Effect of Knee Sleeve on Static and Dynamic Balance in Patients with Knee Osteoarthritis

Shih-Hung Chuang,[1] Mao-Hsiung Huang,[1,2] Tien-Wen Chen,[3] Ming-Chang Weng,[3] Chin-Wei Liu,[1] and Chia-Hsin Chen[1,2]

[1]Department of Physical Medicine and Rehabilitation, Kaohsiung Medical University Hospital, [2]Faculty of Medicine, College of Medicine, Kaohsiung Medical University, and [3]Department of Physical Medicine and Rehabilitation, Municipal Hsiao-Kang Hospital, Kaohsiung, Taiwan.

Patients with knee osteoarthritis (OA) find that use of elastic knee sleeves gives them partial pain relief and a greater sense of joint stability. However, the scientific effects of knee OA patients wearing braces are unclear. The purpose of this study was to investigate the effects of knee sleeves on static and dynamic balance in knee OA patients. Fifty patients with knee OA were enrolled in the study and all subjects were randomly divided into two groups. Initially, subjects in group A did not wear a neoprene sleeve while receiving balance tests but then wore them to be re-tested. Subjects in group B did just the reverse procedure. In this investigation, an instrument (KAT 2000; Breg Inc., Vista, CA, USA), which quantified motor control performance of the lower extremities was used and balance scores from the KAT 2000 software were obtained. The results revealed that the scores of patients wearing braces were significantly lower than those of patients without braces ($p < 0.05$). The finding of this study demonstrated that knee OA patients wearing knee sleeves could experience increased balance ability in both static and dynamic conditions. The improvement might prevent knee OA patients from falling down and increase their sense of security during physical activities.

Key Words: balance, knee, knee sleeve, osteoarthritis
(*Kaohsiung J Med Sci* 2007;23:405–11)

Knee osteoarthritis (OA) is the most common joint disorder among elderly people [1]. About 25% of those above 55 years of age have been reported as having experienced a significant episode of knee pain in recent years and approximately half of these reports were related to some associated disability [2]. Patients with knee OA suffer from progressive loss of function in walking, ascending and descending stairs, and other lower extremity tasks [3]. Balance is an integral component of these activities in daily life. The impact of knee OA on balance may elucidate possible mechanisms of disability in these patients.

Balance is a complex function of numerous neuromuscular processes which include sensory, motor, and integrated components [4]. Impairment in balance is associated with falls and poor mobility in the elderly population [5]. Structures around the knee joint are easily affected in patients with knee OA. Loss of hyaline articular cartilage and impairment of bony remodeling can even result in capsular damage and muscle weakness [6]. Various deficits in neuromuscular performance have recently been suggested as important processes in OA [7]. Impairment of knee proprioception has consistently been related to individuals with knee OA [8]. Balance control is a highly specific proprioception in performance of daily activities. It is also defined as the ability to control the body center

Received: June 2, 2006 Accepted: November 10, 2006
Address correspondence and reprint requests to: Dr Chia-Hsin Chen, Department of Physical Medicine and Rehabilitation, Kaohsiung Medical University Hospital, 100 Tzyou 1st Road, Kaohsiung 807, Taiwan.
E-mail: chchen@kmu.edu.tw

of gravity provided by the feet. Knee OA may result in the deterioration of these systems. Therefore, simple, inexpensive, and easy treatments are required for knee OA patients to enhance their balance.

Treatments of knee OA include alleviating pain, attempting to correct mechanical malalignment, and addressing knee joint manifestation. Joint replacements and arthrodesis surgeries can relieve pain and improve function for some older patients with advanced OA; however, only a small proportion of such patients need operative treatments [9]. Nonoperative treatments for knee OA patients are currently a major healthcare trend [10]. Conservative treatments include weight loss, physical therapy, assistive devices, exercise, and pharmacologic management [11]. Many methods and approaches are aimed at promoting the balance of knee OA patients. Some knee OA patients have found that wearing elastic knee sleeves gives them partial pain relief and a greater sense of joint stability [8]. Various types of knee braces have also been used for prevention of joint degeneration or functional improvement in knee OA patients.

