《研究ノート》

Custom-made hinged knee brace for standing and gait disturbance in a patient with Body lateropulsion caused by Wallenberg syndrome: case report

Masataka KAMIYA, PT, MS[a], Susumu OTA, PT, PhD[b], Yoshinori NAITO, PT, MS[a], Mitsuhito NAKAGAWA, PT[a], Naohito MORISHIMA, PT[a], Ken OHYAMA, MD, PhD[c], Kenji MOKUNO, MD, PhD[c], Tomoji ISHIKAWA, MD, PhD[a]

[a] Rehabilitation Center, Toyohashi Municipal Hospital, Toyohashi, Japan
[b] Department of Rehabilitation and Care, Seijoh University, Tokai, Japan.
[c] Department of Neurology, Toyohashi Municipal Hospital, Toyohashi, Japan

Introduction

Body lateropulsion (BL), characterized by an irresistible falling to one side, reduces functional independence in activities of daily living. BL is occasionally described in Wallenberg syndrome accompanied by limb ataxia and muscle weakness[1-3]. In a previously reported case, a patient with Wallenberg syndrome presenting with severe BL was able to stand stably by wearing an elastic bandage and weights[4]. Few physical therapy interventions for gait disturbances caused by BL have been reported. We report a patient with BL caused by Wallenberg syndrome who complained of low support capacity of his leg. We used a custom-made hinged knee brace (CHKB, Matsumoto Prosthetics & Orthotics Manufacturing Co. Ltd., Japan) that was equipped with rubber tubes to facilitate knee motion (Fig. 1)[5,6]. The CHKB provided a sense of compression to the patient when applied correctly, and weighed 0.3 kg. Ankle weights (0.3~0.6kg), a conventional physical therapy intervention for limb ataxia[7], were applied as a control in the present study. Here we report the effectiveness of the CHKB for a patient with BL.

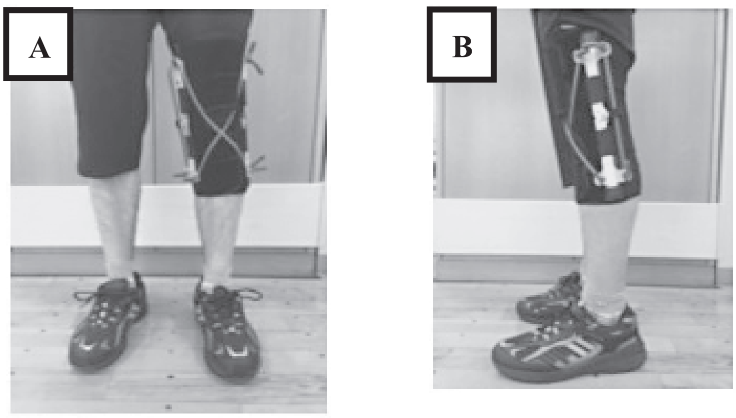

Fig. 1 Custom-Made Hinged Knee Brace
Front view of the custom-made hinged knee brace (A).
Lateral view of the custom-made hinged knee brace (B).

Case Report

A 57-year-old man (171 cm, 69 kg) experienced headache, vertigo, and gait disturbance due to sudden leftward BL. His symptoms did not improve, and he was admitted to our hospital on the day of onset. He was independent in prehospital activities of daily living, and his occupation was a clerk. At the time of admission, he was alert and well oriented. Although his pupils and facial movement were normal, he had horizontal nystagmus and sensory disturbances on the left side of his face. Ataxia was observed in the upper and lower extremities on the left side. Muscle weakness was also observed. Sensation of pain was mildly decreased on the right side of his body. Diffusion-weighted magnetic resonance imaging of the brain revealed a high intensity area at the dorsolateral aspect of the left lower medulla oblongata (Fig. 2). He was diagnosed with Wallenberg Syndrome, and acute-phase medication and rehabilitation were started on the day of admission. Because of the low support capacity of his leg and the severe BL, the standing program started on day 9 and the gait program on day 10. While trying to stand upright with open eyes, he involuntarily leaned to the left and needed to be supported to prevent falling. On day 21, he was able to walk alone using a handrail. This report was conducted in accordance with the declaration of Helsinki (2013 revision), and written informed consent was obtained from the patient.

