Japanese Journal of Comprehensive Rehabilitation Science (2023)

Case Report

Practice of gait training using lower-limb orthosis and body weight-supported walker for severe acute motor axonal neuropathy: a case report

Taishi Kikkawa, RPT, MS,[1] Akemi Takashima, MD[2]

[1]Department of Rehabilitation, Ushioda General Hospital, Kanagawa, Japan
[2]Department of Neurology, Ushioda General Hospital, Kanagawa, Japan

ABSTRACT
Kikkawa T, Takashima A. Practice of gait training using lower-limb orthosis and body weight-supported walker for severe acute motor axonal neuropathy: a case report. Jpn J Compr Rehabil Sci 2023; 14: 49−53.
Introduction: Acute motor axonal neuropathy (AMAN) requires aggressive gait rehabilitation from the early phase of its onset due to the long time required to achieve independent gait. In this report, we describe the progress of gait training using a combination of lower-limb orthosis and body weight-supported (BWS) walker in a patient with severe AMAN.
Case: A 30-year-olds man diagnosed with AMAN underwent two high-dose intravenous immunoglobulin treatments and combined steroid pulse therapy. The patient was admitted to the convalescent rehabilitation ward for 87 days with a Medical Research Council (MRC) score of 7 points for muscle strength and 13 points for Functional Independence Measure (FIM) motor items. He started gait training with a knee-ankle-foot orthosis on the 128th day. Thereafter, the distance of gait training increased with the use of lower-limb orthosis and BWS walker. At the time of discharge, the patient's MRC score had improved to 24 points and his FIM motor items score to 31 points. He was able to walk 90 m using ankle-foot orthosis and forearm walker and was transferred to a rehabilitation facility on day 237.
Discussion: Gait training with lower-limb orthosis and BWS walker was performed on a patient with severe AMAN. As a result, gait training distance increased without adverse events. Gait training can be performed safely and effectively by combining lower-limb orthosis and BWS walker when gait ability is expected to improve, even in severely ill patients.
Key words: acute motor axonal neuropathy, knee-ankle-foot orthosis, ankle-foot orthosis, body weight-supported overground training

Introduction

Guillain-Barré syndrome (GBS) is a polyneuropathy characterized by generalized motor paralysis that rapidly progresses owing to immune abnormalities triggered by infection. GBS subtypes are broadly classified into acute inflammatory demyelinating polyradiculoneuropathy (AIDP) and acute motor axonal neuropathy (AMAN). AMAN is characterized by motor paralysis without sensory disturbances and is more common in Asian countries [1]. Although GBS generally has a good prognosis, 20% of patients still have difficulty gaining independent ambulation 6 months after onset [2], and 52% of patients still have residual gait disturbance 10 years after onset [3]. In particular, AMAN patients experience a longer time to gain independent walking compared to AIDP patients [4] and AMAN is a poor prognostic factor for gaining independent gait 3 months after onset [5]. In conclusion, active and continuous rehabilitation interventions to improve gait ability are essential for AMAN patients.

Rehabilitation interventions for GBS are often reported in patients with high walking ability [6]. Gait training with lower-limb orthosis [7, 8] and body weight-supported treadmill training (BWSTT) are helpful in patients with severe disease [9], but there are no reports of body weight-supported overground training (BWSOT) combined with lower-limb orthosis. This report describes the progress in the combined use of lower-limb orthosis and BWSOT in a patient with severe AMAN.

Corresponddence: Taishi Kikkawa, RPT, MS
Department of Rehabilitation, Ushioda General Hospital, Kanagawa, 1−6−20 Yako, Turumi-ku, Yokohama, Kanagawa 230−0001, Japan.
E-mail: mrcl.kikkawa@gmail.com
Accepted: April 1, 2023.
Conflicts of interest: The authors declare that they have no competing interests.

