ADDUCTION MOMENT, RADIOGRAPHIC DISEASE SEVERITY, AND PAIN IN OSTEOARTHRITIS OF THE KNEE

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INTRODUCTION

The loads acting at the knee joint play a significant yet not completely understood role in the progression of osteoarthritis (OA) of the knee (1,2). Dynamic loading at the knee during gait has the greatest effect on the knee joint, as walking is the most frequently performed activity of daily living (3). An indication of medial-to-lateral load distribution is the external adduction moment, which adducts the knee during the stance phase of normal gait. The adduction moment is the most important kinetic factor that affects medial tibiofemoral OA and the progression of medial tibiofemoral OA (4).

The purpose of this study is to evaluate the relationships between gait analysis and clinical measures, focusing on the adduction moment, OA disease severity (measured radiographically), static mechanical axis and pain.

MATERIALS AND METHODS

Seventy-five patients recruited for this study underwent gait analysis, clinical examination and radiographic evaluation. These 75 patients were 47 men and 28 women with a mean age of 66.4 years (standard deviation 9.8), a mean height of 168cm (standard deviation 9.4), and a mean weight of 79.6kg (standard deviation 13.2).

The range of motion (ROM) of the patient's knee was measured clinically using arthrometers. Pain was measured using a modified Hospital for Special Surgery pain rating system (3). Then, knees were classified into three pain groups. Group A represents pain in level gait and worse (HSS score 0, 10, 25); B, pain when going up or down stairs (HSS score 40, 45); and C, none or ignores (HSS score 50).

Gait was analyzed using 6 retro-reflective markers, a 4 camera Qualisys motion capture system, and a multicomponent force plate. These 6 external markers were placed on the leg along the superior iliac spine, greater trochanter, lateral joint line of the knee, lateral malleolus, lateral calcaneus, and tip of the fifth metatarsal. The data was acquired at 120 samples per second. The patients performed level walking on a 10-meter walkway. The kinetic data was obtained using an inverse dynamics approach. In this technique, the net force and net moments were calculated from measurements of limb segment size, body mass and ground reaction forces. Moments were normalized to percent body weight times height (%BW x Ht) (5,6).

All patients had weight-bearing anteroposterior radiographs of the knee in full extension. The Kellgren and Lawrence grading system (KL grade) (3) was used to classify radiographic severity of tibiofemoral OA. The narrowest width of the joint space was measured in both medial and lateral compartments. The mechanical axis of the lower extremity was measured with the angle between the line connecting the center of the femoral head and the center of the tibial plateau and the line connecting the center of the tibial plateau and the center of the ankle joint.

Initially, the peak adduction moment was compared by t-test between two groups divided with severity of OA (KL grade). Multiple regression analyses were used to test for an association between the mechanical axis and the adduction moment, between the medial joint space width and the adduction moment, and between pain and the adduction moment. Five knees out of these 150 knees were excluded because of lateral OA. This exclusion left 145 knees in the study.

RESULTS

The details of KL grade of the 145 knees were 5 knees in KL grade 1, 77 knees in KL grade 2, 34 knees in KL grade 3, and 29 knees in KL grade 4.

The peak adduction moment was larger in KL 3,4 group than in KL 1,2 group ($p < 0.001$, Table 1). The peak adduction moment correlated significantly with the mechanical axis ($r = 0.633$, $p < 0.001$, Figure 1). There was also a significant inverse correlation between the first peak adduction moment and the medial joint space width ($r = -0.428$, $p< 0.001$, Figure 2). The adduction moment was compared among three groups (A, B, and C) classified with pain. No correlation was found between the adduction moment and pain ($r = 0.0222$, $p = 0.791$). Then same correlations were examined independently in KL 1,2 group and KL 3,4 group. In KL 3,4 group, there was no correlation between the adduction moment and pain, either ($r = 0.0863$, $p = 0.501$, Figure 3). But a weak correlation was shown in KL 1,2 group ($r = 0.213$, $p = 0.054$, Figure 3).

