PROPRIOCEPTIVE ACUITY IN THE FRONTAL AND SAGITTAL PLANES IN KNEE OSTEOARTHRITIS

Martha Cammarata¹,² and Yasin Dhaher¹,²

¹ Department of Biomedical Engineering, Northwestern University, Chicago, IL, USA
² Sensory Motor Performance Program, Rehabilitation Institute of Chicago, Chicago, IL, USA
E-mail: m-cammarata@u.northwestern.edu

INTRODUCTION

The initiation and progression of knee osteoarthritis (OA) may be attributed in part to abnormal loading placed on the articular cartilage during everyday tasks. In particular, changes in frontal plane kinetics and kinematics at the knee may be especially detrimental to joint health [1,2]. These abnormal frontal plane loads may be due to decreased passive ligament-capsule stiffness as well as alterations in neuromuscular control. The latter is partially dependent on joint proprioception, or the perception or joint position and movement. Indeed, proprioceptive impairments to knee flexion and extension have been demonstration in people with knee OA [3] and this deficit has been identified as a risk factor for the progression of the disease [4]. However, despite the significant role that frontal plane loading may play in the progression of knee OA, joint proprioception in the frontal plane of the knee and its modulation with OA has not yet been examined. It is unknown if frontal plane knee proprioception is differentially affected by knee OA compared to sagittal plane proprioception.

Accordingly, the aim of this study was to quantify proprioception in both the frontal and sagittal planes of the knee in healthy and osteoarthritic knees. We hypothesize that proprioceptive acuity will be decreased in the knee OA population and that proprioceptive acuity will be increased in the frontal plane compared to the sagittal plane in both groups. If proprioceptive acuity is differentially modulated by knee OA across planes, it may indicate that the disease differentially affects the contribution of specific sensory afferents, which may be the result of disease induced changes in joint mechanics. This investigation may help to elucidate some of the neuromechanical factors that contribute to the progression of the disease.

METHODS

Thirteen persons with knee OA (7 males, 6 females, age mean (SD) 57 (10) years) and ten age-matched healthy control subjects (7 males, 3 females, age 55 (8) years) participated in the study after providing informed consent. Participants in the knee OA group had been diagnosed with unilateral or bilateral tibio-femoral knee OA according to American College of Rheumatology guidelines and presented radiographic evidence of OA in the symptomatic knee(s) with a Kellgren/Lawrence grade of 2 or higher.

The more affected limb of knee OA subjects and the right leg of control subjects were tested. For testing in the frontal plane, subjects were seated in an experimental chair with the knee fully extended. The ankle was placed in an inflated aircast and secured to a servomotor, which rotated into varus and valgus. Brackets were fastened around the knee to prevent translation. In the sagittal plane, subjects were seated in the chair with the knee at 30° of flexion and the servomotor center of rotation was aligned with the femoral epicondyles. Subjects wore headphones and an eyemask to reduce auditory and visual cues.

Proprioception was assessed in varus, vaglus, flexion, and extension using the threshold to detection of passive movement (TDPM), following a protocol similar to previously published reports [3,5]. From the initial posture, the servomotor rotated the knee at a velocity of 1°/s and subjects were instructed to press a handheld button as soon as movement of the limb was detected. TDPM was defined as the position difference between the onset of movement and the subjects’ detection of movement. Following familiarization with the protocol, at least five trials were performed in each testing direction in a randomized order. The average
of all trials in each direction was used in further analysis.

To determine the effects of knee OA and movement direction on proprioception, a repeated measures Analysis of Variance (ANOVA) with one between factor (subject group) and one within factor (movement direction) was performed with alpha set a priori at 0.05. Post-hoc Tukey-Kramer comparisons were performed to determine specific differences between groups.

RESULTS

TDPM results indicated decreased proprioceptive acuity in the knee OA group compared to the control group (Figure 1). A significant effect of study group (P=0.02) was detected and post-hoc Tukey-Kramer comparisons showed that TDPM values were significantly larger (indicating decreased proprioceptive acuity) in the knee OA group for all directions tested.

![Figure 1: TDPM results (in degrees) for knee OA and healthy control subjects for each direction tested. Error bars represent standard deviation. *Significant difference between OA and control groups (P<0.05)](image)

While on average, TDPM in the frontal plane was decreased compared to the sagittal plane, no significant differences (P>0.05) between movement directions were noted within each study group. Furthermore, the amplitude of difference between groups was consistent across all directions (Table 1).

DISCUSSION AND SUMMARY

Our results indicate that proprioceptive acuity is decreased in knee OA subjects compared to healthy age-matched control subjects equally in both the frontal and sagittal planes of the knee. However, within each group, there were no significant differences noted between movement directions. These results suggest that proprioceptive impairments associated with knee OA are not tissue specific, but rather represent a global decline in proprioceptive acuity. Further, this may signify that assessing TDPM solely in the sagittal plane is a sufficient metric to gauge proprioceptive decline in knee OA.

REFERENCES


ACKNOWLEDGEMENTS

This work was supported by funding from the National Institutes of Health (R01 AR049837), the Arthritis Foundation and the Alpha Omicron Pi Foundation.

Table 1: Difference in TDPM measures between knee OA and Control groups in degrees. Reported as Mean (95% Confidence Intervals)

<table>
<thead>
<tr>
<th>Frontal Plane</th>
<th>Sagittal Plane</th>
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<tr>
<td></td>
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<tr>
<td>Valgus</td>
<td>Extension</td>
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<tr>
<td>0.78</td>
<td>0.89</td>
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<tr>
<td>(0.06, 1.58)</td>
<td>(0.19, 1.59)</td>
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<tr>
<td>Varus</td>
<td>Flexion</td>
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<tr>
<td>0.82</td>
<td>0.67</td>
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<tr>
<td>(0.13, 1.69)</td>
<td>(0.04, 1.58)</td>
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