doi.org/10.11336/jjcrs.14.49

Case

The present case was a 30-year-olds man with no prior medical history who was an office worker with an active lifestyle. He experienced gastrointestinal symptoms, such as abdominal pain and diarrhea, 2 weeks before the onset of the disease. Subsequently, he was admitted to hospital as an emergency as he became quadriplegic owing to weakness of the left upper limb. Antibody test results were positive for anti-GM1 antibodies. A nerve conduction study showed decreased M-wave amplitude and an inability to derive F-waves, but there was no increase in the temporal dispersion of motor nerve conduction velocity (MCV) or sensory nerve conduction velocity (SCV), and the patient was diagnosed with AMAN. The patient's respiratory status deteriorated on the second day, and endotracheal intubation and ventilator management were initiated. The first round of combined high-dose intravenous immunoglobulin and steroid pulse therapy was administered on days 2 to 6, and the second round on days 16 to 20. Prognosis prediction using the modified Erasmus GBS outcome score (mEGOS) [10, 11] showed a score of 7 points at onset and 10 points seven days after onset, which is the most severe condition with a 41% probability of difficulty gaining ambulation 6 months after onset. He was weaned from the ventilator on day 65 and admitted to the convalescent rehabilitation ward on day 87.

Written consent was obtained from the patient and his family for the publication of this case report.

Admission Evaluation

The patient's height and weight were 175.0 cm and 53.9 kg, respectively. His blood pressure was 117/83 mmHg, resting heart rate was in the 100 BPM range, exercise heart rate was in the 140 BPM range, and profuse sweating was also observed. Deep tendon reflexes throughout the body disappeared, and the patient had a Medical Research Council (MRC) score of 7 points, with significant muscle weakness experienced throughout the body. No problems with sensory functions were discovered. The severity of GBS was Hughes functional grade (FG) 4. The blood test results showed a creatine kinase (CK) of 21 U/L. The patient had a tracheostomy, and his nutritional intake was managed by nasogastric tube feeding. He had difficulty in self-expectorating with a cough peak flow (CPF) of 140 L/min and was using mechanical insufflation-exsufflation (MI-E) to expectorate. All basic motions and activities of daily living (ADL) required assistance and the Functional Independence Measure (FIM) motor items had the lowest score of 13 points.

Problems in Rehabilitation Practice and policy of physical therapy

The patient had two problems with rehabilitation practice. First, the patient was at a high risk of falling while walking due to muscle weakness throughout the body. Second, the patient had an increased exercise heart rate and significant muscle weakness, causing the patient to be at risk for overwork weakness (OW) and therefore requiring an adjustment in exercise load. To address these problems, a knee-ankle-foot orthosis (KAFO) was used to prevent knee instability such as knee buckling. In addition, the policy was to implement BWSOT using a body weight-supported (BWS) walker that allowed the patient to adjust the weight load and walk at his own pace. The exercise load was estimated to be 13 based on the rating of perceived exertion (RPE). The amount of walking was adjusted after confirming CK by a blood test.

Intervention and progress

During the initial rehabilitation, the patient's heart rate exceeded 140 BPM when standing, and the patient exhibited noticeable sweating. Therefore, from days 87 to 127, the patient underwent range-of-motion exercises, sitting training, and standing training using a tilt table [12] to transition to gait training. Since the heart rate in the standing position was less than 130 BPM from day 128, the patient started standing and gait training with KAFO on both lower limbs. KAFO uses a ring-lock knee joint to prevent knee buckling. The foot joints were subjected to double action with 0° fixed plantar dorsiflexion. Because the patient had difficulty immobilizing his trunk in the standing position, two therapists began to assist gait training: one to assist in swinging both lower limbs out from behind and the other to immobilize the trunk from the front (Fig. 1A). On day 131, the tracheal stoma was closed, and on day 153, the nasogastric tube was removed, and three meals of porridge and chopped meals were provided. From day 152, he was able to hold his trunk in the vertical position by himself, and so was switched to gait training with the assistance of one therapist and was able to walk 50−75 m (Fig. 1B). Later, as he was able to swing his lower limbs himself, he started BWSOT using a BWS walker (Relief Walking Lift POPO REH-200, Moritoh Co., Ltd., Ichinomiya, Japan) from day 166. This device can achieve BWSOT relatively easily by attaching a harness to a walker with a suspension function. This reduces the load on the lower limbs, allowing both the lower limbs to step and the patient to perform gait training by themselves. Unloading started at 25 kg and was gradually decreased while checking for the presence of knee buckling. The knee joint lock of the KAFO was also gradually removed. On day 172, the CPF increased to 340 L/min, and self-expectoration became possible; thus, MI-E was terminated. On day 203, both lower extremities were changed to ankle-foot orthosis (AFO) and used with a BWS walker. The gait distance increased from 90 m to 240 m (Fig. 1C). The AFO foot joints were set to no plantar flexion limitation and 5° of dorsiflexion using plantar flexion resistance to prevent excessive anteversion of the lower leg. On day 228, he began gait training for 20 m using a forearm walker (Fig. 1D). Using lower-limb orthosis and BWS walker for gait training increased the walking distance (Fig. 2A), decreased the heart rate (Fig. 2B), RPE did not change significantly (Fig. 2C), and the amount of unloading could be gradually decreased (Fig. 2D). Blood tests showed that CK was 31−240 U/L, without significant elevation.

