



## Original Research

# Effects of Contralateral Versus Ipsilateral Cane Use on Gait in People with Knee Osteoarthritis

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## Abstract

**Objective:** To compare the immediate effects of contralateral versus ipsilateral cane use on spatiotemporal gait parameters and peak vertical ground force in overweight or obese adults with symptomatic knee osteoarthritis (OA).

**Design:** Prospective observational study.

**Setting:** An academic tertiary Veterans Affairs Healthcare Center.

**Participants:** Thirty-eight overweight or obese subjects with symptomatic knee OA who had not used a cane for the past 30 days.

**Methods:** Spatiotemporal gait data were obtained with an optical motion capture system while subjects walked without a cane, with a cane contralateral to the more painful lower limb, or with a cane ipsilateral to the more painful lower limb at self-selected speeds. An in-shoe dynamic pressure distribution system was used to measure the vertical ground reaction force.

**Main Outcome Measurements:** Spatiotemporal measures of gait and peak vertical ground reaction force on both lower limbs were recorded for each walking condition: no cane, contralateral cane, and ipsilateral cane.

**Results:** Walking with a cane either contralateral or ipsilateral to the more symptomatic limb led to significant reductions in gait velocity (14%-16%), cadence (12%-14%), and peak vertical ground reaction force (normalized for body weight; 11%-12%) on the more painful lower limb compared with walking unaided ( $P < .05$ ). There were no significant differences in the peak vertical ground reaction force on either lower limbs when comparing walking with a cane contralateral to the more painful limb or walking with a cane ipsilateral to the more painful limb. Subjects also experienced a significant decrease in gait velocity with contralateral or ipsilateral cane use compared with walking without a cane; the lower walking speed was due to a decrease in cadence.

**Conclusions:** These results support the prescription of a single-point cane to offload a lower limb with painful knee OA by holding the cane either ipsilateral or contralateral to the more painful lower limb.

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## Introduction

Knee osteoarthritis (OA) is a major health problem in the United States, affecting approximately 9.3 million Americans. The lifetime risk of diagnosed symptomatic knee OA is greater in obese persons (19.67%) compared with nonobese persons (10.85%) [1]. People with symptomatic knee OA experience pain with weight bearing and often have difficulty carrying out many activities of daily living such as walking, bathing, dressing, use of the toilet, and performing household chores as this condition progresses [2]. They are also prone to tripping with subsequent falls and near falls because knee pain interferes with the ability to avoid stepping on obstacles [3].

The onset and progression of knee OA occur because of excessive forces on the joint arising from abnormal anatomy or aberrant loading as result of joint or meniscal injury, obesity, malalignment, joint laxity, or decreased proprioception [4-6]. The increased force on the knee leads to OA, which is characterized by cartilage loss, bone marrow edema, subchondral bone remodeling, formation of osteophytes, and synovial inflammation. How these events contribute to the pain experienced by patients with knee OA is poorly understood [7]. Walking aids such as canes have been recommended as part of the treatment for knee OA with the goal of decreasing pain by reducing loading across the painful knee, increasing postural stability, improving function, and enhancing feelings of walking

confidence and stability [8-13]. Use of canes during walking improves balance by widening the base of support and reducing limb loading by sharing some of the load [10].

The usual recommendation has been to hold the cane in the hand contralateral to the painful lower extremity as far lateral as possible to maintain a normal reciprocal gait pattern, allow the cane to absorb about 15%-40% of the axial loading, and decrease the knee adduction moment [8-13]. Compared with walking unaided, walking with a cane leads to a decrease in gait velocity, cadence, and knee loading [11,14,15]. If patients with knee OA are taught to vary the body weight support on the cane from 10%-20% when using a cane contralateral to the symptomatic limb while walking with the same speed as unaided gait, there is a dose-dependent reduction in medial knee load as measured by the knee adduction moment [12]. Reduction of the knee adduction moment is important because people with medial compartment knee OA who have higher baseline knee adduction moments are more likely to experience radiographic progression of knee OA [15]. When walking with a cane contralateral to the symptomatic limb for 2 months, patients with knee OA report a decrease in knee pain and improved function, and these clinical effects have been attributed to the decrease in knee loading [16,17].

