Design and development of a semi-rigid hip exoskeleton to reduce metabolic cost

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Robotic exoskeletons can reduce metabolic cost in healthy individuals and restore mobility in patients with peripheral artery disease (PAD). PAD is a cardiovascular disease produced by atherosclerosis of the leg arteries. The primary symptom of PAD is claudication or pain in the legs during walking, which severely shortens the distance a patient can walk. Knowing that up to 40% of the metabolic cost of walking comes from the hip muscles, different groups have been developing rigid exoskeletons and soft exosuits that assist the hip. Assisting at the hip has the advantage that the exoskeleton mass is positioned close to the center of mass, which minimizes the energy cost of the added mass. Soft exosuits have the advantage that they allow greater freedom of movement. However, soft exosuits often cannot apply the same torque magnitudes as rigid exoskeletons, and they rely on friction with the skin to remain anchored. The purpose of this work was to develop a semi-rigid hip exoskeleton that can connect to and be powered by an existing actuation unit, to address the limitations of current existing soft exosuits. We evaluated the device performance by analyzing the match between desired and actual torque applied to the hip joint. Our exoskeleton's semi-rigid design introduces advantages in comfort and efficiency of control in patients with PAD because it requires less friction and compression than soft exosuits. Our initial work demonstrates a good match between the desired and actual torque that the exoskeleton was able to generate for each leg.