LOWER EXTREMITY EMG CO-ACTIVATION PATTERNS DUE TO HIP OSTEOARTHRITIS

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SUMMARY
We assessed the periarticular co-activation pattern (PCAI) of patients with terminal hip osteoarthritis (OA) before and after total hip arthroplasty (THA) and compared it to asymptomatic controls during self selected speed gait.

INTRODUCTION
Muscle co-activation patterns using electromyography have been used extensively to assess changes in the neuromuscular function in individuals with knee OA. Abnormal co-activation patterns are believed to reflect sensory and motor impairments during functional activities such as walking [1]. Knee muscle co-activation indices are also sensitive to the severity of the OA and such measures may be used to discriminate OA severity [2]. However, hip OA while equally prevalent [3,4] has not been met with similar scrutiny. The recent confirmation of association between knee and ankle OA [5] demonstrates the need for assessment of the entire lower extremity neuromuscular function. Therefore, joint specific synergistic muscle co-activation over distinct phases of the gait cycle was evaluated in a group of patients with hip OA, before and after THA, and matched controls.

METHODS
Kinematic, kinetic and electromyography (EMG) data were collected on 12 THA patients (7M & 5F) and 9 age- and gender-matched controls before (Pre) and 3 months post (3m) surgery during gait. Periarticular co-activation indices (PCAI) were calculated separately for each lower extremity joint (hip, knee, and ankle) for three separate phases of the gait cycle (breaking, propulsion and swing) while walking at a self selected speed. The joint specific PCAI was calculated using the EMG activation patterns of the following muscle groups: Hip – gluteus maximus, gluteus medius, rectus femoris, semitendinosus and biceps femoris; Knee – rectus femoris, vastus medialis, vastus lateralis, semitendinosus, biceps femoris and gastrocnemius; and Ankle – gastrocnemius, soleus and tibialis anterior. Two sample and paired t-test procedures were used to test for between group and within THA group (Pre vs. 3m Post surgery) differences, respectively (SPSS 18).

RESULTS AND DISCUSSION
The patients with hip OA showed higher co-activation patterns than the controls at the hip and knee joints during the entire stance phase (breaking and propulsion) of the gait cycle. (Table 1) It was not surprising that hip and knee co-activation patterns exhibit a similar neuromuscular function, since many of the muscles assessed cross both joints. However, higher co-activation values were observed at the hip than the knee and ankle during the breaking phase of the gait cycle for all the subjects. We found no ankle joint co-activation differences between the groups. The THA patients 3 months post surgery retained the habitual neuromuscular function at the hip joint. The only change observed was a co-activation reduction at the knee during propulsion. (Figure 1) It appears those post surgical adaptations, in the neuromuscular co-activation pattern, start at the non-involved joint and do not happen throughout the stance phase of gait simultaneously.

CONCLUSIONS
Higher muscle co-activation in the lower extremity in patients with hip OA was evident at the hip and knee but not at the ankle. In the short term, post THA, increased muscle co-activation continues to persist despite the small improvements observed at the knee joint. The increased co-activation pattern observed is gait cycle phase specific and it is not limited to the involved joint. The PCAI analysis technique used here is promising in assessing the long-term persistence of co-activation and the rehabilitation after surgery.

ACKNOWLEDGEMENTS
Julian Rivera for data collection technical support
DMU-IOER for financial support, Grant #: 112-3167
REFERENCES

Table 1: Periarticular co-activation indices (mean ± standard deviation) indicating percent co-activation for the THA patients (at Pre and 3 month Post surgery) and controls of each of the lower extremity joints during the 3 phases of the gait cycle.

<table>
<thead>
<tr>
<th>Gait Phase</th>
<th>Joint</th>
<th>Breaking Phase</th>
<th>Propulsion Phase</th>
<th>Swing Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hip</td>
<td>Knee</td>
<td>Ankle</td>
<td>Hip</td>
</tr>
<tr>
<td>THA Pre</td>
<td>38.3 * (± 15.3)</td>
<td>32.1 ! (± 13.2)</td>
<td>17.9 (± 6.7)</td>
<td>21.5 ‡ (± 8.8)</td>
</tr>
<tr>
<td>THA 3m Post</td>
<td>38.1 * (± 12.2)</td>
<td>28.8 * (± 12.6)</td>
<td>19.8 (± 5.1)</td>
<td>20.7 ! (± 3.7)</td>
</tr>
<tr>
<td>Control</td>
<td>26.5 ** (± 5.6)</td>
<td>17.1 *! (± 1.9)</td>
<td>15.8 (± 2.5)</td>
<td>9.5 †‡ (± 2.4)</td>
</tr>
</tbody>
</table>

* ! ‡ indicate significant group differences in percent co-activation; * p < .05; ! p < .01; ‡ p < .001