Benefits of Overground Bionic Ambulation in an Individual with Stroke: A Case Study

Erin Lampron, PT, MSPT, NCS, Erika Ozdemirer, PT, DPT, NCS, Alyse Sicklick, MD, Stephanie Zanvettor, MSPT, *Gaylord Hospital, Wallingford, CT*

Gaylord Specialty Healthcare

Background/Purpose

After stroke, common impairments reported are weakness, sensory loss, pain, and fatigue, which may create functional limitations including abnormal gait. These impairments may contribute to serious health conditions such as obesity, diabetes and cardiovascular disease. One option for persons with stroke to regain ambulatory function and limit health risks is the use of Overground Bionic Ambulation (OBA). OBA is battery powered and externally applied, with parameters that can be adjusted for each individual. OBA enables individuals with lower extremity (LE) weakness to stand and walk.

Objective

To explore potential benefits of OBA including: improved LE strength, postural control/ balance and ambulation ability outside of the device, as well as a decreased fall risk in an individual with stroke.

Design/Methods

A retrospective case study report of a 45 y.o. woman with R MCA ischemic stroke. Participant presents with decreased LE strength, impaired postural control/ balance, and abnormal tone contributing to impaired gait. Participant completed 47 sessions of OBA using Ekso™ over 14 months in addition to receiving traditional land and aquatic therapy. Data collected while ambulating in the Ekso™ includes: time spent standing in the device (up time), walk time, number of steps, path and assist data, level of assistance, use of assistive device (AD), adverse effects and incidence of falls. Data obtained from ambulation outside of OBA includes: ambulation distance, level of assistance, use of AD, and LE orthotic use. LE strength scores and Timed Up and Go (TUG) test scores were reviewed. Balance assessments include: Romberg, Sharpened Romberg and single leg stance times.

Gaylord & Ekso™

- **Ekso program started in 2012**
- **Only hospital in CT to have this technology**
- **46 patients-to-date**
- **8 Level II Certified Ekso instructors**
- **790,000 steps and counting**

What is Ekso™ ?

Ekso™ is a wearable robot or exoskeleton that enables people with lower-extremity paralysis or weakness to stand and walk. It is a ready to wear, battery powered, bionic device that is strapped over the user's clothing. Ekso's Variable Assist is a feature which allows clinicians to augment their patients' strength and provides the ability to strategically target deficient aspects of their gait.

How does Variable Assist work?

Variable Assist works by allowing individuals with any amount of lower extremity strength to contribute their own power -- from either leg -- to achieve walking over ground. Based on the therapeutic goals, therapists have the option to assign a specific amount of power contribution to augment their patients' efforts, or to allow the Ekso suit to dynamically adjust to their needs in real-time.

Types of Assistance

- **Bilateral Max Assist**
  Using Bilateral Max Assist, the Ekso suit provides full power to both legs. No strength is required from the patient: only proper balance and weight shifts are required to achieve walking.
- **Adaptive Assist**
  When working in Adaptive Assist, patients with any amount of lower extremity strength contribute what they can to their walking efforts. Ekso dynamically adjusts to produce a smooth, consistent gait.
- **Fixed Assist**
  Using Fixed Assist, either leg of the Ekso contributes a fixed amount of power to help patients complete steps in a specified amount of time.

Feedback Measures

- **Forward Assistance**
  The amount of assistance that the machine provides to the patient in the forward direction. In fixed assist, this number will match the value set by the operator.
- **Minimum Assistance**
  The detected minimum forward assistance that the patient needs to complete swing. This value indicates the approximate assistance at which the patient would struggle to complete the step.
- **Path Assistance**
  The amount of assistance provided to the patient to keep them in the middle of the gait trajectory.

Results

Increases in up and walk time and number of steps per session over time during OBA were observed. Decreased levels of assistance and use of a lesser AD during OBA were also noted. Decreases in path deviation and decreased assistance required from Ekso™ were recorded. No OBA sessions were terminated due to adverse effects. No falls were reported. TUG score improved by 4 seconds, indicating a clinically important decrease in fall risk. Improved ambulation ability outside of OBA was also observed including: increased walking distance, decreased level of assistance, use of a lesser AD, and improved balance and postural control. LE strength improved. No change in LE spasticity was reported.

Timed Up and Go (TUG):

Patient begins seated in standard armchair with back against the chair, arms resting on chair's arms. May use an assistive device and/or bracing however cannot require assistance of a person. Patient is instructed to walk to a line that is 3 meters (9.8 feet) away, turn around at the line, walk back to the chair and sit down.

TUG Norms:

Time	
<10 sec	Normal
11- 20 sec	WFL for frail elderly or individuals with disability
>14 sec	Risk for falls for stroke
>20 sec	Impaired functional mobility
>30 sec	Dependency in most ADLs and mobility skills

Minimal detectable change for chronic stroke: ***2.9 sec***

Patient TUG info:

Although still > 14 sec. and still at risk for falls; there is a clinically meaningful decrease in this fall risk since it is greater than a 2.9 sec. change.

Patient's Ambulation Outside of Ekso Use:

4/29/14: Ambulation 15' using tripod SC with min(A) and circumduction (L) LE, (L) hip hike, decreased hip and knee flexion and decreased weight shift to the (R); 3 point gait pattern

5/5/15: (I) Ambulation greater than 500' using tripod based SC increased knee flexion and hip flexion w/ (L) LE; 2 pt gait pattern; improved (R) weight shift

Patient's Ekso Walking Data

Average # of steps/visit	643 steps
Average Up Time/visit	28 minutes
Average Walk Time/visit	20 minutes
Average Forward Assist for the (L)	88.15
Average Min Assist for the (L)	68.42
Average Path Data	69.97

Started with ambulation using RW then progressed to straight cane use.

Balance/Postural Control

	Sharp Rom (L) Back	SLS (L)
4/29/14	unable	unable
6/17/14	12	1
6/24/14	12	1
8/25/14	15	4
10/14/14	17	5
12/16/14	30	5
2/17/15	30	5
4/2/15	30	4
5/5/15	30	5

Improvements in Strength

	4/29/15	6/24/15	8/25/15	10/3/15	10/14/15	12/16/15	2/17/15	4/2/15	5/5/15
Hip Flexion (L)	4-	4+	4+	4+	4+	4+	4+	5	5
Hip Extension (L)	3+	4+	4+	4+	4+	4+	4+	4+	4+
Hip Abduction (L)	4+	4+	4+	4+	4+	4+	4+	4+	4+
Knee Flexion (L)	3+	3+	3+	3+	3+	3+	3+	4-	4-
Knee Extension (L)	3-	4+	4+	4+	4+	4+	4+	5	5
Ankle DF (L)	1	1	1	1	1	1	1	2-	2-
Ankle PF (L)	2-	2-	2-	3	3	3	3	3	3

Discussion/Conclusion

Traditional gait training strategies often require the use of an AD and customized orthotics, and comes at a high energy cost for both ambulator and therapist. Despite good intentions, traditional methods may contribute to decreased quality of gait, slow gait speed and short ambulation distances. This report demonstrates the use of OBA as a safe and effective gait training tool for a person with stroke. OBA may also improve LE strength, postural control and balance, contributing to a decrease fall risk in this population.