Dynamic Postural Control Features in Patients Underwent Total Hip Replacement Surgery

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INTRODUCTION:
Total hip replacement (THR) is a widely accepted strategy to resolve the pain and functional limitation caused by hip arthritis or joint necrosis. Previous studies showed that THR was able to relieve the hip pain, change static standing balance, improve gait and quality of life. Previous studies found that patients would increase the walking speed 1 year after THR and their performances approached the normal adults'. The researchs also showed that the affected leg’s single support time increased significantly at 10 years after the surgery, due to relief of pain and improved range of motion. And the other research showed that, the stride length was improved at 3 months after the surgery. The challenges of postural stability during crossing obstacles is greater than walking in daily life. But there is few study investigated the performances of crossing obstacles in THR patients. Previous studies showed that there were different postural control strategies between the young and older adults. The studies measured the COM-COP inclination angles during obstacle crossing, using the variances such as anterior-posterior, medial COM-COP peak inclination angles (A-P, M angles), instantaneous anterior and upward COM velocity (COM-Vy, COM-Vz) (Fig. 1). In older adults, there were slower COM-Vy, greater M angles, and smaller A-P angles than the young adult’s performances, in the purpose of conservative crossing strategy. But there was still no study focused on the THR patients while they executing the challenged crossing obstacle activities. The aim of this study is to compare the dynamic posture control at 1 week before surgery, 6 weeks and 3 months after surgery in THR patients to understand the recovery processes. The results of this study were expected to help clinicians develop the rehabilitation plans for optimal fall prevention after surgery and thus, fastening the patients returning to independent life and increasing the quality of life.

METHODS:
10 patients with first time received THR surgery participated in this study, and they were tested at 1 week before the surgery, 6 weeks and 3 months after the surgery. All of them had normal corrected vision, depth perception, and cognitive function. Each subject walked in an 8-m long walkway in self-selected speed of level walking and crossing 3 different height obstacles (10cm, 20cm, 30cm). We chosen the affected leg acted as the leading leg (namely support leg, not the trailing leg or propel leg) while crossing obstacle for safety (Fig. 2).

There were 39 and 2 infrared retro-reflective markers placed on the body landmarks and the obstacle set for calculating the variances. 8-camera motion analysis system (Vicon 512, Oxford, UK) and 2-forceplate (AMTI, USA) with 120Hz, 960Hz sampling rate placed on each side of the obstacle to collect data was used. For safety, each subject had to wear suspension system to prevent any accident during experiment. The data was calculated into the walking speed, affected leg single support time and single/ double support leg time ratio in level walking, A-P and M peak inclination angles, instantaneous COM-Vy and COM-Vz occurred on the peak inclination angles (Fig. 1) by Motion Processor (Chen, H. C. and Ergonomic Team, CYUT, 2008), and the variances were tested using one-way analysis of variance (ANOVA) to compare the level walking performance for each testing phase, and using two-way repeated measures ANOVA to compare the height and testing phase effects within the subjects. The α level was 0.05, the post hoc analysis was Bonferroni analysis, and SPSS version 10.0 (SPSS Inc., Chicago, IL) was used for all statistical analysis.

RESULTS:
The results showed that, there was no significant difference in walking speed, step length, and single/ double support leg time ratio during level walking (Fig. 3). But there was significant height in medial inclination angle ($p = 0.030$), significant time effect in COM-Vy ($p = 0.005$), and both time and height effect in COM-Vz ($p = 0.002, p = 0.018$) during obstacle crossing (Fig. 4).

DISCUSSION:
The aim of the present study was to investigate the differences of the recovery process in each phase. The results showed that gait performances was not different significantly. It might be due to insufficient follow-up time for the affected leg to recovery. But the results showed that the COM-COP was affected by both obstacle height and testing phase, specially in the M-angles, COM-Vy, and COM-Vz. This results indicating that the more challenging the activity was, the more instability the dynamic postural control would be in the THR patients, and these subjects might use more compensatory strategies.

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