Wearing an orthosis for knee OA patients is important for their balance; however, the underlying mechanisms of bracing effects are unclear. The clinical efficacy of wearing knee sleeves has also been evaluated by quantitative analysis in a few randomized studies [12,13]. The purpose of this study was to investigate the effect of knee sleeves on static and dynamic balance in knee OA patients. The hypothesis was that knee sleeves could improve the balance of knee OA patients in both static and dynamic conditions.

Patients and Methods

Patients

All recruited subjects experienced knee pain and were diagnosed with knee OA. They all met the criteria of the American College of Rheumatology for knee OA [14] and were treated at the Department of Physical Medicine and Rehabilitation of Kaohsiung Medical University Chung-Ho Memorial Hospital (KMUH), between August 2004 and June 2005. This study was approved by the institutional review board of KMUH. Each participant signed an informed consent. Patients with (1) prior leg fractures, (2) other types of arthritis, (3) any previous knee surgery, and (4) neurologic disease such as stroke or Parkinson's disease were excluded.

Figure 1. *Custom-manufactured neoprene sleeves (CB0601; Zong-Hsin Factory, Kaohsiung, Taiwan).*

All subjects were randomly divided into two groups (group A and group B). Custom-manufactured neoprene sleeves (CB0601; Zong-Hsin Factory, Kaohsiung, Taiwan) were used for knee balance in this study (Figure 1). Initially, subjects in group A did not wear a neoprene sleeve while receiving the balance tests but then donned them at the retest. Subjects in group B received the reverse procedure of group A.

Instrumentation

A balance system machine (KAT 2000; Breg Inc., Vista, CA, USA) for quantifying motor performance of the lower extremities was used (Figure 2A). The balance system consists of a circular platform supported at its central point on a pivot. The stability of the platform is controlled by varying the pressure in a pneumatic bladder that rests between the platform and the base of the unit. The platform is instrumented with a two-axis tilt sensor, which quantifies the position of the platform in two planes. Tilt displacement data (ordered pairs measured in degrees of tilt referenced to the X and Y axes) is acquired via a computerized A/D data acquisition system at a rate of 25 Hz as a function of time. A specially designed software program includes routines for static balance testing (characterization of the ability to stabilize or equilibrate the platform in either single or double leg stance) and dynamic balance testing (controlled movement or tilting of the platform in response to visual cues during double leg stance only). Balance scores (Figure 2B) from the KAT 2000 were obtained according to the position away from the referred point (zero point). A score is calculated by

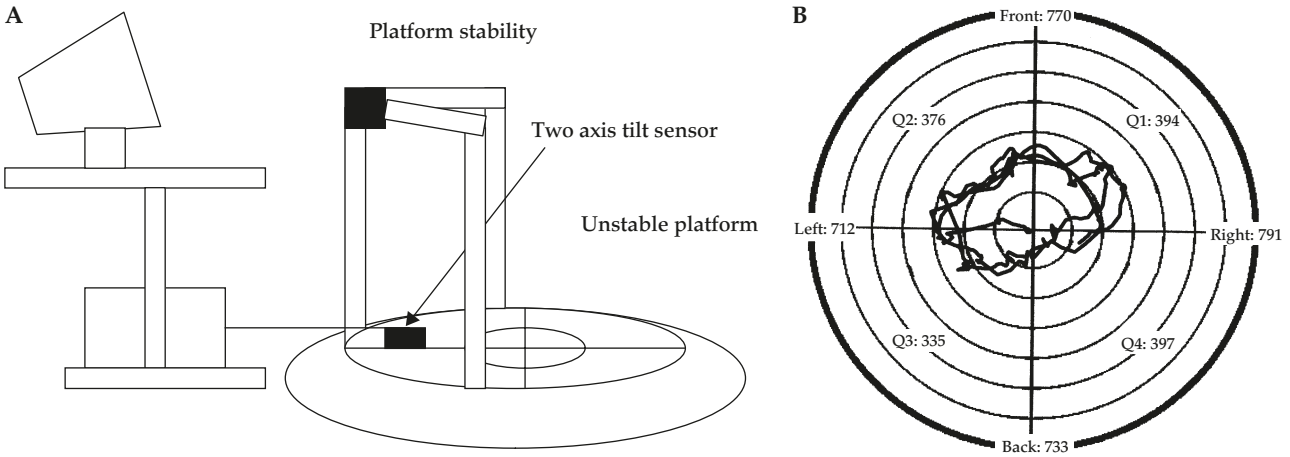

Figure 2. *(A) The instrument for balance assessment (KAT 2000; Breg Inc., Vista, CA, USA). (B) An example of balance scores.*

