

Background and Purpose:

Background:

Advancements in exoskeleton technology has made lower extremity powered exoskeletons an accessible and adjunctive treatment to aide in the restoration of upright mobility in persons with spinal cord injury. However, the impact of scapular girdle and upper extremity strength and function has on gait training with an exoskeleton device for individuals with higher level spinal cord injuries remains unexplored.

Purpose:

To describe the evaluation m rehabilitative and gait training process of an individual with an incomplete SCI with the goal of achieving independence with an exoskeleton device in the community.

Client History:

Client sustained a spinal cord injury secondary to a motor vehicle accident resulting in C-6 tetraplegia with a zone of partial preservation to T2. Initial ASIA classification of B. Clients prior medical history was unremarkable. Client underwent acute spinal stabilization surgery followed by acute rehabilitation and day rehabilitation services. Client sought outpatient physical therapy services to determine feasibility of robotic assisted walking and adaptive sport training.

Examination and Systems Review:

•Cardiovascular & Pulmonary:

- BP 96/54 mmHg HR 73 bpm SpO₂ 99% RR 14 rpm
- BP managed by Midodrine 5 mg.
- *Occasional Autonomic Dysreflexic episodes
- BMI – 24.6

•Neurological:

- Cranial nerves: intact.
- Sensation intact for B UE's – Inconsistent for light touch for trunk and B LE's;
- Reflexes: Biceps, Triceps, Patellar, and Achilles 3+
- Muscle Tone: 2-3 fluctuating hamstrings, adductors and plantarflexors

•Integumentary:

- Intact – history absent of pressure ulcers – all surgical incisions well healed

•Musculoskeletal:

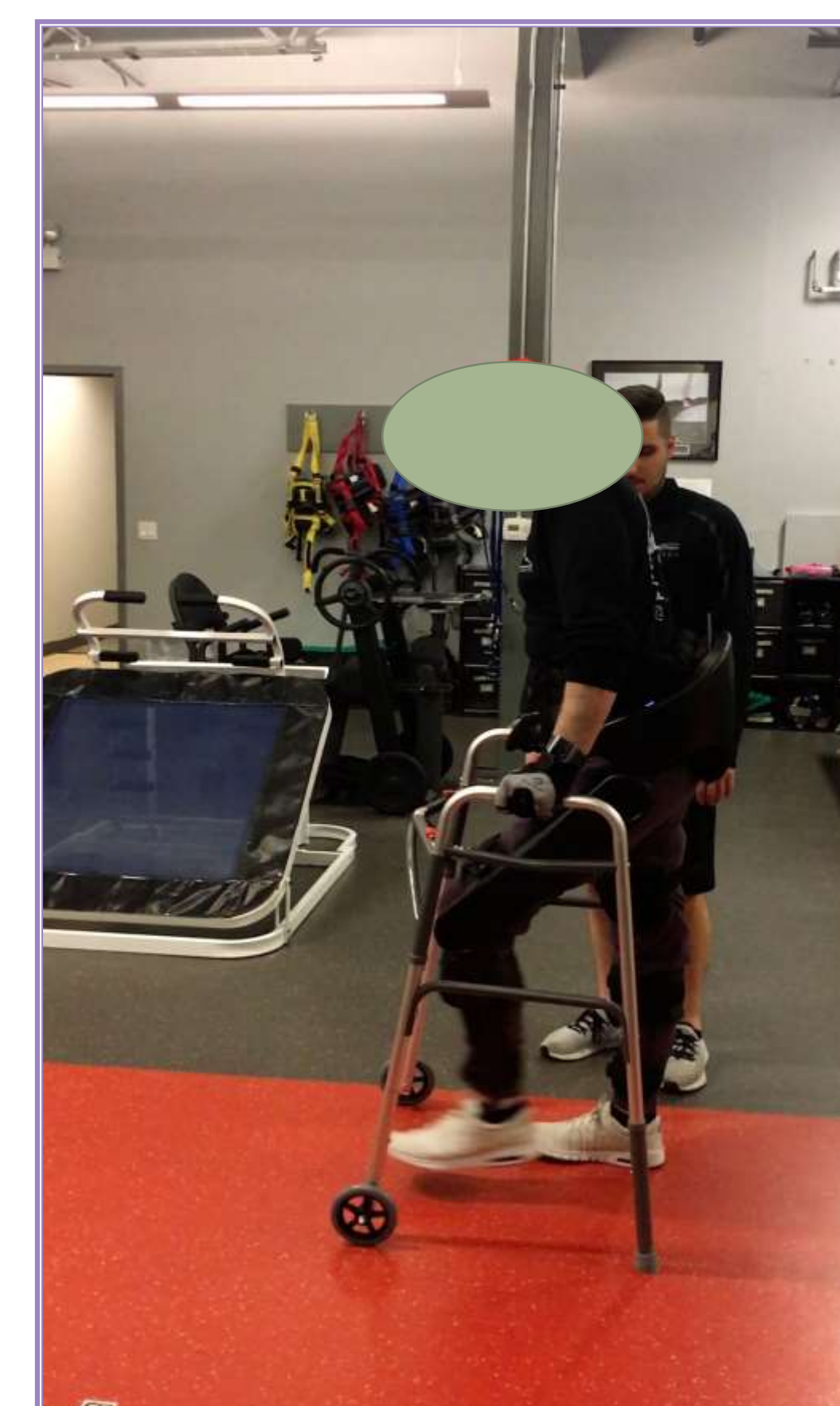
- Cervical spine – Min limitations with B Rotation and Side bending –
- Lumbar spine: minimal limitations for all planes – hyper lordosis noted in standing
- PROM – WNL - B UE & L LE
- AROM/Strength – B UE - 5/5 throughout
- B LE – Hip 2/5, Knee 1/5, ankle 0/5

