



## Changes in gait characteristics of women with early and established medial knee osteoarthritis: Results from a 2-years longitudinal study



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### ABSTRACT

**Background:** Despite the large number of cross-sectional studies on gait in subjects with knee osteoarthritis, there are scarcely any longitudinal studies on gait changes in knee osteoarthritis.

**Methods:** Gait analysis was performed on 25 women with early and 18 with established medial knee osteoarthritis, as well as a group of 23 healthy controls. Subjects were asked to walk at their comfortable speed. Kinematic and kinetic data were measured at baseline and after 2 years follow-up.

**Findings:** Results indicated that the early osteoarthritis group, similar to established osteoarthritis group, showed significantly higher maximum knee adduction angles compared to the controls during the early stance phase of gait. None of the kinematic or kinetic measures, changed over two years in the early osteoarthritis group. In the established osteoarthritis group, at the time of entry, an increased first and second peak knee adduction moment, as well as higher mid-stance knee adduction moment and knee adduction moment impulse, were present compared to the control and the early osteoarthritis groups. Mid-stance knee adduction moment and knee adduction moment impulse, further increased over two years only in the established osteoarthritis group. For all three groups, the peak knee flexion angle during the stance phase decreased significantly over time.

**Interpretation:** Increased maximum knee adduction angle during stance phase was the only alteration in the gait pattern of subjects with early knee osteoarthritis compared to the controls. This suggests that, unlike in the later stages of the disease, gait is rather stable over two years in early osteoarthritis.

### 1. Introduction

Knee osteoarthritis (OA) has been reported as one of the major causes of disability, mainly in women (Felson, 1995). Knee joint loading in walking and other activities of daily living provokes pain and discomfort in this joint, which has a substantial negative influence on locomotion, and quality of life (JOHANNES, 1998; Steultjens et al., 2000).

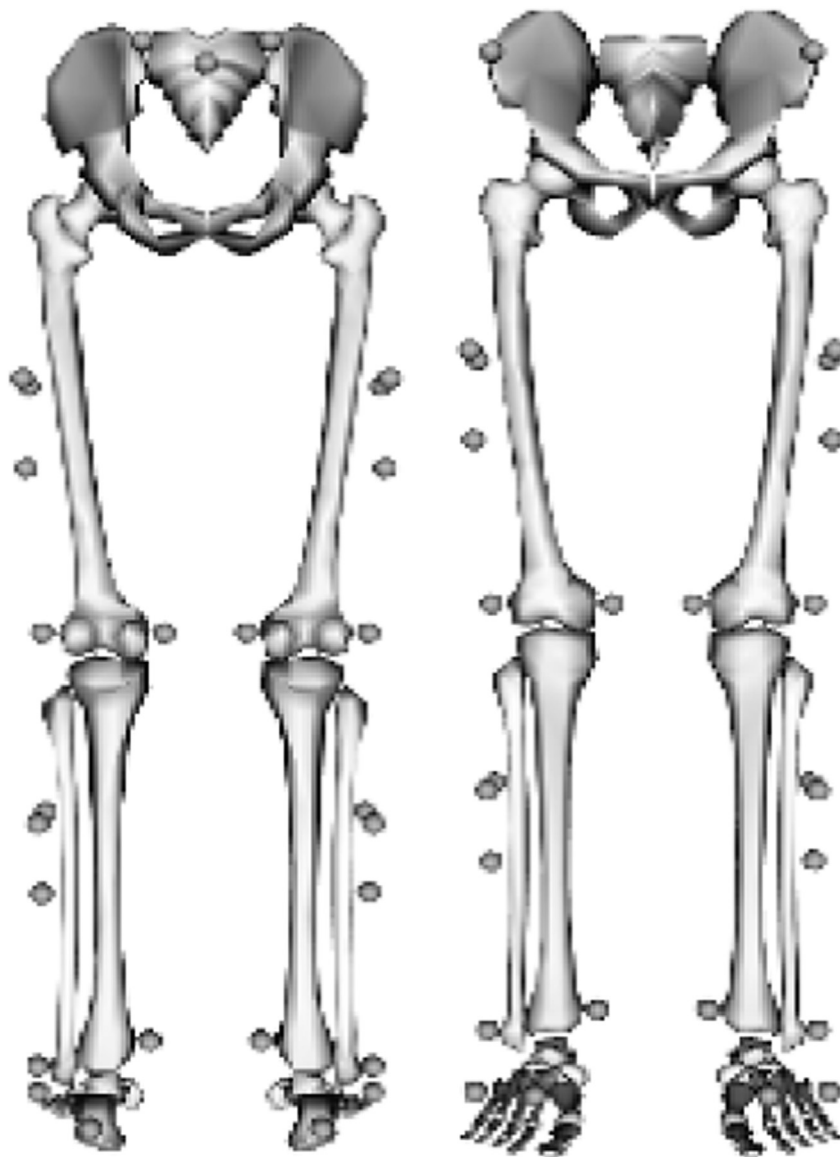
The role of biomechanical factors in the initiation and progression of knee OA has been supported by a vast number of studies (Radin et al., 1991; Roemhildt et al., 2010). Altered gait patterns, compared to controls, have been reported frequently in people suffering from knee OA (Baliunas et al., 2002; Debi et al., 2009; Gök et al., 2002; Hurwitz et al., 2000). They walk with lower speed (Asthen and Deluzio, 2005;

