The Impact Of An Ankle Foot Orthosis On Gait Recovery In MS: Pilot Data

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BACKGROUND & OBJECTIVE

Lower extremity motor weakness at the ankle (in both the anterior tibialis and gastrocnemius/soleus) is a common and functionally profound progressive impairment in Multiple Sclerosis (MS). Ankle foot orthoses (AFO) are frequently prescribed to minimize the consequences of weakness in the lower leg for persons with MS who are ambulatory. There are a variety of orthosis designs that are utilized but research evaluating the impact of these devices is quite limited. The current understanding of neuroplasticity after injury would suggest that orthosis design has the potential to significantly impact motor recovery of gait. However, many designs restrict range of motion, particularly plantarflexion, which interferes with the heel rocker and forefoot rocker, both of which are critical for typical gait kinematics. The purpose of this study was to investigate the impact of a hinged orthosis, Tamarack joint with adjustable check strap (TCS AFO) (Figure 1) on spatial and temporal gait parameters, electromyography (EMG), and walking endurance, in select individuals with MS.

METHODS

Four adults living with MS (Table 1) were fitted for a custom fabricated TCS AFO either unilateral or bilateral. Over a 12 week period, the subjects participated in 5 gait training sessions which were at weeks 1, 2, 3, 7, and 10. Each session was 45-60 minutes in duration. The participants were also prescribed a customized home-walking program which was modified according to the participant's progress at each clinic visit. Outcome measures were assessed at: initial visit, week 5, and week 13.

OUTCOME MEASURES

The outcome measures for the study include: 1. GAITRite System for temporal and spatial parameters, 2. EMG of the anterior tibialis (AT), gastrocnemius (GN), and vastus lateralis (VL) muscles, 3. 6 Minute Walk Test (gait endurance) 4. Lower extremity strength (hand-held dynamometry and single leg heel raise), 5. Fatigue scale, 6. Video tape of over ground gait analysis, 7. 12-Item Multiple Sclerosis Walking Scale (12-Item MSWS)

Study Orthosis (TCS AFO)

Figure 1. Custom-fabricated articulating AFO with Tamarack dorsiassist joint and an adjustable posterior check strap. The Tamarack joint in the TCS AFO provides dorsiflexion assistance during swing limb advancement without obstructing ankle plantarflexion at loading response. The adjustable posterior check strap provides stance phase control of tibial progression, compensating for plantarflexion weakness. Our hypothesis was that with the TCS AFO individuals practice optimum gait kinematics which will potentially improve gait efficiency and endurance.

Table 1. Participant details.

	Age/Sex	Post Diagnosis Interval	Disease Modifying Medication	AMPYRA (Y/N)	Spasticity Medication (Y/N)	PF Strength R L	DF Strength R L	Pre-treatment Orthosis or Device	TCS AFO (L, R)
101	39/M	9	Avonex	Y	N	2+/5 5/5	4/5 5/5	R Bioness L300 and L300-Plus	R
102	47/F	20	Tysabri	4-AP	Y	2+/5 2/5	5/5 2+/5	Left Bioness L300	L
103	57/F	30	Copaxone	N	N	2+/5 2+/5	4/5 4/5	No orthosis	L/R
104	52/F	10	Copaxone	N	N	3/5 2/5	4/5 3+/5	No orthosis	L

RESULTS

Figure 2 depicts the EMG analysis of the AT, GN and VL muscles during self selected walking velocity (SSWV) at the initial and final assessment. Table 2 depicts individual results for the 6 MWT including distance covered and calculated gait velocity. Table 3 depicts individual step length and single limb support information from the GAITRite assessment. The individual change in patient perception of the impact MS has on their ability to walk (MSWS-12) is displayed in Figure 3.

Figure 2. EMG analysis of anterior tibialis (AT), gastrocnemius (GN), and vastus lateralis (VL) muscles during self-selected walking velocity (SSWV).