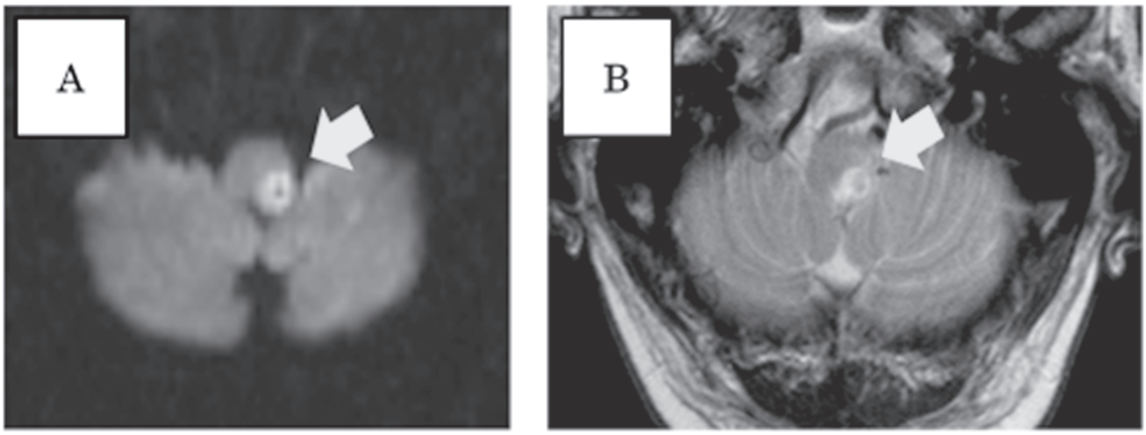

Fig. 2 Brain magnetic resonance imaging findings
Diffusion-weighted image (A) and T2 weighted image (B) showed a high intensity area at the dorsolateral aspect of the left lower medulla oblongata.

Custom-Made Hinged Knee Brace

The CHKB was made from a standard hinged knee brace with metal struts on the medial and lateral sides of knee, and the addition of rubber tubes supported the patient's muscle strength. The CHKB weighed 0.3 kg. The rubber tubes supporting the knee extension crossed at the tibial tuberosity, and those supporting knee flexion ran parallel on the rear surface of the lower extremity. We used three different types of rubber tubes. The tension generated by extending the rubber tubes from their original length to the upper and lower hooks (21 cm) was 1, 2, and 3 kgf, respectively. The optimal combination of rubber tubes was determined by measuring the fastest walking speed while using parallel bars. The combination of extension at 2 kgf and flexion at 1 kgf was determined to be optimal for the patient. The assisted knee extension torque of the combination (extension at 2 kgf and flexion at 1 kgf) measured using a push pull gauge was 1.94 Nm and 2.48 Nm at 0° and 15° of knee flexion, respectively.

Assessment

From day 21 to 25, the patient's postural stability was assessed with either no apparatus, ankle weights (0.5kg), or the CHKB.

1) Postural sway areas during standing were examined using a postural sway meter (Twin Gravicorder G-6100, Anima Co. Ltd., Japan). He could not maintain a standing position when the distance between his feet was 15 cm. Therefore, we set the distance between feet to 30 cm. Postural sway area during standing with either no apparatus, ankle weights, or CHKB was 7.9 cm^2, 4.7 cm^2, and 3.7 cm^2, respectively (Fig. 3).

2) To assess lateral tilt angles from a line perpendicular to the floor to the line between the center of the ankle and the acromion, his frontal gait posture was imaged using videography (EX-FH 100, Casio Co. Ltd., Japan) when he walked using a handrail. The maximum lateral tilt angle of the body was measured once each by three physical therapists not related to the present study, and the mean value was obtained. The maximum lateral tilt angle was observed during mid stance of the left leg. The maximum lateral tilt angle in the frontal plane during walking with either no apparatus, ankle weights, or CHKB was 8.1°, 9.1°, and 6.2°, respectively (Fig. 4).

3) Maximum isokinetic extension torque was measured using an ergometer (Strength Ergo 240, Mitsubishi Electric Engineering Co. Ltd., Japan). Maximum isokinetic extension torque was 75.9 Nm (right leg) and 51.5 Nm (left leg).

4) Maximum isometric knee extension muscle strength in a sitting positon (knee and hip flexed to 90°) was measured using a hand-held dynamometer (MicroFET2, Hoggan Scientific, LLC, USA). Isometric knee extension muscle strength was 171 N (left leg), and when wearing the CHKB, it was 197 N; an increase of 15.2%.

