Ground Reaction Force Alterations Due to Experimentally-induced Anterior Knee Pain During Walking

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INTRODUCTION

• Knee pain is common: ½ of Americans will suffer knee pain and related costs are nearing 20 billion dollars (Gottlob et al., 1999; Murphy et al., 2008)

• Knee pathology usually includes pain, swelling, muscle inhibition and atrophy, joint instability, and altered biomechanics

• Although pain is a primary symptom of knee pathology, the independent influence of pain on movement mechanics is unclear
PURPOSE

• The purpose of this study was to evaluate the influence of experimentally-induced anterior knee joint pain on ground reaction forces (GRF) during walking.

• We hypothesized that experimentally-induced anterior knee pain would result in: (1) increased vertical GRF and (2) decreased stance time.
METHODS

• Twelve subjects (6 male, 6 female; age = 23 ± 3 yrs; height = 1.73 ± 0.09 m; mass = 75 ± 14 kg) walked under 3 conditions:

  1. Pain—hypertonic saline (5.0% Na)
  2. Sham—isotonic saline (0.9% Na)
  3. Control—no saline

• Saline (6 ml) was infused over 20 minutes
METHODS

For each condition:

1. 3 baseline walking trials were performed (Time 1)
2. Infusion was initiated (painful and sham conditions)
3. 15 minutes later, 3 more walking trials were performed (Time 2)
4. Catheter was removed
5. 20 minutes later, 3 more walking trials were performed (Time 3)
Methods

Dependent variables:

1. Subject-perceived pain
2. Walking speed
3. Peak impact force (PI)
4. Peak impact force loading rate (LR)
5. Unloading force (U)
6. Peak push-off force (PP)
7. Stance time
DATA ANALYSIS

• Normalized GRF were averaged for each time (time 1, time 2, and time 3) and condition (pain, sham, and control), for each subject.

• Repeated measures ANOVA ($\alpha = 0.05$) was used to detect differences among times, among the three different conditions.

• Tukeys post hoc analyses were also used.
RESULTS

A condition × time interaction existed for subject-perceived pain level

![Graph showing subject-perceived pain levels over time for Control, Pain, and Sham groups. The graph indicates significant differences at certain time points, marked with an asterisk (*), and suggests that the Pain group experiences higher pain levels compared to the Control and Sham groups. The results are statistically significant at p < 0.01.]
RESULTS

A condition × time interaction did not exist for walking speed

(p = 0.90)
RESULTS

Experimentally-induced pain resulted in decreased peak impact GRF during Time 2
RESULTS

Impact GRF loading rate was not influenced by experimentally-induced pain

![Graph showing peak vertical force loading rate over time for different conditions with p < 0.07](image-url)
RESULTS
Experimentally-induced pain resulted in an increased unloading GRF during Time 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Control</th>
<th>Sham</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>0.72</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>Time 2</td>
<td>0.68</td>
<td>0.70</td>
<td>0.76</td>
</tr>
<tr>
<td>Time 3</td>
<td>0.72</td>
<td>0.70</td>
<td>0.68</td>
</tr>
</tbody>
</table>

$\text{(p < 0.01)}$
RESULTS

Experimentally-induced pain resulted in a decreased peak push-off GRF during Time 2

![Graph showing peak vertical push-off force (BW) over time for three conditions: Control, Sham, and Pain. The graph indicates a significant decrease in peak force for the Pain condition during Time 2, marked with an asterisk (*) and a p-value of less than 0.01.]
RESULTS

Stance time was not influenced by experimentally-induced pain

\[ p < 0.22 \]
RESULTS
Effects of experimentally-induced anterior knee joint pain for three different subjects
DISCUSSION

• Generally, our hypotheses were not supported; most GRF characteristics were decreased as a result of the pain condition.

• The experimental pain model did promote knee joint pain.

• This may have been a result of a conscious or subconscious decision made by the subject to reduce GRF to the affected leg.
DISCUSSION

• This observed emphasis to the unaffected leg may occur during other functional movements and increase GRF the unaffected leg

• This hypothesized increase in GRF to the unaffected leg may lead to increased injury/disease