measuring the distance from the tilted position to the reference position and adding up the absolute numbers over the duration (approximately 30 seconds) of the test [15]. Lower scores indicated better balance performance. When the score was equal to zero, balance function was considered perfect.

Procedure

The subjects performed the tests barefoot and were asked to stand with their body central line perpendicular to the floor and slightly spread their legs so that their feet were aligned with their shoulders. They could slightly adjust their posture until they felt comfortable with the proper position. Subjects were tested with knee flexed at approximately 10° and with their arms across their chests. Each subject was given at least a 5-minute practice period to become familiar with the balance device.

For the static balance test, the subjects were instructed to keep the platform as level as possible for about 30 seconds. For the dynamic balance test, the subjects had to move the platform in a circular direction while chasing a moving object on a computer screen for about 30 seconds. All subjects completed three consecutive balance trials in both static and dynamic conditions on the platform.

By viewing the monitor, subjects could judge their balance function. They did their best to maintain their center of gravity in the referred position so that they could get the minimum scores. A 10-minute resting time was provided between static and dynamic trials. Another 10-minute resting time was provided between the test while wearing knee sleeves and that without knee sleeves.

Table. Characteristics of patients with knee osteoarthritis

	Group A ($n=25$)	Group B ($n=25$)
Age (yr)		
Range	44–76	40–78
Mean ± standard deviation	61.24 ± 8.8	64.32 ± 10.4
Males (n)	4	4
Females (n)	21	21

Data analysis

The assessments of patients' balance performance were according to the paths of the center of pressure on the monitor. The scores were averaged from the three trials. The paired t test was used to compare subjects wearing or not wearing a neoprene sleeve in both static and dynamic status. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS version 11; SPSS Inc., Chicago, IL, USA). The $p < 0.05$ level was used to denote statistical significance.

RESULTS

Eight male and 42 female patients aged 40–78 years were enrolled in the study. The characteristics of the subjects are shown in the Table. In both groups, the mean values (standard deviation) of patients' ages

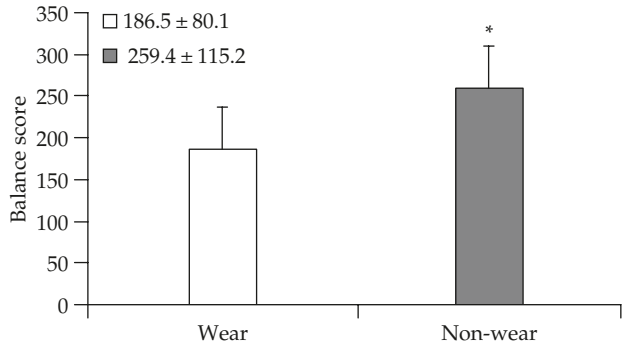

Figure 3. *Static balance test in group A. Balance scores of patients wearing neoprene sleeves and those not wearing sleeves. Values are presented as mean ± standard deviation. *p < 0.05.*

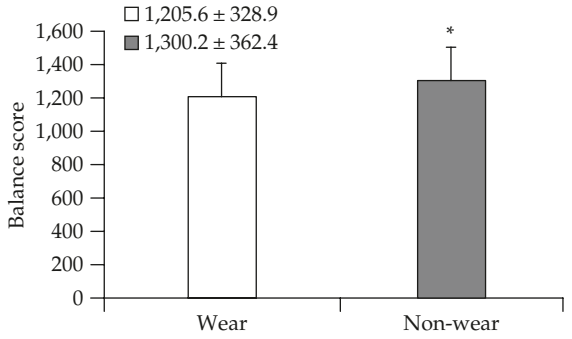

Figure 5. *Dynamic balance test in group A. Balance scores of patients wearing neoprene sleeves and those not wearing sleeves. Values are presented as mean ± standard deviation. *p < 0.05.*