Gök et al., 2002), increased knee flexion at heel-strike (Childs et al., 2004; Mündermann et al., 2005), and reduced knee flexion excursion during the stance phase of gait (Asthen and Deluzio, 2005; Baliunas et al., 2002). Several studies have shown that the external knee adduction moment (KAM), is greater in people with knee OA compared to healthy controls (Baert et al., 2012; Gök et al., 2002).

The observed gait deviations in subjects suffering from knee OA may be compensatory strategies aimed at reducing stresses on, and the range of motion of the affected joint (Baliunas et al., 2002; Debi et al., 2009; Gök et al., 2002; Hurwitz et al., 2000). However, with progression of the disease and associated morphological changes, the effectiveness of the aforementioned strategies may decrease. Moreover, previous reports suggest that neuromuscular and proprioceptive deficits in subjects with knee OA may actually lead to altered gait strategies

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**Fig. 1.** Marker set used for motion capture: Fifteen markers placed on five clusters were fixed bilaterally to the lateral thighs and lateral lower legs, and posterior to the pelvis. 12 markers were placed bilaterally on the anterior superior iliac spine, lateral femoral epicondyle, lateral malleolus, calcaneus, fifth metatarsal head and the mid-foot.

that increase joint loading (Hortobágyi et al., 2005; Hurley, 2003; Johansson et al., 2000; Lewek et al., 2005).

Gait alterations associated with knee OA are found to vary with OA severity (Astéphen et al., 2008a; Astéphen et al., 2008b; Sharma et al., 1998). Thorp et al. reported an increase in both the peak knee adduction moment (KAM) and the KAM impulse, with an increase in radiographic severity of knee OA (Thorp et al., 2006). A study on gait alteration in patients with early knee OA, reported no gait alterations in this group compared to the healthy controls (Baert et al., 2012). Hurwitz et al. found decreased stance phase knee flexion angles, as well as decreased early stance phase knee flexion moments in patients with severe knee OA compared to controls, but not in subjects with moderate knee OA (Hurwitz et al., 2000).

Despite the large number of cross-sectional studies on gait of subjects with knee OA (Al-Zahrani and Bakheit, 2002; Gök et al., 2002; Hunt et al., 2006; Kaufman et al., 2001; Thorp et al., 2006) there are scarcely any longitudinal studies on gait changes in knee OA. However, to obtain more insight in the role of disease severity and time in gait alterations, longitudinal studies are necessary. Therefore, we performed a longitudinal study on the kinematic and kinetic characteristics of gait in women with early knee OA, women with established knee OA and in healthy controls over a two-year follow-up period. We hypothesized

that both early and established OA groups will show gait variable differences compared to controls, with fewer differences between the early OA group and the control group. We also hypothesized that the early OA group will demonstrate progressive changes over time, moving towards a pattern similar to the established OA group.

## 2. Methods

### 2.1. Study population

Sixty-six women participated in this study. All subjects were informed of the procedures of the study and signed informed consent forms approved by the local ethical committee of Biomedical Science, KU Leuven, Belgium prior to testing. The study was conducted in agreement with the principles of the Declaration of Helsinki.

Forty-three individuals with knee OA were clinically diagnosed by a rheumatologist or orthopedic surgeon of the University Hospitals Leuven. Recruitment of the control subjects ( $n = 23$ ) was done through social organizations. The inclusion criteria for the control group were, K & L grade 0 or 1 on the radiography of both knees, asymptomatic, no history of knee OA and other pathology involving any lower extremity joints. Standard anterior-posterior weight-bearing radiographs in fixed

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