Interventions:

| Training Phase | Activities |
|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Initial Phase 6 months – 60 visits | <ul style="list-style-type: none"> • Dynamic Sitting Balance • Body Weight Strength Training/Conditioning • NMES assisted functional training/transitional movements • Crawling |
| Exploratory Gait Phase: 10 months – 70 Visits | <ul style="list-style-type: none"> • Static and Dynamic Trunk Stability Training • LokoMat Training • Overground Manually Assisted Walking in Rifton • FES Cycling, Boxing and Cardiopulmonary Endurance Training • Whole Body Vibration |
| Exploratory Exoskeleton Training: ReWalk & Indego 3 months – 30 visits | <ul style="list-style-type: none"> • Trunk Stability Training • Cardiopulmonary Training • Transfer Training • Don/Doff of Device • Overground Training in each device |
| Specific Indego Exoskeleton Training: 12 sessions for Level 1 – Home and Limited Community Use | <ul style="list-style-type: none"> • Level & unlevel surface waking • Ramps & Curbs • Transfers • Emergency Procedures • 600 meter walk* • Specific Scapular Girdle Musculature Training |
| Scapular Girdle Musculature Training ¹ | <ul style="list-style-type: none"> • External Rotators • Rhomboid & Middle Trapezius • Lower Trapezius • Latissimus Dorsi • Posterior Deltoid • Triceps |

