退化性膝關節炎患者在動態平衡干擾系統上的姿勢控制與平衡表現

謝昭榕 [1] 楊世偉 [2] 謝霖芬 [3] 陳家緯 [1]
國立陽明大學復健科技輔具所 [1] 國立陽明大學醫學工程研究所 [2] 新光吳火獅紀念醫院復健科 [3]
E-mail: Kenny_2626@hotmail.com

摘要

內側退化性膝關節炎患者因膝關節的疼痛與變形導致功能性障礙。就生物力學觀點，關節穩定度與本體感覺與肌力強度有關，而內側退化性膝關節炎患者因疼痛亦會影響肌肉的活化。本研究目的即利用動態平衡干擾探討退化性膝關節炎患者在上述因子的相互作用下其姿勢控制策略。本研究收取退化性膝關節患者與正常老人各 20 人做爲對照，評估人體計測、視覺疼痛量表、Lequesn 關節指數與 WOMAC 功能性評估量表，並使用等速肌力儀，動態活動干擾測試儀，足底壓力量測板，了解壓力中心晃動軌跡、動態干擾晃動適應性與目標肌群扭力極值、功率的關係，同時在動態干擾之下量測下肢肌肉活化時序以探討調控平衡之策略。

研究結果顯示，在等速肌力測試下 OA 受測者有較低之 peak torque and muscle power。膝關節 flexion/extension co-activity ratio, Hip joint abd/add co-activity ratio 亦較正常族群小。在動態干擾之下，OA 受測者在 0.3Hz 動作時有較大的前後及左右晃動軌跡。膝關節退化的程度與疼痛度與肌力大小、活化時間，及晃動平衡能力無相互關係，因此 OA 受測者的動態姿式控制主要決定於髖及膝關節肌群的活化量與協同作用的能力。

關鍵字：退化性膝關節炎、動態平衡干擾、姿勢控制策略、肌肉協同作用

一、前言

Osteoarthritis (OA) is the most prevalent form of arthritis in the elderly. In Taiwan, the prevalence of OA ranged from 5.1% to 6.3% (Chou, 1994). Due to the pain, abnormal loading on cartilage surface and uneven joint force distribution, the proprioception, postural control and joint stability of the subjects with knee OA are impaired (Birmingham, 2001). All the impairments cause knee OA subjects have difficulties in functional activities, such as walking, squatting and, rising from a chair, as well as poor dynamic posture control.

Posture control involves the ability to recovery from instability and anticipates the external perturbation to avoid instability. The previous literature showed the characteristic patterns of muscle activities were associated with postural control (Horak & Nasher, 1986). However, the movement pattern of proper postural control related to the joint stability is not clear in subjects with knee OA. The purpose of this study was to investigate the postural control ability of subjects with knee osteoarthritis by using dynamic perturbation system.

二、研究方法

Twenty subjects with bilateral medial compartmental knee osteoarthritis were recruited from the outpatient clinic of Department of Rehabilitation, Shin Kong Wu Ho-Su Memorial Hospital. Besides, twenty healthy, age-matched control subjects volunteered to participate in the study. Requirements for inclusion consisted of no lower limb pathology, neurological impairments that might affect postural control. Each subject participated in a series of tests including basic data measurements, dynamic perturbation test and muscular strength assessments.

Balance data were collected while subjects stood on the dynamic perturbation system. A harness was used to secure the subjects from falling. The pressure platform was set to sample data at 33 Hz. The Steward platform was set for sinusoidal angular rotation, running 10° up and down at 0.3Hz/0.6Hz for 30 seconds. Stability was evaluated the excursion of CoP sway, CoP travelled distance, and CoP contained area (Figure 1). During the first few continuous sway, the CoP ran back and forth, at the time of adaptation, the CoP will coincide the control signal from Steward Platform perturbations. (Figure 2) In perturbations, surface EMG was used to find the onset of lower limb muscle activation.

The peak torque and averaged power were chosen to represent muscular strength in the analysis. The peak torque was the highest point in any given maximal isokinetic effort, and the power was the area under the torque curve over the time.

