INTRODUCTION

Motivation

- Adult degenerative scoliosis (ADS) is a common musculoskeletal problem in older adults affecting up to 68% of the individuals older than 70 years old, causing low back pain and mobility issues. [1]
- Surgical intervention for ADS can improve gait, balance and other health related clinical scores.
- Due to the high variation in ADS patients (e.g., severity of ADS (Cobb angle), affected side, and position /number of disks involved) tracking the improvements following a surgery is challenging.
- Muscle synergies, a potential way that the CNS controls the muscles, have been extracted and have shown promise in explaining post-surgery enhancements in ADS patients [2]. A greater number of synergies were required for walking following a surgery, verifying a more complex and advanced gait control [2].
- Entropy, an indicator of the randomness and disorder, may uncover the enhancements in control. High entropy is associated with randomness while low entropy shows a deliberate control (Fig. 1).
- Entropy takes all the muscles into account. Hence, it can track the enhancements in patients despite their high variations.

Objectives

- To compare the entropy of the walking muscle synergies before and after surgical alignment in ADS patients.

Hypotheses

- We hypothesize that the entropy associated with walking muscle synergies of ADS patients will decrease following a surgery, indicating a more deterministic control.

METHODS

Subjects

- Thirteen ADS patients participated in this IRB-approved study with their own written consent.
- Subjects were excluded in case of a Cobb angle more than 50 degrees.

RESULTS

- The entropy values for each individual’s synergy was calculated (minimum, maximum, average, and standard deviations were 2.40, 3.76, 3.19, and 0.26, respectively). All synergies indicated a significant decrease in their entropy following surgery (p-values < 0.001) (Table 1).

<table>
<thead>
<tr>
<th>Synergy</th>
<th>W1</th>
<th>W2</th>
<th>W3</th>
<th>W4</th>
<th>W5</th>
<th>W6</th>
<th>W7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-surgery</td>
<td>5.26 ± 3.41</td>
<td>3.12 ± 3.30</td>
<td>0.24 ± 0.17</td>
<td>0.31 ± 0.18</td>
<td>0.21 ± 0.19</td>
<td>0.21 ± 0.19</td>
<td>0.21 ± 0.19</td>
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<tr>
<td>Post-surgery</td>
<td>0.39 ± 0.32</td>
<td>0.27 ± 0.28</td>
<td>0.23 ± 0.22</td>
<td>0.22 ± 0.25</td>
<td>0.22 ± 0.25</td>
<td>0.22 ± 0.25</td>
<td>0.22 ± 0.25</td>
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p-value: 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001

DISCUSSION and CONCLUSION

- Low back pain, has the potential to affect motor control by reducing the joint movements to reduce the pain.
- Surgery may change the motor control and walking by reducing the pain levels, the geometric deformity, and the asymmetry in ADS patients.
- Lower entropy values following a surgery may indicate that the CNS is more likely to deliberately activate a muscle to reach a certain kinematic or kinetic goal rather than unwanted co-activations to restrain the joint movements, and consequently, pain reduction.
- The higher entropy may indicate a more random and chaotic control of the muscles before surgery [4].
- Prior research has also shown a similar association between lower entropy a more deterministic COM control in quiet standing [4].
- Surgery is helping ADS patients to have more complex and deterministic control while walking.
- The findings are not limited to ADS patients and propose a novel method to track the improvements in different patients following different treatments.

References