INTRODUCTION

In recent years, core stability has become an extremely popular topic among clinicians, researchers, and physically active people in general. It is believed that the core musculature (muscles of the abdomen and lower back) contracts to stabilize the spine and provide a solid foundation of movement for the lower extremities [1]. Consequently, this has led to the popular notion that insufficient core stability may lead to inefficient movements that may ultimately lead to injury [2].

The scientific data supporting the relationship between core stability and lower extremity injury is limited and primarily cross-sectional or retrospective [2]. Causal conclusions cannot be drawn from these studies or from the prospective studies that also exist. Therefore a new paradigm is needed to determine causal relationships between core stability and lower extremity movement.

The purpose of this study was to develop a core stability knockdown protocol (CSKP) that reduces one’s ability to control movement of the torso. By allowing core stability to be reduced in an isolated, controlled manner this paradigm will permit within-subject analyses during a single testing session. Such a protocol could then be used to determine the influence of core stability on various biomechanical variables.

METHODS

Five subjects (1 female, age = 24.8±2.9 years, height = 1.78±0.08 m, mass = 77.6±18.7 kg) provided IRB-approved informed consent prior to participating in this study. Each subject had their core stability measured before and after the CSKP using a novel unstable quiet sitting test developed by our research team, shown in Figure 1. We designed this test in order to objectivley and quantitatively measure core stability in a way that could also be replicated in the clinical setting. In this test, a participant sat on top of the rounded end of a BOSU ball positioned on a platform high enough so that their feet did not touch the ground. This platform was placed on top of two Bertec 4060-10 force plates embedded in the ground. Participants were instructed to sit as still as possible for 60 seconds with their eyes closed while performing a secondary task of counting backwards in increments of 4. Recent postural control research has utilized a similar secondary task during quiet standing because it may be a more functional measure of stability since typically attention is divided between multiple tasks and not solely focused on postural control [3].

Figure 1. Unstable quiet sitting test used to quantitatively measure core stability.

During the trial, center of pressure (COP) data were recorded and used as measures of core stability. Measured variables included: COP path length, average anterior-posterior (A-P) COP velocity, and average medial-lateral (M-L) COP velocity. For
each condition (baseline/pre-CSKP, post-CSKP) three trials were collected and the median was used for analysis.

After a participant’s baseline core stability was measured, they completed the CSKP. The CSKP consists of 4 dynamic and 4 isometric exercises chosen by our research staff to target both the superficial and deep core musculature with minimal involvement from the lower extremity muscles. All subjects completed each exercise to voluntary exhaustion or until proper form could not be maintained in the following order: 1) right side bend on a BOSU ball, 2) left side bend on a BOSU ball, 3) back extension reps on a BOSU ball, 4) sit-ups on a Swiss ball, 5) right side plank, 6) left side plank, 7) back extension hold, and 8) traditional plank. All exercises were completed consecutively with minimal to no rest between each. Following the CSKP, participants were given a 3 minute rest to allow their breathing rate to return to normal. A participant’s post-CSKP core stability was measured immediately after this rest as previously described.

Two sided paired t-tests were used with a significance level $\alpha = 0.05$ to test the hypothesis that after the CSKP participants had significantly different COP measures following the CSKP, signifying a change in core stability.

**RESULTS AND DISCUSSION**

The average change in COP measures from pre- to post-CSKP is shown in Table 1. We found that both COP path length and mean M-L COP velocity were significantly different and mean A-P velocity trended toward significance when tested 3 minutes after the conclusion of the CSKP. Looking at the mean difference in COP measures from pre- to post-CSKP we found all COP measures increased for all subjects, confirming a reduction in core stability. Since the core stability measurements took an additional 3 minutes, this protocol significantly increased these measures for at least 6 minutes following the conclusion of the CSKP. This demonstrates that the CSKP negatively affected postural control of participants indicating that the knockdown protocol was successful in temporarily reducing a person’s core stability.

This approach minimizes confounding variables and eliminates retention and compliance issues that frequently arise in long-term intervention studies. The protocol should allow for causal conclusions to be drawn when studying core stability and has the potential to be used in a variety of settings to further establish the relationship between core stability and lower extremity function. Knowledge gained from studies utilizing this approach will be able to determine the degree to which core stability changes are associated with various biomechanical changes. This knowledge may assist in the development of improved injury prevention and rehabilitation protocols.

**Table 1:** Average change in COP measures for all subjects (N=5) from pre- to post-CSKP. *signifies a significant difference at a significance level $\alpha = 0.05$.

<table>
<thead>
<tr>
<th>COP path length (mm)</th>
<th>Mean Change $\pm$ SD (Post-CSKP – Pre-CSKP)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>200.17 $\pm$ 123.28</td>
<td>0.0221*</td>
</tr>
<tr>
<td>Mean A-P COP velocity (mm/s)</td>
<td>1.92 $\pm$ 1.69</td>
<td>0.0647</td>
</tr>
<tr>
<td>Mean M-L COP velocity (mm/s)</td>
<td>2.37 $\pm$ 1.16</td>
<td>0.0105*</td>
</tr>
</tbody>
</table>

**REFERENCES**


**ACKNOWLEDGEMENTS**

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