Background

What is an RGO?
- The Reciprocating Gait Orthosis (RGO) is a rehabilitation device that enables people with lower limb paralysis to walk with the aid of crutches or a walker (Figs. 1, 2).
- RGO’s prevent motion at the knee and the ankle, and limit motion of the hip to the sagittal plane.
- The hip joints of the RGO are mechanically linked so that extension of one hip joint forces flexion in the other, and vice versa.

Motivation
- Walking with an RGO is slow and exhausting.
  - Walking velocity is 7 times slower than able bodied people.1
  - Energy expenditure is 7 times greater than able bodied people.1
- The gait dynamics of RGO users has not been thoroughly investigated.
- The purpose of this study is to measure the kinematics and kinetics of RGO gait and see how they might contribute to the high energy expenditure associated with RGO gait.

Results & Discussion

Posture
- RGO users walk with their trunks flexed throughout the gait cycle (Fig. 3).
  - They extend their trunks during the single support phase of gait (highlighted in gray) to induce flexion of the swing leg.
- During portions of the single support phase, less than half of the user’s weight is supported by the foot (Fig. 4).
  - The remainder of the weight is borne through the user’s arms.
  - Arm muscles fatigue faster than leg muscles.1
- Due to the flexed posture of the trunk, forces acting at the shoulders promote trunk extension while forces at the hip promote flexion (Fig. 5).
  - Arm loading is necessary to achieve trunk extension in single support by increasing shoulder forces and decreasing hip forces so that there is a net extension moment.

Energy Conservation
- During able-bodied gait, decreases in potential energy coincide with nearly equal increases in kinetic energy, and vice versa. Therefore, mechanical energy is conserved to a great extent.
- For RGO users, decreases in potential energy coincide with decreases in kinetic energy in single support (highlighted in gray), so mechanical energy is poorly conserved (Fig. 6).
- Shoulder forces opposing forward progression during single support may contribute to the loss of mechanical energy (Fig. 7), reducing mechanical energy conservation.

Reciprocal Link
- Studies have shown that the reciprocal link barely assists leg swing, if at all.1
- Some researchers have suggested that the link may resist leg swing.1
- Power dissipation was observed at the swing leg hip joint for a majority of single support (Fig. 8).
- Dampening at the hip joint could also account for the dissipation of power. Further inquiry is required.

Methods
- Recruited 4 subjects over the age of 6 to walk in the VA Chicago Motion Analysis Research Laboratory (VACMARL).
- 8 infrared cameras and passive reflective markers were used to measure the motion of body segments.
- 6 force plates embedded in the floor measured the ground reaction forces acting on the subjects and their walking aids.
- The trajectories of the body segments and the ground reaction forces were used to calculate joint angles as well as the forces and torques acting on the joints and the mechanical energies of the body segments.

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References

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