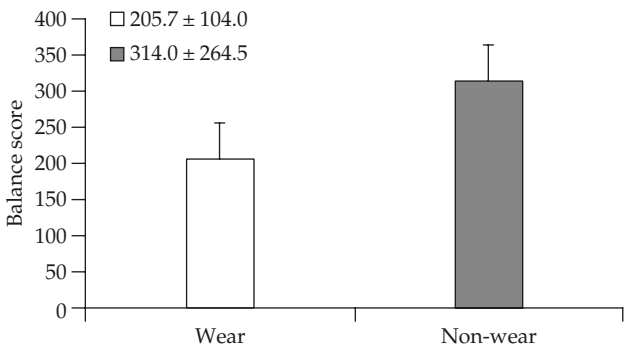

Figure 4. *Static balance test in group B. Balance scores of patients wearing neoprene sleeves and those not wearing sleeves. Values are presented as mean ± standard deviation.*

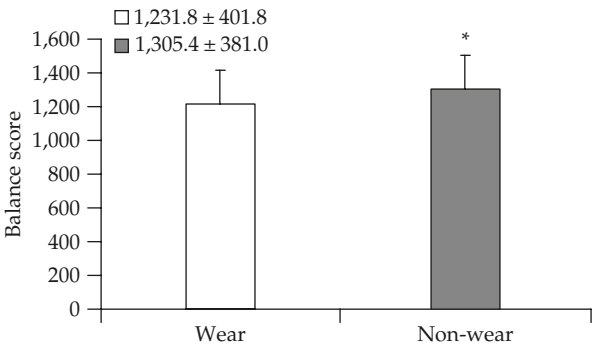

Figure 6. *Dynamic balance test in group B. Balance scores of patients wearing neoprene sleeves and those not wearing sleeves. Values are presented as mean ± standard deviation. *p < 0.05.*

were 61.24 (8.8) and 64.32 (10.4) respectively. Age showed no significant difference in both groups. For static balance, the scores of the patients wearing neoprene sleeves in group A (186.5 ± 80.1) were significantly lower than those in patients without knee sleeves (259.4 ± 115.2) (Figure 3); however, there was no significant difference in group B (Figure 4). For dynamic balance, scores of patients wearing knee sleeves (1,205.6 ± 328.9) were significantly lower than those of patients without knee sleeves (1,300.2 ± 362.4) in group A (Figure 5). A similar result was also found in group B (Figure 6).

Discussion

The results of our study demonstrated that knee OA patients wearing knee sleeves showed better balance control in static and dynamic conditions than those without neoprene sleeves. Scores of patients wearing neoprene sleeves were reduced to 28% compared to those without neoprene sleeves in the static balance test, but there was no statistical significance in group B. In the dynamic balance test, scores of patients wearing neoprene sleeves were reduced to 8% in group A and 7% in group B. There was statistical significance in both groups. Therefore, the neoprene sleeves offered knee OA patients good balance control in both dynamic and static conditions.

The control of balance is a complex process. Previous investigators have demonstrated that proprioception and muscle strength of lower limbs appear to be important determinants of balance in the elderly [16–18]. The decline of strength and balance might be related to falls in the elderly [19–20]. These mechanisms might be observed in the balance deficit for knee OA patients. Individuals with knee OA also displayed some impairment in their postural control. It was more prominent in the dynamic conditions [4]. From these results, wearing knee sleeves seems to play

an important role in increasing dynamic function for patients with knee OA.

Simple and inexpensive devices to improve balance can be recommended for knee OA patients. Knee sleeves, a kind of rehabilitational orthosis, are expandable with slip-on characteristics and are usually made of neoprene with a nylon cover. These devices provide warmth and even compression that may enhance knee joint proprioception [21–23]. Valgus braces have been reported to decrease pain and improve function in knee OA patients [24–26]. Patients may gain symptomatic relief after using simple knee braces. This might be elicited through an improvement in joint-position sense [6]. Therefore, patients wearing knee sleeves may improve knee joint proprioception and then increase static and dynamic function in daily activities.

