Doing Robot-Guided Ankle Exercises At Home Can Help Improve Walking Skills for Children with Cerebral Palsy

Cerebral palsy (CP) is the most common movement-related disability in children. CP is caused by brain damage early in life that can limit the brain’s ability to control muscle movements. Although many children with CP can walk with or without assistive devices, they may develop stiffness or spasms in their muscles crossing the ankle, causing difficulties with gait, balance, or long-distance walking. A combination of stretching and strength-building ankle training exercises can help children with CP improve their walking abilities. These exercises are often included as part of physical therapy. However, they can also be done through a portable robotic system. The system guides children through a standardized set of exercises that combine ankle stretching and strength-building using a motivating game-play design. In a recent NIDILRR-funded study, researchers compared the effectiveness of this robot-guided ankle training between that done in a laboratory setting and at home. They wanted to find out if the robot-guided ankle training could still be beneficial if it is done at home instead of in a laboratory setting.

Researchers at the Rehabilitation Engineering Research Center on Technologies for Children with Orthopedic Disabilities enrolled 41 children with CP in a study to test such a system. The children were 7-18 years old, and all could walk with or without assistive devices. All of the children participated in a six-week robot-guided ankle training program focusing on the ankle joint which was more severely affected. About half of the children were randomly assigned to the laboratory-based training group, where they completed the program in the research laboratory under a researcher’s supervision. The other half of the children were assigned to the home-based training group, and they completed the program at home under their parents’ supervision.

All children participated in three robot-guided ankle training sessions each week for six weeks. The robotic device consisted of a pedal attached by a lever to a motor, which was connected to a computer. During each session, the child sat in a comfortable chair and placed his or her foot on the pedal of the robotic device with the knee extended. The foot was strapped to the pedal and a leg brace supported the extended leg. The pedal could be tilted up and down, either by the child or by the motor. The robot was connected to the computer so the ankle exercises could be incorporated into a pre-programmed computer game and movement could be recorded for analysis by the researchers. Each session began with 10 minutes of ankle rotations performed by the robot to stretch the
ankle muscles. Then, the child participated in 20 minutes of specially-designed computer games. There were several game options and the child controlled game play using his or her foot movements. For example, the child flexed their foot both up (toward the shin) and down (away from the shin, like pushing on an accelerator) against resistance provided by the robot to move a spaceship or play a piano on the computer's screen. The session concluded with 10 more minutes of ankle stretching like what they did at the beginning of the session. All children from both the laboratory-based and home-based programs received their first training session in the laboratory, where the robot’s settings were adjusted individually for each child. For the children in the home-based program, the parents took the already-adjusted robot home and reassembled it for use in the remaining home-based sessions without changing any settings. The parents then uploaded performance data for each session from the robot onto a server to be evaluated by the researchers. All of the children in both programs completed all 18 ankle training sessions over the six weeks of the study.

To measure the effectiveness of the robot-guided ankle training program, the researchers administered a series of tests to all the children three times: before the program, immediately after the program, and at a six-week follow-up after the program. The tests measured how far the children could flex their ankle up or toward the shin voluntarily (active range of motion) and how far their ankles could be passively flexed by the robot (passive range of motion). The children also completed tests of balance, spasticity (muscle tightness), ankle stiffness, ability to perform coordinated leg movements (like curling their toes or bending and straightening their knees), and how far they could walk during a 6-minute time span.

The researchers found that both the laboratory-based and the home-based robotic ankle training programs led to improvements in ankle movement. Children in both groups had greater active range of motion and could walk further during a 6-minute period immediately after the training compared to before the training. At the six-week follow-up, they also showed decreases in ankle spasticity. The only major difference between the groups was that some of the training’s immediate benefits lasted longer for those children who participated in the laboratory-based training program than for those who used the device at home. In particular, the children in the home-based group started to reverse some of their gains in passive range of motion and some of their ankle stiffness had returned by the six-week follow-up. By comparison, the children in the laboratory-based program maintained their gains in range of motion and reduction of ankle stiffness and spasticity. The authors noted that the difference in progress may have happened because the stretching in the laboratory-based program may have been more rigorous than that in the home-based program, since the engineer supervising the program in the lab was able to increase the stretch settings as the children’s flexibility improved.

The authors noted that robot-guided exercise programs done at home may be a good supplement to traditional physical therapy for children with CP. The robotic
interface can standardize the program and add game-like elements to make the exercises more enjoyable. Doing the program at home may allow children to add more exercises between each traditional physical therapy sessions, hence exercise more frequently to maintain strength and flexibility. Home-based therapy may also decrease the number of in-clinic sessions needed, reducing costs for families and accelerating children’s functional skill development. Rehabilitation researchers may want to test the efficacy of home-based robot-guided exercises for children with more severe forms of CP.

To Learn More
The Rehabilitation Engineering Research Center on Technologies for Children with Orthopedic Disabilities has a collection of resources for parents and practitioners at http://www.tech4pod.org

See the robot-assisted ankle therapy in action in this described video: http://youtu.be/osRMixEpTjY

United Cerebral Palsy is the leading support and advocacy organization for people with CP, their families, and practitioners who support them. Visit them at http://www.ucp.org and check out their health and wellness resources at http://ucp.org/resources/health-and-wellness/

To Learn More About this Study

Research In Focus is a publication of the National Rehabilitation Information Center (NARIC), a library and information center focusing on disability and rehabilitation research, with a special focus on the research funded by NIDILRR. NARIC provides information, referral, and document delivery on a wide range of disability and rehabilitation topics. To learn more about this study and the work of the greater NIDILRR grantee community, visit NARIC at www.naric.com or call 800/346-2742 to speak to an information specialist.

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