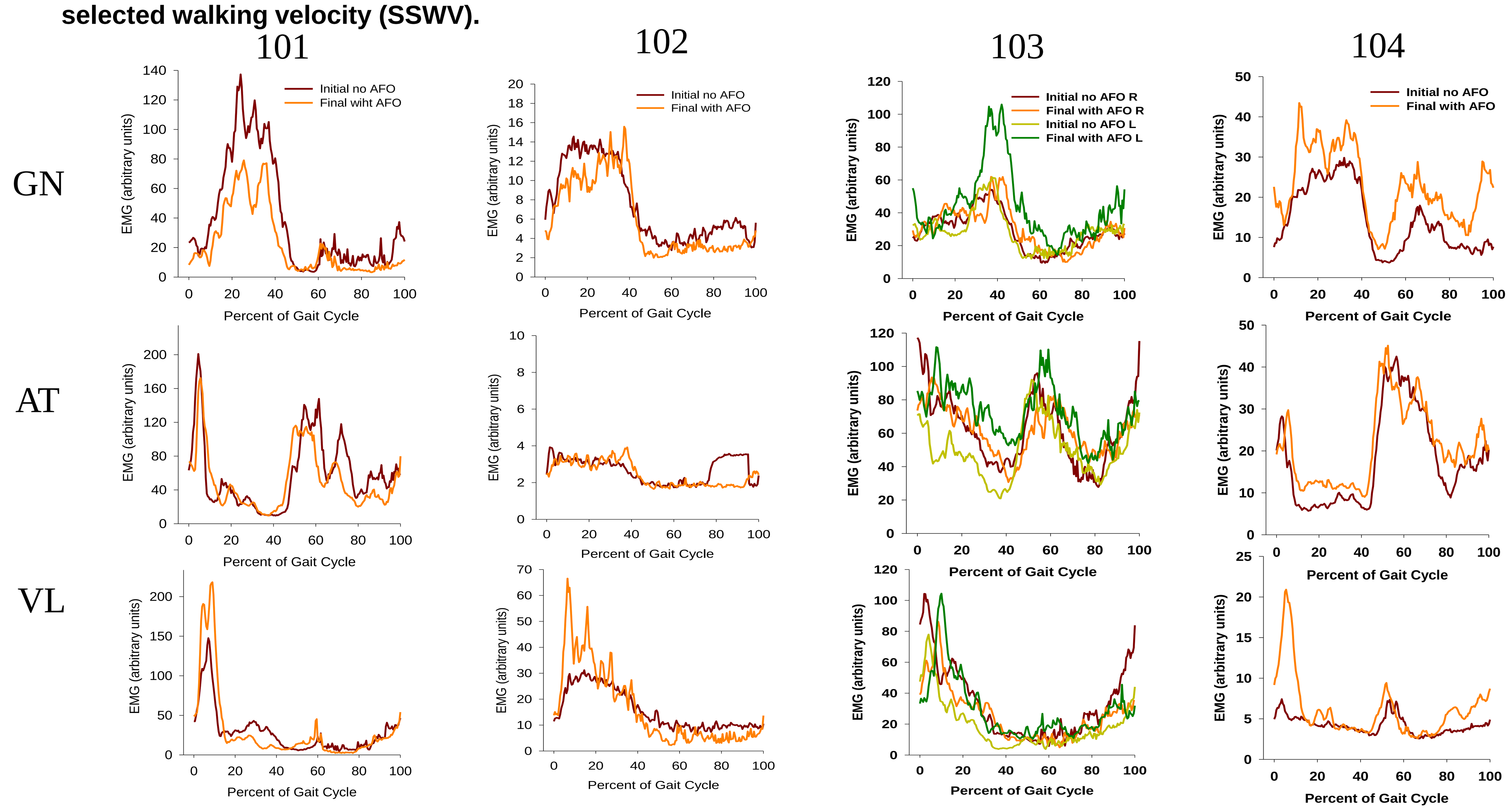


Table 2. 6 Minute Walk Test Results

	6 MWT (m)			6 MWT Velocity (m/sec)		
	Initial	Week 5	Week 13	Initial	Week 5	Week 13
101	386.8 *, NoAD	399.6 RA, NoAD	576.38 RA, NoAD	1.07	1.11	1.6
102	269.1 **, C	260.3 LA, C	252.37 LA, C	0.75	0.72	0.7
103	419.1 NoA, NoAD	327.4 BA, C	361.2 BA, C	1.16	0.91	1.00
104	272.8 NoA, C	311.5 LA, C	336.5 LA, C	0.76	0.87	0.93

