**Introduction:** Myelomeningocele (MM) is complex disease that often results in functional disability. Studies have shown that approximately 50-60% of young adult patients ambulate in the community, with around 20% of these patients using an assistive device, such as Lofstrand crutches [1]. During crutch walking, peak axial loads are a substantial amount of body weight. Literature has shown that long term crutch usage can result in upper extremity (UE) pathologies, such as destructive shoulder arthropathy, degenerative arthritis of the shoulder and wrist, or carpal tunnel syndrome [2, 3]. Klimaitis et al found that bearing weight through the upper limbs may hasten the development of degenerative arthritis in the shoulder [4].

Currently, there are limited models for quantitative assessment of UE dynamics in children with MM. Dynamics of the lower extremity during crutch-assisted gait have been studied extensively in children with MM using three-dimensional (3D) motion analysis [5]. However, movements of the UE during walking have only been investigated to a small extent in children with MM [6]. Therefore, a 3D biomechanical model of the UEs was developed for dynamic analysis of Lofstrand crutch-assisted gait in children with MM. This research study investigates two common types of gait patterns used by children with MM: 1) reciprocal gait and 2) swing-through gait. We hope to gain a better understanding of the demands placed on the UE during reciprocal and swing-through gait with children with MM. Investigation of the forces exerted on the UE will be helpful in understanding joint loading patterns and ambulatory control associated with the respective crutch-assisted walking patterns. We also hope to determine whether particular methods of walking are less stressful on the UE joints.

**Materials and Methods:** The UE model is composed of 2 crutch segments and 7 rigid-body segments: right/left trunk, right/left upper arm, right/left forearm, and right/left hand. Twenty-six passive reflective markers were used to model the coupled UEs and crutches. The model design was based on previous work and recommendations by the International Society of Biomechanics (ISB) [7, 8]. Lofstrand crutches were instrumented with six-axis AMTI sensors to measure the applied reaction forces. UE dynamics were captured using a Vicon MX system. Kinematic and transducer force data were combined in an inverse dynamics algorithm to determine forces at the crutches and shoulders. Five subjects with MM participated in a gait analysis at Shriners Hospital for Children, Chicago. The authors would like to thank Mei Wang, Sahar Hassani, Adam Graf, Kathy Reiners, and Vicky Young and for their contributions to this study.

**Results:** Cadence, walking speed, and stride length were greater during reciprocal and swing-through gait than reciprocal gait. Table 1. Temporal-Distance Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reciprocal Gait</th>
<th>Swing Through Gait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadence (cycles/min)</td>
<td>97</td>
<td>75</td>
</tr>
<tr>
<td>Walking Speed (m/s)</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Stride Length (m)</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Stride Duration (s)</td>
<td>0.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Kinematic results exhibited larger joint ranges of motion during swing-through gait [9]. In comparing the crutch forces three-dimensionally, the superior crutch forces were the highest. Right and left crutch forces were greater during swing-through gait than reciprocal gait in all directions, except lateral. Right and left shoulder forces presented similar morphology during reciprocal and swing-through crutch-assisted gait. The highest shoulder joint forces were directed superiorly.

**References:**

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