At the final evaluation on day 236, his weight was 59.4 kg, and the exercise heart rate was stable in the 90 BPM range with no sweating (Fig. 2B). Deep tendon reflexes appeared throughout the body but were diminished. The MRC score improved to 24 points (Table 1). The Hughes' FG was 3, and a 90 m gait was possible with the AFO and forearm walker, whilst being monitored (Fig. 2A). The FIM motor items score improved to 31 points and the patient was able to use a wheelchair to move around the hospital independently (Table 2). The patient had no adverse

Figure 1. Progress of gait training.
(A) Gait training with the assistance of two therapists, using KAFO on both lower extremities, on days 128−151 after onset. (B) Gait training with the assistance of one therapist, using KAFO, on days 152−165. (C) Gait training with AFO and BWS walker on days 203−227. (D) Gait training with AFO and forearm walker on days 228−236. KAFO, knee-ankle-foot orthosis; AFO, ankle-foot orthosis; BWS walker, body weight-supported walker.

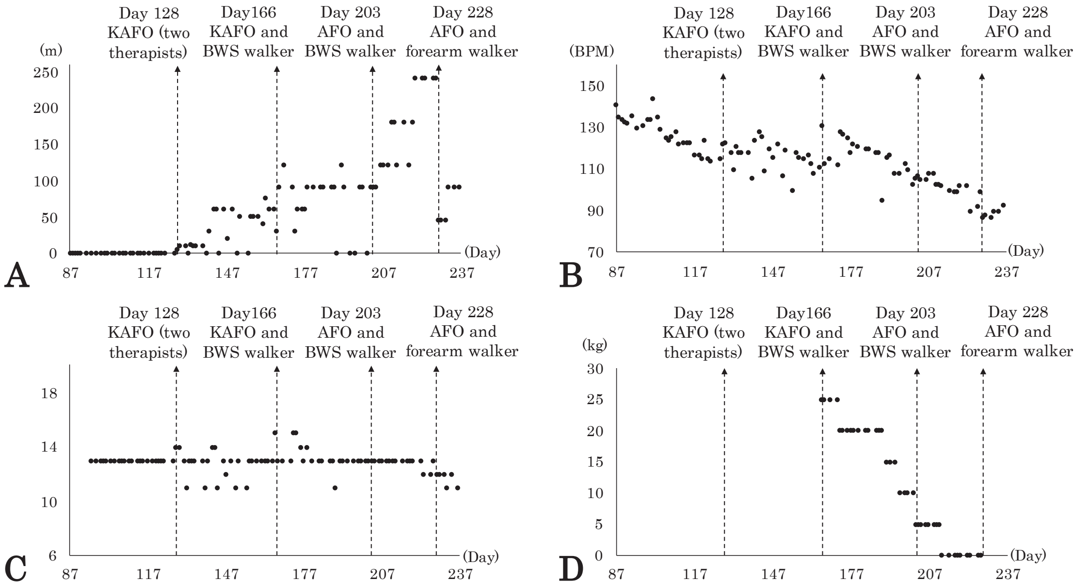

Figure 2. Progress of gait distance, heart rate, RPE, and unloading during gait training.
(A) Walking distance. (B) Heart rate. (C) RPE, rating of perceived exertion. (D) Unloading weight. KAFO, knee-ankle-foot orthosis; AFO, ankle-foot orthosis; BWS walker, body weight-supported walker.

Table 1. Time course of Medical Research Council (MRC) score.

	Day 1	Day 7	Day 87	Day 127	Day 157	Day 185	Day 214	Day 236
Shoulder abduction (right/left)	0/0	0/0	0/0	0/0	1/0	1/1	1/1	1/1
Elbow flexion (right/left)	0/0	0/0	1/1	1/1	1/1	1/1	1/1	1/1
Wrist extension (right/left)	0/0	0/0	1/0	1/0	1/0	2/1	2/1	2/1
Hip flexion (right/left)	0/0	0/0	1/1	2/1	2/1	2/2	3/3	3/4
Knee extension (right/left)	0/0	0/0	1/1	1/1	1/1	2/3	3/4	3/4
Ankle dorsiflexion (right/left)	0/0	0/0	0/0	1/0	1/0	2/1	2/1	2/1
MRC sum-score	0	0	7	9	10	19	23	24

Table 2. Time course of Functional Independence Measure (FIM) motor items.