A commercially available balance assessment device (KAT 2000; Breg Inc.) was specially calibrated for this investigation. The reliability and reproducibility of this balance system has been well described [15]. A software program was also specifically developed for data acquisition and analysis. Scores of balance functions could be calculated and real-time results of balance performance were immediately displayed on the monitor. This device is convenient and might be valid in assessing postural balance abilities for patients with knee OA.

There were some limitations in this study. This was a cross-sectional study and gender distribution was not easily controlled due to the high prevalence of female subjects with knee OA. In the future, a long-term study of the effects of wearing neoprene sleeves for knee OA patients will be required. Knee sleeves do not provide ligamentous support, therefore, they cannot give sufficient fixation in unstable knee joints. Wearing knee sleeves over a long period may result in joint swelling. These symptoms could impede venous and lymphatic return around the knee joints. Therefore, patients wearing knee sleeves should be educated on programs of quadriceps and hamstring flexibility and strengthening exercises [27].

The findings of this study demonstrate that knee OA patients could improve their balance function in both static and dynamic conditions after wearing knee sleeves. The improvement might prevent knee OA patients from falling down and increase their sense of security during physical activities. The neoprene sleeve, a less cumbersome and less costly alternative, has been accepted clinically on the basis of subjective performance. Therefore, it is effective to wear knee sleeves for knee OA patients during performance of static and dynamic activities.

References

1. Lawrence RC, Helmick CG, Amett FC, et al. Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. *Arthritis Rheum* 1998; 41:778–99.
2. Peat G, McCamey R, Croft P. Knee pain and osteoarthritis in older adults: a review of community burden and current use of primary health care. *Ann Rheum Dis* 2001; 60:91–7.
3. Guccione AA, Felson DT, Anderson JJ, et al. The effects of specific medical conditions on the functional limitations of elders in the Framingham study. *Am J Public Health* 1994;84:351–8.
4. Hinman RS, Bennell KL, Metcalf BR, et al. Balance impairments in individuals with symptomatic knee osteoarthritis: a comparison with matched controls using clinical tests. *Rheumatology* 2002;41:1388–94.
5. Campbell AJ, Borrie MJ, Spears GF. Risk factors for falls in a community-based prospective study of people 70 years and older. *J Gerontol* 1989;44:112–7.
6. Kirkley A, Webster-Bogaert S, Litchfield R, et al. The effect of bracing on varus gonarthrosis. *J Bone Joint Surg Am* 1999;81:539–48.
7. Sharma L, Pai YC. Impaired proprioception and osteoarthritis. *Curr Opin Rheumatol* 1997;9:253–8.
8. Barrett DS, Cobb AG, Bentley G. Joint proprioception in normal, osteoarthritic and replaced knees. *J Bone Joint Surg Br* 1991;73:53–6.
9. Buckwalter JA, Stanish WD, Schenk RC. Nonoperative treatment of knee osteoarthritis. In: *Proceedings of the Sixty-Seventh Annual Meeting of the American Academy of Orthopaedic Surgeons*, 2000:60–73.
10. Buckwalter JA, Stanish WD, Rosier RN, et al. The increasing need for nonoperative treatment of patients with osteoarthritis. *Clin Orthop* 2001;385:36–45.
11. Felson DT. Clinical practice. Osteoarthritis of the knee. *N Engl J Med* 2006;354:841–8.
12. Messier SP, Royer TD, Craven TE, et al. Long-term exercise and its effect on balance in older, osteoarthritic adults: results from the Fitness, Arthritis, and Seniors Trial (FAST). *J Am Geriatr Sco* 2000;48:131–8.
13. Birmingham TB, Kramer JF, Inglis JT, et al. Effect of a neoprene sleeve on knee joint position sense during sitting open kinetic chain and supine closed kinetic chain tests. *Am J Sports Med* 1998;26:562–6.
14. Altman R, Asch E, Bloch D, et al. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the knee. *Arthritis Rheum* 1986;29:1039–49.
15. Losse GM, Howard ME, Cawley PW. Correlation of lower extremity injury to balance indices: an investigation