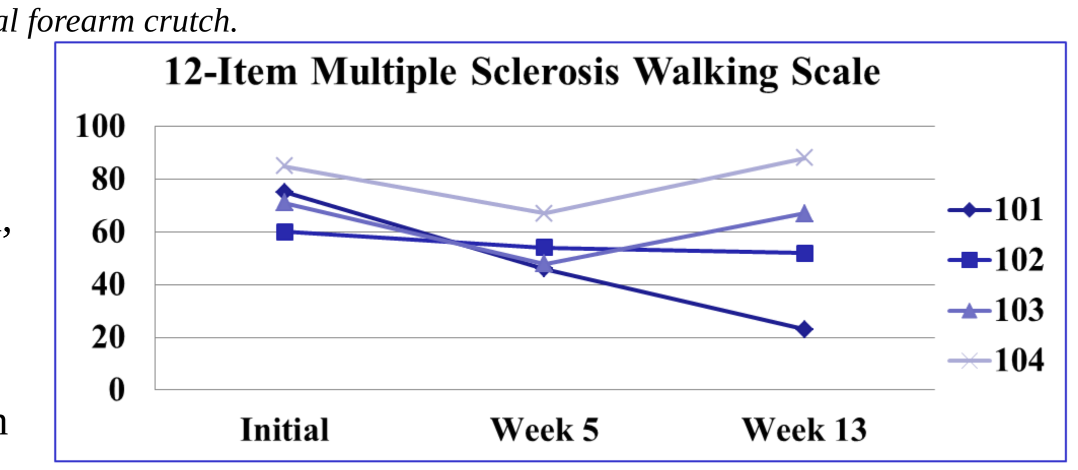
NoA = No AFO, LA = Left TCS AFO, RA = Right TCS AFO, BA = Bilateral TCS AFO, NoAD = No assistive device, C = Single point Cane, BC = Bilateral single point canes, SFC = single forearm crutch, BFC = bilateral forearm crutch. ***101 wore a right Bioness L300 and L300 Plus for the initial assessment.* ****102wore a Bioness L300 on the left leg for the initial assessment.*

Table 3. GAITRite Step Length and Single Limb Stance Results

	Step Length Left/Right (cm)			Single Limb Support Left/Right (% Gait Cycle)		
	Initial	Week 5	Week 13	Initial	Week 5	Week 13
101	69/73 NoA, NoAD	76/76 RA, NoAD	73/80 RA, NoAD	39/33	38/34	37/32
102	33/39 NoA, C	45/48 LA, C	50/49 LA, C	19/42	23/32	25/35
103	53/50 NoA, NoAD	57/48 BA, C	59/57 BA, C	35/36	35/30	36/36
104	48/49 NoA, C	41/44 LA, C	53/56 LA, C	30/40	28/30	31/37

NoA = No AFO, LA = Left TCS AFO, RA = Right TCS AFO, BA = Bilateral TCS AFO, NoAD = No assistive device, C = Single point Cane, BC = Bilateral single point canes, SFC = single forearm crutch, BFC = bilateral forearm crutch.

Figure 3. MSWS –12 change across treatment duration, a higher score indicating greater disability related to gait dysfunction



CONCLUSIONS

Subject 101 demonstrated dramatic improvements in gait velocity (0.53 m/sec increase), gait endurance (189.6 m increase on 6 MWT) and self-report of gait impairment (52 point decrease on MSWS-12). The greater improvements attained by this subject compared to the others may be due to his younger age and shorter post diagnosis interval. Subject 102 demonstrated minimal change in gait velocity and endurance but did improve on step length (17 &10 cm increase) and single limb support which demonstrates a more efficient gait pattern. She also demonstrated an 8-point improvement on the MSWS-12, a potentially dramatic change for someone living with MS for 20 years. Subject 103 was the only subject in this group to be braced bilaterally, furthermore she had been diagnosed with MS for 30 years. She demonstrated a slowed velocity (.16 m/sec decline) and endurance however she did improve her step length (6 cm and 7 cm increase) demonstrating an improvement in gait efficiency. She reported a dramatic improvement in self-perception of gait impairment (23 point change on MSWS-12) at 5 weeks, however her score went back up (by 19 points) at the final assessment despite her subjective positive comments on the impact of the TCS AFOs. Subject 104 had an illness the week before her final testing session. Despite the illness she demonstrated improvements in gait velocity (.17 m/sec increase), endurance (63.7 m increase on 6 MWT), and step length (5 cm & 7 cm increase). The illness may have impacted her MSWS-12 score which improved at the 5-week mark (18-point decline) but then declined at the final testing (21 point increase).

After 12-weeks of wearing the TCS AFO, there were no temporal changes in EMG profiles for the GN, AT, and VL. However, given the long post diagnosis interval for these subjects, a longer training period may be required to see a change in EMG profiles. Additional studies with the TCS AFO are underway with modifications to the treatment frequency and duration, as well as to the AFO design to provide greater assistance with tibial progression during single limb support.