	Day 87	Day 120	Day 148	Day 176	Day 202	Day 236
Eating	1	1	1	1	1	4
Grooming	1	1	1	1	1	1
Bathing	1	1	1	1	1	1
Dressing (upper body)	1	1	1	1	1	1
Dressing (lower body)	1	1	1	1	1	1
Toileting	1	1	1	1	1	1
Bladder management	1	4	4	4	4	5
Bowel management	1	4	4	4	4	7
Transfer (bed)	1	1	1	1	1	1
Transfer (toilet)	1	1	1	1	1	1
Transfer (bath)	1	1	1	1	1	1
Wheelchair	1	1	1	1	1	6
Stairs	1	1	1	1	1	1
Total	13	19	19	19	19	31

events during hospitalization, such as falls and elevated CK and RPE levels, suggestive of OW (Fig. 2C). His diet became a regular diet, and he was able to take meals on his own using a portable spring balancer. Since further improvements in physical function and ADLs were expected, the patient was transferred to a rehabilitation center on day 237.

Discussion

This patient had severe AMAN and was predicted by mEGOS to have difficulty gaining independent ambulation during hospitalization in the convalescent rehabilitation ward. The prognosis for AMAN is poor in the short term due to the long time required to acquire independent gait. However, long-term improvement is expected, and some patients can walk independently within a few years [4]. As the patient was also young, it was considered likely that gait ability would improve with gait training. Two results were obtained by the combination of lower-limb orthosis and BWSOT in this patient: the patient was able to actively perform gait training and acquire ambulation with a forearm walker, and the patient experienced an increase in gait training distance without any adverse events.

Regarding the first result, the patient's ability to actively perform gait training and acquire ambulation with a forearm walker was considered to have facilitated the learning of gait by setting an appropriate task difficulty level and conducting task-oriented gait training. In general, motor control over gait and other activities is learned through repetitive practice of tasks owing to use-dependent plasticity [13]. In addition, if the task difficulty is too high, motor learning will be hindered by harder exercises [14]. In conclusion, repetitive practice of tasks and adjustment of difficulty levels are important in rehabilitation. The effects of task-oriented training have been demonstrated in GBS [15]. It is thought that for this patient, it was possible to set an appropriate task difficulty level by adjusting the lower-limb orthosis as well as the amount of unloading according to muscle strength. In addition, the use of the BWS walker may have facilitated the learning of overground gait. Unlike the BWSTT, BWSOT generates its own power source and gait more actively [16]. If the goal is to acquire an overground gait that generates propulsive force, BWSOT may contribute more to improving the overground gait than BWSTT.

The second result was that the patient experienced an increase in gait training distance without any adverse events. In the rehabilitation of GBS, adverse events such as falls and OW should be kept in mind [12]. Falls were prevented by using lower-limb orthosis and BWS walker. Sixty percent of GBS patients admitted to convalescent rehabilitation wards require AFOs to prevent dropping feet [17]. Falls by this patient were prevented by using KAFO for knee buckling and AFO for foot stumbling. BWS gait training was selected to prevent OW and increased heart rate. BWS gait decreases muscle activity and heart rate in neurologically disordered individuals compared to normal gait [18]. It is inferred that adjustment of the amount of unloading and walking based on CK, heart rate, and RPE prevented OW due to overload and increased the gait training distance.

This case report has several limitations. The first was the improvement in gait ability may have been due to improvement in physical functions, such as natural recovery and improvement in nutritional status, making it difficult to fully control the rehabilitation method and verify its effect. However, we believe that the short-term recovery of gait ability in this patient was equal to or better than that in previous literature [9]. BWSTT for axonal GBS was limited to a walking distance of up to 40 m with 30 kg unloading at 34 weeks after onset [9]. The results suggest that the combination of lower-limb orthosis and BWSOT was useful in optimizing the amount of assistance and increasing the walking distance. The second limitation was that the patient in this research has not been followed up in detail, and his progress, particularly his gait ability, is unknown. However, this patient came to the hospital 1 year and 6 months after onset and was found to be independent in outdoor gait, using AFO. In the future, it will be necessary to accumulate data on the progress of gait ability in patients with severe GBS and to verify effective rehabilitation measures.