utilizing an instrumented unstable platform. In: *The American Orthopaedic Society for Sports Medicine's Specialty Day, American Academy of Orthopaedic Surgeons Annual Meeting, New Orleans, Louisiana, 27 February 1994*.
16. Kaplan FS, Nixon JE, Reitz M, et al. Age-related changes in proprioception and sensation of joint position. *Acta Orthop Scand* 1985;56:72–4.
17. Whipple R, Wolfson L, Derby C, et al. Altered sensory function and balance in older persons. *J Gerontol* 1993; 48:71–6.
18. Messier SP, Glasser JL, Ettinger WH, et al. Declines in strength and balance in older adults with chronic knee pain: a 30-month longitudinal, observational study. *Arthritis Rheum* 2002;47:141–8.
19. Gehlsen GM, Whaley MH. Falls in the elderly: Part II, balance, strength, and flexibility. *Arch Phys Med Rehabil* 1990;71:739–41.
20. Lord SR, Clark RD, Webster IW. Physiological factors associated with falls in an elderly population. *J Am Geriatr Soc* 1991;39:1194–2000.
21. Perlau R, Frank C, Fick G. The effect of elastic bandages on human knee proprioception in the uninjured population. *Am J Sports Med* 1995;23:251–5.
22. Paluska SA, McKeag DB. Using patellofemoral braces for anterior knee pain. *Phys Sports Med* 1999;27:81–2.
23. Miller AA, Knight KL, Feland JB, et al. Neoprene thigh sleeves and muscle cooling after exercise. *J Athlet Train* 2005;40:264–70.
24. Matsuno H, Kadowaki KM, Tsuji H. Generation II knee bracing for severe medial compartment osteoarthritis of the knee. *Arch Phys Med Rehabil* 1997;78:745–9.
25. Birmingham TB, Kramer JF, Kirkley A, et al. Knee bracing for medial compartment osteoarthritis: effects on proprioception and postural control. *Rheumatology (Oxford)* 2001;40:285–9.
26. Pollo FE, Otis JC, Backus SI, et al. Reduction of medial compartment loads with valgus bracing of the osteoarthritic knee. *Am J Sports Med* 2002;30:414–21.
27. Martin TJ, Fitness CoSMa. American Academy of Pediatrics: Technical report: knee brace use in the young athlete. *Pediatrics* 2001;108:503–7.

護膝對膝關節退化病人在動靜態平衡反應的效果

莊世鴻[1]　黃茂雄[1,2]　陳天文[3]　翁銘正[3]
劉晉瑋[1]　陳嘉炘[1,2]
[1]高雄醫學大學附設醫院　復健科
[2]高雄醫學大學　醫學院醫學系
[3]高雄市立小港醫院　復健科

護膝對於某些膝關節退化病人而言，具有減輕疼痛、增加關節穩定度的功能。然而，目前尚未有足夠的科學根據來證實護膝的效用。本研究的目的，在於探討護膝對膝關節退化病人在動靜態平衡反應的效果。共有 **50** 位患有膝關節退化的病人納入本研究中，並隨意分成兩組。**A** 組患者首先以未穿戴護膝方式進行平衡測試，之後再以穿戴護膝的方式進行相同測試；**B** 組患者穿戴護膝接受測試的順序則與 **A** 組相反。本研究之平衡測量儀是採用具有定量下肢運動控制功能的 **KAT 2000**。 實驗結果顯示，除了 **B** 組靜態平衡測試外，有穿護膝組的平衡數值皆低於沒有穿護膝組的平衡數值，且有統計學上之意義 ($p < 0.05$)。所以我們認為，膝關節退化的病人穿戴護膝可增加其動靜態平衡的能力，或許可降低跌倒的機率並增加日常生活的安全性。

關鍵詞：平衡，膝蓋，護膝，退化性關節炎
(高雄醫誌 **2007;23:405－11**)

收文日期：**95** 年 **6** 月 **2** 日
接受刊載：**95** 年 **11** 月 **10** 日
通訊作者：陳嘉炘醫師
高雄醫學大學附設醫院復健科
高雄市**807**三民區自由一路**100**號