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GameBased NonWeight Bearing Exercise to Improve Postural Balance in Diabetic Patients Underjoining Hemodialysis

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Background: Poor balance, falls, and foot problems are serious deterrents for the diabetic patients due to the obesity and diabetic foot ulcer. In addition, for the diabetic patients undergoing hemodialysis (HD) treatment, the HD process often leaves them too fatigued to engage in any physical activity or daily exercise, further deteriorating their motor functions and increasing risk of falling. Exercise would be effective for this population. However, due to the time availability, post-dialysis fatigue, as well as limitation of transportation to exercise facility, the conventional exercise for this population is impractical. Objective: We are developing an interactive foot and ankle exercise game that can be played during HD sessions to improve foot region blood flow, as well as reduce foot problems. In this study, we examined the feasibility and effectiveness of this innovative wearable sensor based non-weight bearing exercise (Exergame) to improve postural balance in diabetic patients undergoing HD treatment. Methods: Sixty diabetic subjects receiving HD treatment were recruited and randomized into an intervention group (IG: n = 29, age = 63.3±7.9 years, BMI = 31.2±6.5 kg/m2, female = 41%) and a control group (CG: n = 31, age = 66.5±10.7 years, BMI = 32.3±8.2 kg/m2, female = 55%). Both groups underwent a 4-week ankle and foot exercise program (30 minutes per session, two sessions per week) during HD process. The IG received exercise via the Exergame program, which uses wearable sensors attached on subject's feet. The subject's 3-dementional ankle and foot movements were visualized in real-time on a computer screen placed in front of him/her. The subject performed some game-like tasks by moving and rotating the foot and ankle. The difficulty level of the task was gradually increased depending on ability of the subject (like a game) from a simple flexion-

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extension movement to more complex movements including medial-lateral movement with different range of motion. The CG received traditional foot and ankle exercise without any technology. Postural balance was assessed in the semi-tandem test. Balance tests were performed at baseline and conclusion of the program, under both eyes-open and eyes-closed conditions. Balance parameters included ankle sway and hip sway in anterior-posterior (AP) direction (degree), medial-lateral (ML) direction (degree), as well as in area (degree2). Results: All IG subjects achieved to complete all exercise tasks indicating the feasibility of the Exergame platform. No adverse event or difficulty were reported indicating practicality of the exercise program. None subject in the IG was dropped out during the 4-week exercise program. Low dropout rate may indicate acceptability of the proposed Exergame platform. Under eyes-open condition, the IG had significant ankle sway reduction in the AP direction (Cohens’ d effect size = 0.55, p = 0.037), when comparing with the CG. At conclusion, the AP direction ankle sway reduced 18% in the IG, while in the CG it increased 58%. More significant improvements of postural balance were observed under eyes-closed condition. When comparing with the CG, the IG had significant ankle and hip sway reductions in both AP and ML directions, as well as in area (p < 0.050). The highest effect size contrasting changes between the IG and CG was also observed for ankle sway in ML direction (Cohens’ d effect size = 0.76, p = 0.005). Conclusions: This study demonstrated feasibility, acceptability, and effectiveness of an innovative Exergame program to improve postural balance in diabetic patients undergoing HD treatment. The key innovation of the proposed intervention is its practicality to be done during HD process, which could address the limitations of prior exercise interventions in HD patients, for example the low adherence of therapeutic exercise.