THE EFFECTS OF PAIN RELIEF ON OBSTACLE AVOIDANCE IN KNEE OSTEOARTHRITIS

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INTRODUCTION
Falling in the elderly is a public health problem. Tripping on an obstacle is the most frequent cause of falls. Osteoarthritis has also been associated with falls in epidemiological studies, and the pain associated with it has been shown to increase the propensity to trip on an obstacle. Pain-relieving intra-articular injections are widely utilized in the treatment of knee osteoarthritis, and the extent to which they decrease the propensity to trip on an obstacle has not been studied. The present investigation examined the effects of pain-relief injections in patients with painful knee osteoarthritis (KOA) on obstacle avoidance success (OAS) rates in older adults. We hypothesized that pain-relieving intra-articular knee injections in KOA patients would improve OAS rates, but not to the level of healthy controls.

METHODS
We tested 9 subjects (1 male, 8 female) with painful unilateral or bilateral KOA who had a mean (sd) age of 60.4 (7.0) years, and 14 healthy control subjects (10 male, 4 female) who had a mean age of 61.1 (10.0) years. Three patients had unilateral KOA (2 right leg, 1 left), 4 had bilateral KOA with pain greater in one limb (2 right leg, 2 left), and 2 had bilateral KOA with equal pain in both limbs. The control subjects were tested a single time. The KOA patients were tested twice, once before the pain-relieving intra-articular knee injection and once 15 min after the injection, with the exception that age, body mass index (BMI), contrast sensitivity, and depth perception (described below) were tested a single time in all subjects. Pain was assessed using a visual analog scale (VAS). BMI was computed as the ratio of body weight divided by the square of body height. Visual acuity was tested using a standard eye chart. Contrast sensitivity was measured using the Melbourne Edge Test. The Howard Dolman depth perception apparatus (Lafayette Instrument, Lafayette, IN) was used to test the subjects' depth perception. The length of time, up to 30 sec, that the subject was able to stand on the most painful limb (or right limb in the controls) was used to measure balance.

In order to test subjects’ abilities to avoid stepping on a suddenly appearing obstacle (light beam), subjects were asked to walk down a walkway 9.5 m long and 0.94 m wide, upon which was a surface of 600 conductive aluminum strips, each 8 mm wide, and with adjacent strips spaced 2 mm apart. The strips were sampled at a rate of 100 Hz using a data acquisition board (Intelligent Instrumentation Inc., Tucson, AZ) controlled with a PC. The system computed walking speed and step length and predicted upcoming footfall locations. The PC also controlled a servomotor (QuickSilver Controls, Covina, CA), which was used to flash a band of light onto the floor in a random order at predicted right and left footfalls. The band of light was 10 cm wide and 85 cm long and projected transversely across the walkway over a 2 m range and near the far end of the walkway. The obstacle position was controlled to within 0.5 cm and measured to within 1 cm. Times were measured to within 10 msec. The conducting strips detected foot longitudinal placement to within 1 cm. This apparatus is similar to that reported by Chen et al.2

Subjects walked at a speed between 1.0 and 1.07 m/s. There were six trials for the right limb and six for the left limb in a random order. The light beam was flashed on the floor 350 ms before the predicted footfall. OAS scores were calculated. For each of the twelve trials in which the light flashed, a score of 1.0 was given for each successful avoidance and 0.0 for stepping on the obstacle. Successful avoidance was defined as not stepping on the virtual obstacle with any part of the shoe. Some subjects were able to avoid the obstacle by rotating the forefoot laterally at the last instant (initially breaking the plane of the light), or dorsiflexing the ankle with only the toes elevated above the band of light. In these circumstances, 0.5 was given as the score. The 12 trials were pooled and an overall OAS score was obtained for each subject. To obtain individual rates of success, the OAS scores for each were divided by twelve to obtain an OAS rate.

The two-tailed student t-test was used to determine if there were differences in age, BMI, contrast sensitivity, and depth perception between the KOA and control groups. A two-tailed paired t-test was also used to determine differences in OAS rates between unilateral and bilateral KOA subjects in both the pre- and post-injection states. ANOVA and the Tukey post hoc test were used to determine differences in pain, single leg stance duration, and OAS rates between the pre-injection KOA, post-injection KOA, and control subjects.

Simple linear regression analysis was performed to determine if pain or single leg stance duration had statistically significant predictive capability for the dependent variable (OAS rate) across all three test groups (pre-injection KOA, post-injection KOA, and controls). Statistical significance was defined as p = 0.05.

RESULTS
The mean OAS rate of the KOA patients was 44% less than that of the control subjects prior to receiving the pain-relieving intra-articular injection (p<0.0001). The pain-relieving injection increased the OAS rate of the KOA patients by 31% (p = 0.016). After the injection, the OAS rate of the KOA patients was 20% less than that of the control subjects (p = 0.032). There was no significant difference between the pre-injection or post-injection OAS rates in either the unilateral or bilateral KOA subjects.

The mean pain score of the KOA subjects prior to injection was 48% greater than that after injection (p = 0.033). The mean single leg stance duration of the KOA subjects prior to injection was not significantly different from that after injection (p=0.706). However, the single limb stance duration of the KOA subjects prior to injection was 54% lower than that of controls (p = 0.001), and that of the subjects after injection was 43% less than that of the controls (p = 0.006). Also, the BMI of the KOA subjects was 29% greater than that of the controls (p < 0.0001).

The OAS rates of all subjects (pre-injection, post-injection, and control) decreased linearly as pain increased (p = 0.003). The OAS rates of all subjects also decreased linearly as single leg stance decreased (p=0.018). Age, contrast sensitivity, and depth perception were not significantly different between the KOA and the control subjects.

DISCUSSION
The results supported our hypothesis that pain relieving intra-articular injections would improve the ability of people with painful KOA to avoid stepping on a suddenly appearing obstacle, but not to the level of healthy control subjects. Pain relief improved the OAS rate of the patients to within 20% of that of the healthy control subject. Thus, pain appears to be a major factor that increases the propensity of KOA patients to trip on an obstacle. There were deficits in balance (single limb stance duration) in the KOA subjects which were not affected by pain relief. The effects of balance on OAS rate independent of pain. Furthermore, there are apparently factors in addition to pain and balance that affect the ability of people with KOA to avoid contacting a suddenly appearing obstacle. Comorbid factors that may affect obstacle avoidance in people with knee osteoarthritis include reduced proprioception, varus-valgus deformity, abnormal knee laxity and quadriceps weakness. Future studies will be required to determine if these or other factors affect the ability of people with KOA to avoid contacting a suddenly appearing obstacle. Nevertheless, the results of this study indicate the importance of treating knee pain alone in reducing the propensity of people with painful KOA to avoid stepping on a suddenly appearing obstacle.

REFERENCES