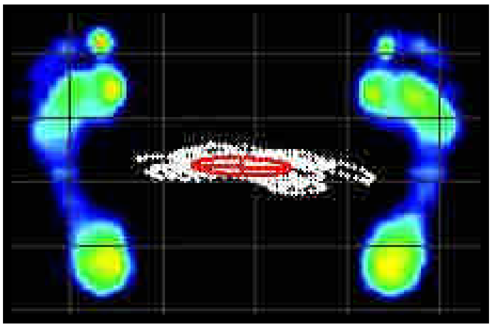

Figure 1 Ellipse area of CoP

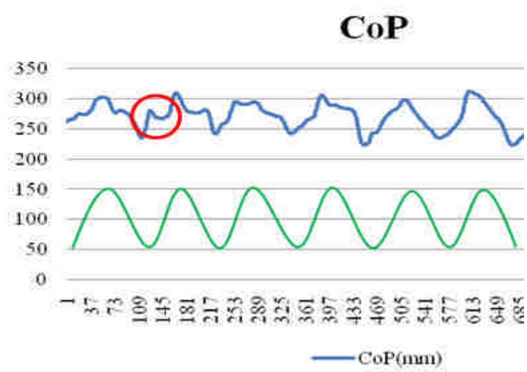

Figure 2 Trajectory of CoP

三、結果與討論

During dynamic perturbation, both groups reflected a tendency to decrease their body sway between the first few trials (Figure 3). Knee OA group demonstrated larger postural sway in either fore-aft or lateral-medial direction, as the perturbation frequency increased the sway became larger. The average adaption cycles for the OA subjects was about two cycles more (Table 1), and the normal subjects normally had the muscle activated pattern from distal ankle to proximal hip joints and left to right, however, the OA group did not show a consistent pattern but as the perturbation frequency increased the hip muscle were used more in keeping the body balance. The OA subjects were more likely used the hip and knee muscle synergy to keep the posture.

Subjects with knee OA had weaker joint peak torque and muscle powers particular in 60^{o}/s knee extensor torque/power, 180^{o}/s knee flexor torque, extensor power (Table 2), 30^{o}/s ankle plantar torque, 120^{o}/s ankle plantar torque, plantar/dorsi power; they were significantly differed from the normal group. The flexion/extension co-activity ratio, Hip joint abduction/adduction co-activity ratios were also smaller than the normal ones.

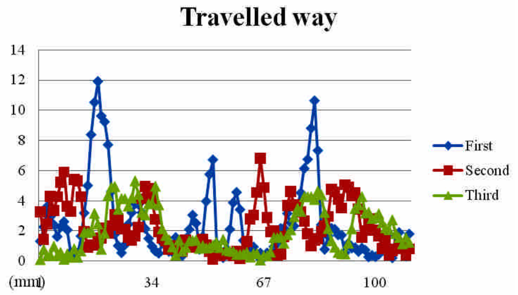

Figure 3 Total travelled way during the first three trials

四、結論與建議

The CoP measures during perturbation were able to explain the variance of posture control ability between normal and knee OA subjects. Greater CoP trajectories and ellipse area were found in knee OA, particularly at 0.6Hz perturbations. This suggested knee OA had better adaptation with platform movements at 0.3 Hz. 0.6 Hz rotations can be used to discriminate the control mechanism between two groups.

Muscle strength of lower extremity is critical to maintain knee joint stability. OA group showed significant knee extensor weakness. To maintain joint stability and coordination of movement, they strengthen hip extensor (mainly hamstrings) activity to improve joint stability and shift the power generation to hip joint for compensation.

五、參考文獻

[1] Birmingham TB, Kramer JF, Kirkley A, et al. (2001) Knee brace for medial compartment osteoarthritis: effect on proprioception and postural control. Rheumatology, 40:285-289.

[2] Chou CT, Pei L, Chang DM, et al. (1994) Prevalence of rheumatic diseases in Taiwan: a population study of urban, suburban, rural differences. J Rheumatol, 21:302-306.

[3] Horak FB, Nasher LM (1986) Central programming of postural movements: adaptation to altered support-surface configuration. J Neurophysiol, 55:1369–1381.

Table 1 Number of cycles to adaptation

	Normal group	OA group	p value
Pitch 0.3Hz	3.47±1.50	5.17±1.03	0.002
Pitch 0.6Hz	4.00±1.41	5.63±1.82	0.006
Roll 0.3Hz	2.83±1.58	3.85±1.21	0.06
Roll 0.6Hz	3.00±1.18	4.91±1.30	0.002

Table 2 Average muscle power of knee joint

Muscle power (N-M-rad/sec)	Normal group	OA group	p value
60°/sec knee extension	15.51±6.79	8.34±2.67	0.007
60°/sec knee flexion	11.01±3.86	8.77±3.45	0.018
180°/sec knee extension	23.17±10.66	9.32±1.04	0.008
180°/sec knee flexion	18.58±5.71	12.67±6.62	0.02