribed weight-bearing categories. OpenGo science is only acceptable for feedback in lower weight-bearing categories. SensiStep is not able to give adequate feedback in any weight-bearing category.

Implications: The results of the current study give insight in the validity of biofeedback systems when used in dynamic situations. For successful implementation in daily practice, further research is needed to investigate the usability in training and monitoring adherence to prescribed weight-bearing instructions.

Keywords: Biofeedback system; Weight bearing; Validity

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