Introduction
Joint pain is the most common complaint with osteoarthritis (OA) and is usually accompanied by decreases in joint motion and mobility.1,2 Typical treatments include oral medications that have analgesic effects with or without anti-inflammatory properties. Other options are glucocorticoids, or more recently, joint fluid substitutes, like hyaluronic acid. Treatment with NSAIDs 3-4 and intraarticular injection (IAI) of the knee5 have been reported to increase gait speed and knee loading in patients with knee OA. However, there have been no reports on the effects of pain relieving agents on knee loading during stair stepping. We hypothesized that a pain relieving intraarticular injection (IAI) of the severely painful osteoarthritic knee would result in increased loading of the medial compartment of the affected knee during stair stepping.

Methods
We tested the gait and stair stepping of 21 healthy control subjects, the gait of 19 OA patients and stair stepping of 14 OA patients (Table 1).

Table 1. Characteristics of subjects (standard deviations in parentheses)

<table>
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<tr>
<th>Sex (Females/Males)</th>
<th>Age (years)</th>
<th>Weight (kg-f)</th>
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<tr>
<td>OA Patients</td>
<td>67.5 (± 7.5)</td>
<td>88.1 (± 18.1)</td>
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<tr>
<td>Control Subjects</td>
<td>61 (± 7.0)</td>
<td>70.9 (± 9.6)</td>
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All patients in this study were diagnosed with severe knee pain resulting from OA of the medial compartment of the knee. The protocol was approved by the Institutional Review Board of the University of Chicago and informed consent was obtained.

The motion analysis laboratory included a 9.5 meter walkway. Ground reaction forces were measured using a multicomponent force platform (Advanced Mechanical Technologies, Inc. Newton, Mass.) located in the center of the walkway. The kinematic parameters were measured with the WatSMART (Northern Digital, Waterloo, Ontario, Canada) optical electronic three-dimensional digitizing and analysis system, which includes two cameras that detect the positions of infrared light-emitting diodes. The diodes were placed in an arrangement of six or eight diodes on a rigid disc. Discs were attached using elastic straps to the foot, shank, thigh, and pelvis on the patient’s affected limb. The force platform data consisted of the three components of the ground-reaction force vector, the location of the resultant point of application of the force vector, and the vertical twisting moments. Acquisition of the force and kinematic data was synchronized with a sampling rate of 100 samples per second. These data were processed using the Data Analysis Program (DAP) software (Northern Digital, Waterloo, Ontario, Canada) to determine the three-dimensional position of each rigid disc in inertial coordinates. Custom written automated software was used to perform pattern recognition on the processed data and extract the data of interest. These data were then validated by visual inspection of the waveforms. Euler angles were used to compute the three-dimensional angles of the ankle, knee, and hip joints. The force and motion data along with the anthropometric measurements of the patient and the angular and linear velocities of the segments of the lower extremity were used to compute the three-dimensional external moments at the ankle, knee, and hip joint of the diseased limb. The moments were expressed as a percentage of body weight multiplied by lower limb length.

We used two protocols: gait and stair stepping. For gait, subjects walked along the walkway in a self-selected manner. For stair stepping, subjects were asked to stand, feet together, at a distance of twenty cm from the end of the subject’s great toes to a 20 cm high step, step onto the step with the affected limb, in the case of the patients, or with the right limb, in the case of the controls, step over the step and onto the ground with the opposite limb, step onto the ground with the implanted limb, and then walk along the walkway, all in a continuous fashion.

Three trials of gait and of stair stepping were collected. Then, the pain-relieving injection was given. The IAI consisted of 3 cc of 1% procaine, 20 mg of triamcinolone, and 1 mg of dexamethasone. The patient sat on a chair and rested for 15 minutes before collecting three additional trials of gait and stair stepping. The data from the three trials of gait (one stride for each trial) and of stair stepping during each of the two gait assessments was averaged. The one-tailed, paired t-test was used for determining statistically significant differences in the measurements of temporal-distance, kinematics, and external moments between the pre- and post-injection data since these data were not independent. The one-tailed t-test was used for determining statistically significant differences in the measurements of these variables between the patients’ post-injection data and the controls’ data since these data were independent. Values of α ≤ 0.05 were considered significant.

Discussion
The results showed that following the pain-relieving IAI, the patients experienced increased loads in the medial compartments of their knees during gait as a result of increased external adduction moments about their knees in agreement with a prior study6. Furthermore, the post-injection magnitude of the external adduction moment was increased to a level that was not significantly different from that of the controls. The IAI also increased the external knee flexion moment to a level that was not different from that of the controls. Thus, the pain relieving IAI tended to normalize gait.

However, the results for stair stepping did not support our hypothesis. No significant differences were found during stair stepping in the external adduction-abduction moments about the knee following injection. Furthermore, the patients’ post-injection magnitudes were significantly less than those of the controls. Thus, one or more factors in addition to pain are responsible for the inability of the patients to load their knees more normally during stair stepping. Since stair stepping is among the most demanding of daily activities on the quadriceps muscles and since quadriceps strength is decreased in knee OA7, this suggests that quadriceps weakness is likely at least partly responsible for the abnormally low knee loading during stair stepping following pain relief.

References