	KL grade 1,2	KL grade 3,4	P value
Age	65.6 (10.1)	67.3 (9.2)	0.29
ROM (extension-flexion)	3.32 - 131.3 (3.92) (5.23)	7.25 - 123.4 (5.00) (8.82)	< 0.001
Peak adduction moment	**2.73 (0.72)**	**3.56 (0.72)**	**< 0.001**

Table 1. Values compared by t-test

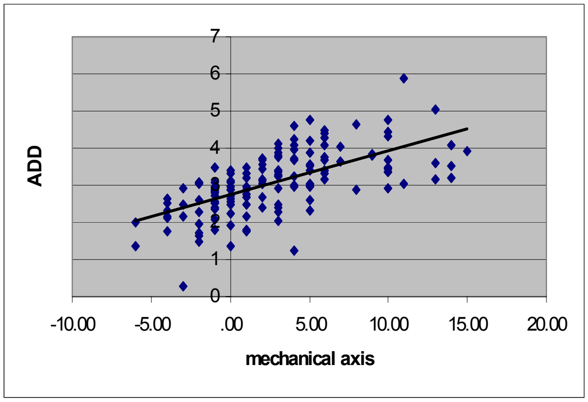

Figure 1. Mechanical axis and adduction moment

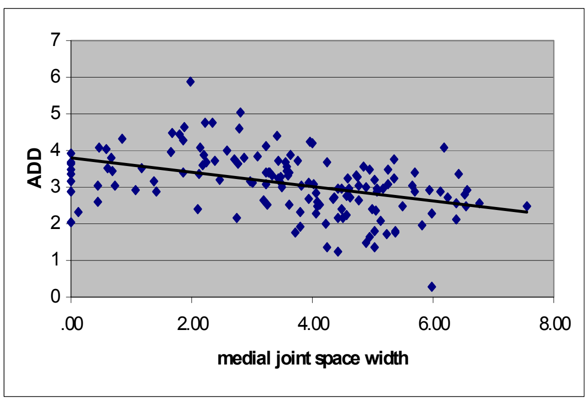

Figure 2. Medial joint space width and adduction moment

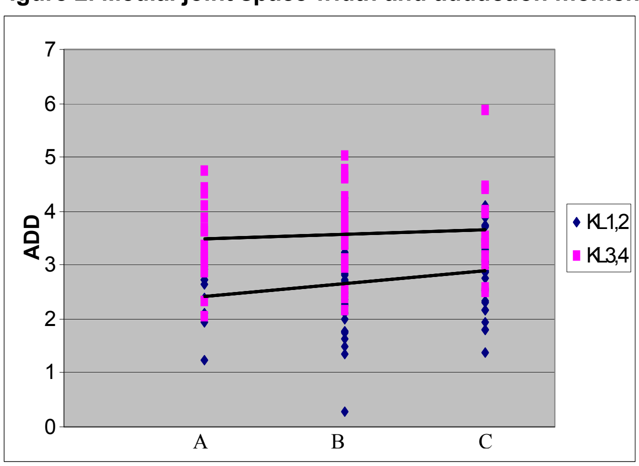

Figure 3. Pain and adduction moment

DISCUSSION

In this study, it was shown that the adduction moment was greater with progression of medial tibiofemoral OA of the knee. The adduction moment plays an important role on the progression of the medial tibiofemoral OA, because the adduction moment during gait is the primary determinant of the load on the medial compartment of the knee joint. It is important to know the adduction moment of the patient when treating patients with OA of the knee, since the adduction moment not only correlates with the severity of OA, but also affect the clinical outcome of some surgeries, such as high tibial osteotomy (7).

There was no correlation between the adduction moment and pain in all the 145 knees in this study. But the adduction moment is slightly significantly correlated with pain only in KL 1,2 group ($r = 0.213$, $p = 0.054$, Figure 3). The knee in early stage OA is almost equivalent to a normally aged knee anatomically. Although treatment for OA of the knee tends to be directed at relieving pain, joint pain is considered by many to be a kind of protective mechanism that keeps the joint from overloading (8). An inverse relationship between pain and the adduction moment in this study was weak, but could be thought of as a result of the protective mechanism.

It is interesting that the correlation between pain and the adduction moment was shown only in KL 1,2 group. It may be a clue in thinking about prevention of the progression of OA. Patients with little pain might have greater adduction moment during walking, especially in early stage of OA. That greater adduction moment should be reduced from the point of view of preventing disease progression.

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