Despite the recommendation to hold the cane on the contralateral side to maintain a reciprocal gait, some patients prefer to use the cane on the ipsilateral side, which leads to a nonreciprocal arm/leg gait pattern. A few studies have examined the biomechanical effects of contralateral versus ipsilateral cane use on lower limb muscle activity, spatiotemporal variables of gait, and forces on the lower limb in healthy adult subjects. With either ipsilateral (nonreciprocal arm/leg gait) or contralateral (reciprocal arm/leg gait) cane use, muscle activity around the knee as measured by tibial strain rates decreased similarly [18]. When healthy subjects walked with the cane ipsilateral to an imagined painful right lower limb, peak vertical reaction force acting on the foot in heel strike and midstance phase decreased the most when the cane and heel touched the ground simultaneously and the center of force on the foot did not shift significantly [19]. With contralateral cane use, however, the center of force on the foot shifted medially, and touching the ground after the heel strike was the most efficient method to decrease peak vertical reaction force on the foot [19]. Based on these results in healthy subjects, Lyu et al [19] suggested that patients with varus knee OA should use the cane in the ipsilateral hand, while patients with valgus knee OA should use the cane in the contralateral hand. These investigators also indicated that using the contralateral cane so that the tip of the cane touches the ground at the same time as the foot or using the ipsilateral cane so that the tip of the cane touches at the same time as the heel were the

optimal techniques to decrease peak vertical reaction force on the foot. Both ipsilateral and contralateral cane use reduced cadence by 13% compared with walking unaided in healthy young adults [20].

Information is limited on the effects of contralateral and ipsilateral cane use on gait in people with musculoskeletal conditions affecting the lower limb. Patients who had undergone total hip or knee replacement or were preoperative for total knee replacement had greater gait velocity with contralateral than with ipsilateral cane use. Increased mean knee joint motion, increased peak vertical ground reaction forces, and decreased sagittal plane hip motion characterized their gait when walking with a cane on the ipsilateral side compared with the contralateral side [21]. Ipsilateral cane use during gait in women with knee OA led to increased frontal plane loading of the hip and knee during the stance phase compared with contralateral cane use or walking unaided, suggesting that ipsilateral cane use may have detrimental effects on medial knee loading [14].

What remains unknown is whether the biomechanical effects of cane use on gait, peak vertical ground reaction force, and underlying motor control in people with knee OA differ between walking with a cane contralateral or ipsilateral to the more symptomatic knee. The objectives of this study were to determine the spatio-temporal gait characteristics and peak vertical force on the more symptomatic lower limb in people with painful knee OA when walking with a cane contralateral versus ipsilateral to the affected limb. It was hypothesized that contralateral cane use would be more effective than ipsilateral cane use in decreasing peak vertical force on the more symptomatic limb.

## Methods

### Setting and Participants

This study was conducted at the Veterans Affairs West Los Angeles Healthcare Center, an urban tertiary academic hospital. Thirty-eight community-dwelling patients were recruited for the study. These patients had knee pain on movement, which they scored at  $\geq 35$  mm on a 100-mm visual analogue scale for most days of the previous month. Patients had either unilateral knee pain or knee pain that was worse on one side. Other inclusion criteria included weighing less than 300 lb, no cane use for the past 30 days, fulfillment of the American College of Rheumatology criteria for knee OA [22], and radiographic Kellgren-Lawrence scale knee OA grade  $\geq 1$  [23]. We excluded persons who had knee trauma or surgery, including arthroscopic surgery, within the past 6 months; upper body weakness; injury or amputation to the lower extremity joints; symptomatic spine, hip, ankle, or foot disease; isolated patellofemoral disease manifested by primarily anterior knee

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