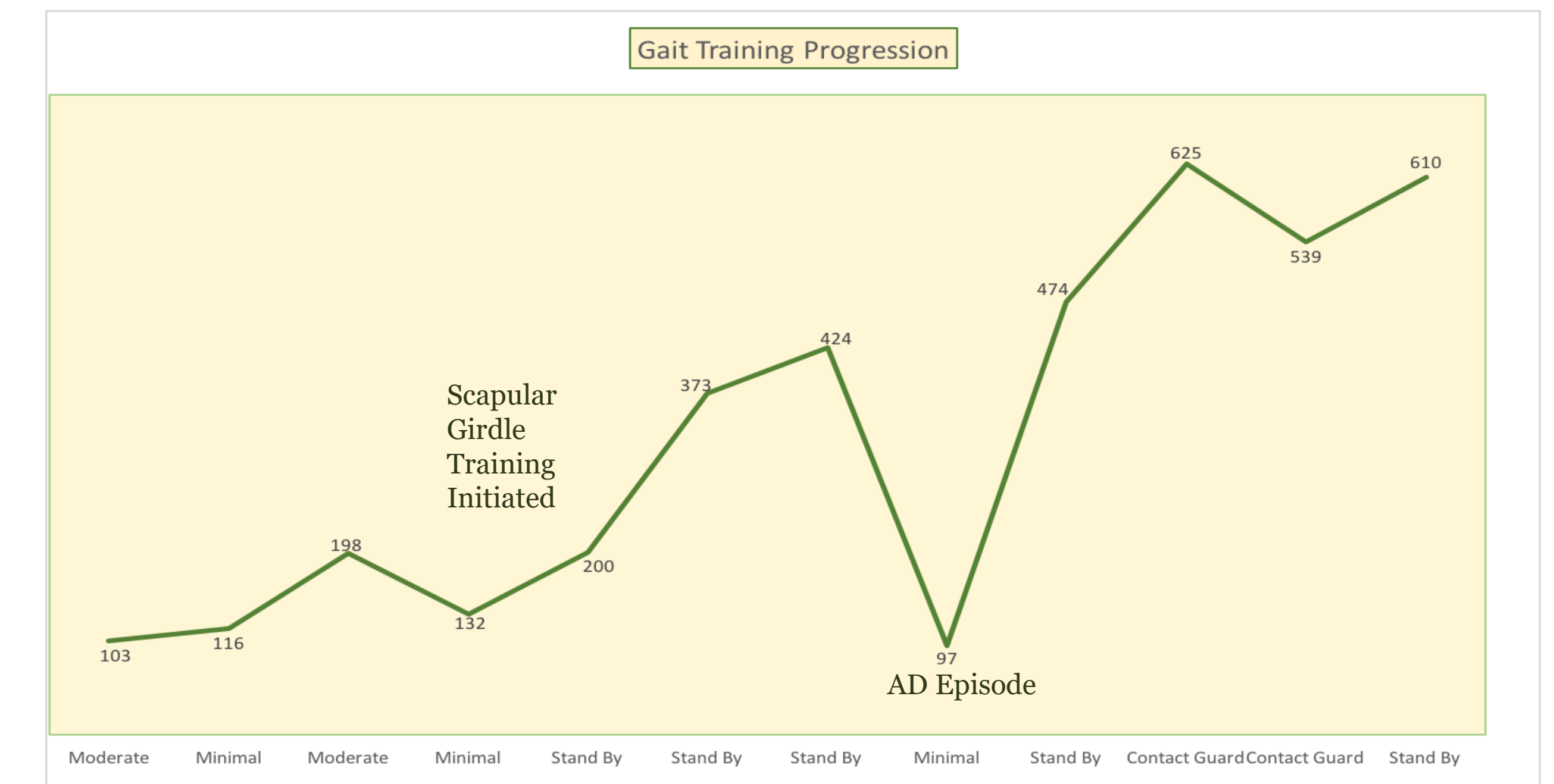


Session 1



Session 12

Outcomes:



Initial WISCI Index: 1 - Parallel Bars 2 person assist < 10 meters
Final WISCI Index: 9 - Walker - Exoskeleton - no assist > 20 meters
Successful completion of Level 1 Exoskeleton Training for home and limited community use

| Muscle Group | Normal Value ³ | Initial Dynamometry | | Final Dynamometry | |
|--------------------|---------------------------|---------------------|------|-------------------|------|
| | | Right | Left | Right | Left |
| Quadratus Lumborum | 46 #/20.8 kg | 33# | 36# | 44# | 48# |
| Latissimus Dorsi | 68#/31.29 kg | 23# | 28# | 50# | 42# |
| Pectoral Major | 86#/39.00 kg | 37# | 45# | 65# | 78# |
| Posterior Deltoid | 49#/22.22 kg | 42# | 52# | 48# | 56# |
| Lower Trapezius | 32#/14.51 kg | 7# | 12# | 14# | 16# |
| Triceps | 42#/19.05 kg | 34# | 33# | 39# | 50# |

Discussion:

Attainment of home and community use of an exoskeleton is feasible, however the sustained use of the key muscles during walker assisted paraplegic gait appears to have a greater impact on the attainment of the 600 meter criteria than then general guideline of “good upper extremity strength”. In this case, consistent achievement of the distance of 600 meters was not attained until the patient achieved approximately 60-75% of normal dynamometry readings.

Conclusions:

Conclusion: Through testing of scapular and shoulder girdle musculature contributes to lower extremity unloading during the gait cycle. Although the exoskeleton provides robotic assistance to advance the leg, if the users thorax is not stabilized sufficiently, the device will not advance. Specific exercise prescription to address scapular girdle strength and sustained power output should be incorporated into exoskeleton training.

Limitations: This is a single subject report and cannot be generalized.

Future Directions: Required specific versus upper extremity and scapular girdle musculature strength during exoskeleton use such as power to BMI ratios are merited for further investigation.

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