EVALUATION OF DYNAMIC BALANCE FUNCTION USING VERTICAL GROUND REACTION FORCE AND LIMIT OF STABILITY PERFORMANCE IN PATIENTS WITH ANKLE FRACTURE

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INTRODUCTION

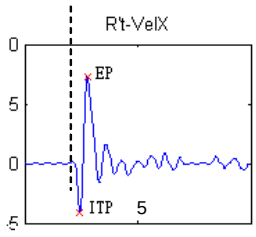
Limit of stability (LOS) represents the ability of a person to voluntarily sway to various directions. It is thus an important test to evaluate the patients with balance dysfunction. Stability and mobility of the ankle are crucial for maintaining body equilibrium in erect position. Ankle fracture might impair the joint function and thus further affect balance performance [1]. Testing LOS on a computerized posturography system provides information of reaction time, end point excursion, direction control and etc. However, in our pilot study, these variables showed no significant difference between tested sides in ankle fracture patients. Thus we suspected these selected parameters could only score the general performance and were not sensitive enough to show the deficits in these patients. The literature suggested ground reaction force (GRF) can be useful for assessment of balance during quiet standing [2]. Therefore, the purpose of this study was to perform a further analysis on the acceleration of COP, which reflects the horizontal GRFs, and the vertical ground reaction force (VGRF) in order to considerately detect the balance changes after ankle fracture.

METHODS

Fourteen unilateral ankle fracture patients after surgical or casting intervention were recruited. The basic data of patients and the ankle dorsiflexion/plantarflexion ranges of motion (ROM) were recorded. Then, the subjects performed LOS test, voluntarily moving their COP to the target area in eight directions, on a computer posturography system (NeuroCom, Inc. USA). For the unilateral affected patients, the directions could be considered as: affected side (A), affected-forward (Af), forward (F), sound-forward (Sf), sound side (S), sound-backward (Sb), backward (B), affected-backward (Ab). The dual force plateform system was used to record the vertical GRF of each foot and COP. For further evaluation, a self-written MATLAB (MathWorks, USA) program was used to calculate the velocity of COP to define the moments of the initial turning point (ITP; the 1st COP turning point toward the target after the test initiated) and the endpoint excursion (EPE; the primary attempt to reach the target) (Figure.1). The velocities and accelerations of COP as well as the percentage of vGRF (PvGRF) on each side at these two critical moments were obtained for further comparison. To compare between affected and sound limbs, the paired t-test was used to analyze the differences of: (1) COP velocities to sound side and affected side (Af vs. Sf; A vs. S; Ab vs. Sb); (2) COP accelerations to sound side and affected side (Af vs. Sf; A vs. S; Ab vs. Sb); (3) PvGRF between limbs in each corresponding direction; (4) PvGRF between directions in each limb. For standardization, ROM values were presented as percentages of normal ranges. Then correlation analysis was used to find the relation between the LOS variables and standardized ROM.

RESULTS

The results showed no correlation between ankle ROM and the LOS variables. Velocities and accelerations of COP both showed no sides' difference neither at the moments of ITP nor EPE. Similar results were found in the comparison of PvGRF between limbs in each corresponding direction. In the comparison of PvGRF between directions in each limb, no significant difference were found in the sound limb while significant differences of Af vs. Ab at ITP and A vs. Af at EPE in the affected limb were demonstrated with smaller values in Af direction (Figure.2).



EPE & ITP with COP velocity curve

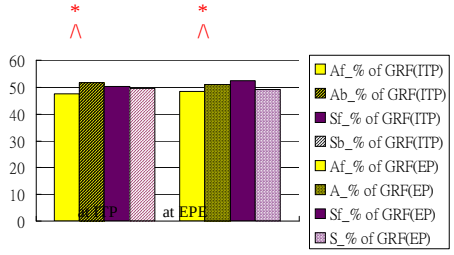


Fig ns. Significant differences were indicated with an asterisk.

DISCUSSION AND CONCLUSIONS

In this study, the PvGRF showed a trend that the ankle fracture patients moved their COP toward the affected side less, especially to the affected-forward direction. It suggested that though the general performance of LOS test on the computerized posturography system in ankle fracture patients seemed quite similar at each limb, the PvGRF under each limb could reveal their different performances. Furthermore, the ankle ROM did not show any correlation to the LOS variables, which implied the adaptation after fracture rather than impaired ROM might be the primary factor that limited the weight shifting to the affected side. So rehabilitation for these patients should not only focus on the general performance or ROM impairment but also the symmetrical weight shifting training.

REFERENCES

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