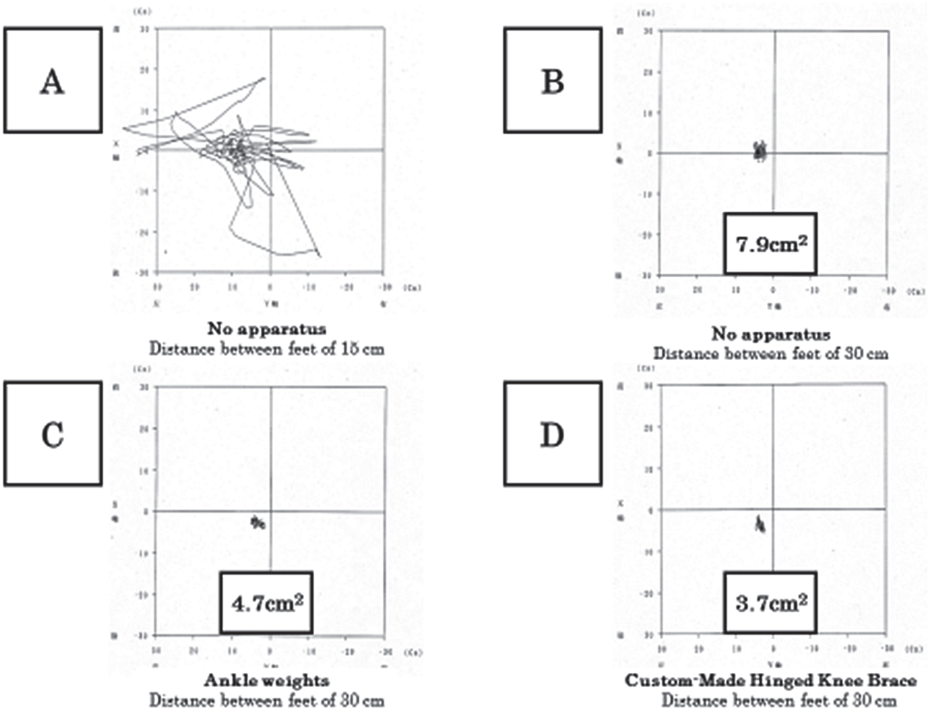

Fig. 3 Postural sway areas

Postural sway areas with no apparatus (distance between feet of 15 cm) is shown in the left upper panel (A). This patient could not maintain a standing position when the distance between feet was 15 cm. Postural sway with no apparatus (distance between feet of 30 cm) is shown in the right upper panel (B), and with ankle weights, left lower panel (C), and with the CHKB, right lower panel (D). The CHKB more effectively improved the postural sway area compared with either no apparatus or ankle weights.

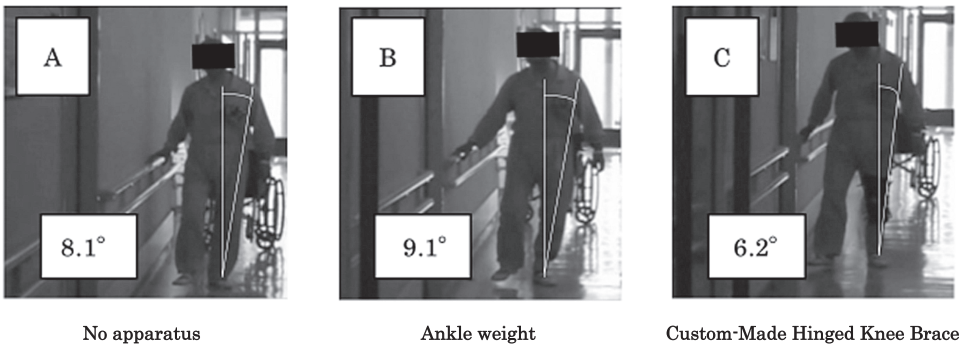

Fig. 4 maximum lateral tilt angle

The CHKB more effectively improved the maximum lateral tilt angle compared with either no apparatus (A) or ankle weights (B). Maximum lateral tilt angles with the CHKB is shown in the figure (C).

Discussion

The present findings suggested that the standing and gait disturbance were more effectively improved by the CHKB than by the conventional physical therapy intervention. When the patient wore ankle weights, the postural sway area during a static task was improved, but the maximum lateral tilt angle during the dynamic task of walking was aggravated. Wearing the CHKB improved posture in both the static and dynamic tasks.

The findings in this case were similar to those of a previously reported patient with Wallenberg syndrome presenting with severe BL who was able to stand stably by wearing an elastic bandage and weights[4)]. Compression garments are thought to increase cutaneous stimulation, and improves proprioceptive feedback and joint position awareness[8, 9)]. The patient confirmed feeling compression when he wore the CHKB. Thus, the CHKB appears to have an effect similar to that when wearing an elastic bandage or compression garment. The weight of the CHKB (0.3 kg) was considered appropriate for this patient, because ankle weights (0.3~0.6 kg) are applied as a conventional physical therapy intervention for limb ataxia[7)]. Postural sway while standing on a firm surface is associated with proprioception in the lower limbs[10)]. The compression and weight of the CHKB are thought to enhance proprioception better than ankle weights alone.

BL with limb ataxia is likely due to impaired proprioception resulting from a lesion of the ascending dorsal spinocerebellar tract[13)]. Unconscious proprioceptive information is delivered to the cerebellum via the anterior and posterior dorsal spinocerebellar tracts[14)]. The BL of Wallenberg syndrome could be caused by lesions of the vestibular nuclei, cerebellar peduncle, or spinocerebellar tracts[3)]. The patient exhibited limb ataxia, and the diffusion-weighted and T2 weighted images (Fig. 2) showed a high intensity area at the dorsolateral aspect of the left lower medulla oblongata. Therefore, these findings indicated a disturbance of the dorsal spinocerebellar tracts or the cerebellar peduncle, and suggest that proprioceptive stimulation could be beneficial for BL with limb ataxia.

Additionally, the maximum lateral tilt angle was observed during mid-stance of the left leg. The duration of a single-leg stance is the best index of the limb's support capability[12)]. The rubber tubes might provide effective leg extension support during mid stance. The muscle strength support by the rubber tubes could improve muscle weakness.

Conclusion

This novel intervention using a CHKB could be beneficial for patients with BL caused by Wallenberg syndrome accompanied by limb ataxia and muscle weakness.

Acknowledgement

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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