INTRODUCTION:
Osteoarthritis (OA) is a common joint disorder with OA of the knee being especially common and debilitating. Most of the current treatment options for this condition focus on symptomatic relief with little effect on those characteristics which, if corrected, could work to modify the disease progression. Proprioception deficits are known to occur with knee OA and it has been proposed that correction of these deficits may help to slow disease progression. While wearing knee braces and sleeves has produced some improvement in proprioception in the non-weight bearing knee (1,3,4) a novel means of enhancing these effects may be through stochastic resonance electrical stimulation. Stochastic resonance (SR) stimulation has been demonstrated to enhance the sensitivity of mechanoreceptors in increasing the output of sensory systems (2, 5). The purpose of this research was to determine whether proprioception measured by joint position sense (JPS) is improved through the use of electrical stimulation in combination with a neoprene knee sleeve in a population with mild to moderate medial knee OA. We hypothesized that the stimulation/sleeve conditions would improve proprioception compared to both the control and the sleeve alone conditions.

METHODS:
Following approval by the UNC Institutional Review Board, 38 subjects (26 females, 12 males) with mild to moderate (KL grade 1-3) medial knee OA were recruited for testing. Subjects gave their informed consent before testing began. Before testing began, subjects completed several questionnaires concerning their demographics, self-reported knee instability, as well as the functionality of their knee (KOOS). Each subject’s JPS was measured during five conditions: (no stimulation/no sleeve NE/NS1; counterbalance of three conditions: 50uA stimulation/sleeve E50/S, 75uA stimulation/sleeve E75/S, and no stimulation/sleeve NS/E50; and no stimulation/no sleeve NE/NS2) during both a partial weight bearing (PWB) and a nonweight bearing (NWB) task. To test for memorization or fatigue effects, a control condition was presented first and last in both the PWB and NWB tasks with a counterbalancing of the three remaining conditions. A blindfold and earphones with white noise were worn by each subject during testing to eliminate visual and auditory cues. Electrotytic tilt sensors were strapped to both the thigh and shank of the test limb in order to measure the target and reposition knee angles. During the NWB task, the subjects were seated in a reclined position with approximately 110° flexion to the target knee. During the PWB task, the subjects were returned to the starting position and holding for 5 seconds, the subject then actively attempted to reposition their test limb at the target angle. For the PWB task the subject was supine on a relatively frictionless, sliding, reclined platform. Each trial began with the subject actively moving from full extension to the target angle, returning to the starting position, and then attempting to actively reposition their knee to the target angle. The test limb was determined as the limb most severely affected with knee OA or in the case that both knees were equally affected, the subject’s dominant limb was tested.

The electrical stimulation consisted of either a 50uA or 75uA Gaussian white noise signal with zero mean (s.d.=0.05mA, 0-1000Hz bandwidth) applied through electrodes placed approximately 2cm above and below the knee joint line on the medial and lateral sides of the knee. During both the PWB and NWB tasks the absolute difference (error) between the target knee angle and the reproduction angle was calculated and averaged across the 5 trials within each of the five conditions. Following JPS testing, each subject’s threshold of detection of the electrical stimulation was measured. One-way repeated measures analysis of variance was conducted to determine overall significant differences between the measured variables for each of the two tasks (NWB and PWB). Tukey’s test was then performed to determine specific statistical differences (p<0.05) between the various testing conditions by making multiple comparisons.

RESULTS:
A paired t-test determined there was no significant difference between the two control conditions (NE/NS1 and NE/NS2) which allowed for only the first control condition (NE/NS1) to be included in subsequent statistical analysis. The one-way repeated measures ANOVA (4 conditions) revealed significant differences in both the NE/S (p=0.012) and E75/S (p=0.04) conditions compared with the control condition in the PWB task (Figure 1). The absolute error of the E50/S condition was not found to differ from the control condition. No significant differences were found among the testing conditions in the NWB task.

DISCUSSION:
Our results were only partially supportive of our hypothesis. The sleeve alone condition and the E75/S condition significantly improved JPS compared to the control condition in the PWB task. However, there were no improvements in the E50/S condition compared to the control and no improvements in any condition in the NWB task. Additionally, the stimulation/sleeve conditions were not significantly improved compared to the sleeve alone conditions. One new finding is the sleeve alone condition significantly improved JPS from the control in the PWB task (5). Several studies have demonstrated increases in proprioceptive acuity with knee sleeves/braces but only in a NWB situation (1,3,4).

While previous studies in normal subjects have found improvements in JPS when wearing sleeves during a NWB task, our finding of no improvement with the sleeve during the NWB task is in agreement with previous results in OA subjects (6). SR stimulation may still have the potential to enhance the dynamic function of the knee as past studies in the spine also did not find improved JPS with SR stimulation, but did see improvements in balance (7). Our study is limited by the SR stimulation amplitudes used. While the stimulation amplitudes used in this study have significantly improved balance in elderly subjects when applied at the knee in previous studies (8), they may not have been sufficient to elicit activation of mechanoreceptors within a degenerative joint.

REFERENCES:

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