Acknowledgments

The authors grateful to the patient who cooperated in this report and the staff of Ushioda General Hospital.

References

1. Doets AY, Verboon C, van den Berg B, Harbo T, Cornblath DR, Willison HJ, et al. Regional variation of Guillain-Barré syndrome. Brain 2018; 141: 2866–77.
2. Rajabally YA, Uncini A. Outcome and its predictors in Guillain-Barre syndrome. J Neurol Neurosurg Psychiatry 2012; 83: 711–8.
3. Forsberg A, Press R, Holmqvist LW. Residual disability 10 years after falling ill in Guillain-Barré syndrome: a prospective follow-up study. J Neurol Sci 2012; 317: 74–9.
4. Hiraga A, Mori M, Ogawara K, Kojima S, Kanesaka T, Misawa S, et al. Recovery patterns and long term prognosis for axonal Guillain-Barré syndrome. J Neurol Neurosurg Psychiatry 2005; 76: 719–22.
5. López-Hernández JC, Colunga-Lozano LE, Garcia-Trejo S, Gomez-Figueroa E, Delgado-Garcia G, Bazán-Rodríguez L, et al. Electrophysiological subtypes and associated prognosis factors of Mexican adults diagnosed with Guillain-Barré syndrome, a single center experience. J Clin Neurosci 2020; 80: 292–7.
6. Arsenault NS, Vincent PO, Yu BHS, Bastien R, Sweeney A. Influence of exercise on patients with Guillain-Barré syndrome: a systematic review. Physiother Can 2016; 68: 367–76.
7. Nagatomo K, Arai H, Koumura Y. Effectiveness of gait training for a severe Guillain-Barré syndrome patient requiring a mechanical ventilator: case report. Jpn J Compr Rehabil Sci 2019; 10: 103–7.
8. Tanaka M, Wada Y, Kawate N. Effectiveness of gait training with lower limb orthosis for a patient with severe Guillain-Barré syndrome at a kaifukuki rehabilitation ward. Jpn J Compr Rehabil Sci 2021; 12: 48–52.
9. Tuckey J, Greenwood R. Rehabilitation after severe Guillain-Barré syndrome: the use of partial body weight support. Physiother Res Int 2004; 9: 96–103.
10. Walgaard C, Lingsma HF, Ruts L, van Doorn PA, Steyerberg EW, Jacobs BC. Early recognition of poor prognosis in Guillain-Barre syndrome. Neurology 2011; 76: 968–75.
11. Yamagishi Y, Suzuki H, Sonoo M, Kuwabara S, Yokota T, Nomura K, et al. Markers for Guillain-Barré syndrome with poor prognosis: a multi-center study. J Peripher Nerv Syst 2017; 22: 433–9.
12. Mullings KR, Alleva JT, Hudgins TH. Rehabilitation of Guillain-Barré syndrome. Dis Mon 2010; 56: 288–92.
13. Wolpert DM, Diedrichsen J, Flanagan JR. Principles of sensorimotor learning. Nat Rev Neurosci 2011; 12: 739–51.
14. Marchal-Crespo L, Michels L, Jaeger L, López-Olóriz J, Riener R. Effect of error augmentation on brain activation and motor learning of a complex locomotor task. Front Neurosci 2017; 11: 526.
15. Bersch I, Fridén J. Long-term effect of task-oriented functional electrical stimulation in chronic Guillain Barré syndrome-a single-subject study. Spinal Cord Ser Cases 2021; 7: 53.
16. Barela AMF, Gama GL, Russo-Junior DV, Celestino ML, Barela JA. Gait alterations during walking with partial body weight supported on a treadmill and over the ground. Sci Rep 2019; 9: 8139.
17. Gupta A, Taly AB, Srivastava A, Murali T. Guillain-Barre syndrome–rehabilitation outcome, residual deficits and requirement of lower limb orthosis for locomotion at 1 year follow-up. Disabil Rehabil 2010; 32: 1897–902.
18. Apte S, Plooij M, Vallery H. Influence of body weight unloading on human gait characteristics: a systematic review. J Neuroeng Rehabil 2018; 15: 53.