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Case Study

Does elongation training effectively improve motor function?—a single-case design verification study—

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Abstract. [Purpose] The aim of this study was to investigate whether elongation training (ELT) was effective in improving motor function in a single case. [Participant and Methods] A 90-year-old male with Parkinson's syndrome participated in this study. This study used the A-B-A type of single case design. In the 'A' period, normal lower limb exercises (extension and abduction of the hip joint) were performed. The same exercise from the 'A' period was performed using an elongation band in the 'B' period for ELT. The implementation period included 2 weeks of the 'A' period, 2 weeks of the 'B' period, and then 2 weeks of the 'A' period again. Motor function was evaluated using the one-leg standing time on each side, and the Timed Up and Go Test (TUG). [Results] In the 'A' period, there was no change in the one-leg standing time on each side and the TUG. However, in the 'B' period, the one-leg standing time on each side increased, and the TUG values decreased. When returning to the 'A' period, the one-leg standing time on each side decreased, and the TUG increased. [Conclusion] It can be suggested that ELT safely improves motor function at home, even in older people.

Key words: Elongation training, Motor function, Resistance training for the elderly

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INTRODUCTION

The elderly population in Japan is unique in the world, and it is predicted that 40% of the Japanese population will be above 65 years of age by 2050[1)]. Therefore, the importance of preventive care has been pointed out against the increase in care provided by the aging rate in the future[2)]. As a part of the preventive care measures, it has been reported that motor functions such as lower limb muscle strength and walking speed can be improved by exercise training in the elderly and the frail elderly[3, 4)]. However, the exercise training in these reports was conducted using a training machine used in a sports gym, and the exercise load intensity was set at about 70% of the maximum muscular strength[3, 4)]. The main issues involved elderly training are that the training environment is limited and risk of injury due to heavy exercise is higher. Therefore, in order for elderly people to continue training, it is important that the training can be performed easily and safely at home. Recently, elongation training (ELT) has been developed as a simple and easy training method to improve motor function[5–8)]. ELT uses an elastic band with high extensibility (Elongation Band, ELT Health Promotion Laboratory Inc., Otsu, Japan)[7, 8)] that performs automatic movements while extending the elastic band in the longitudinal direction of the limb or trunk. ELT is considered useful as a simple self-exercise technique[5, 6)]; however, there are very few reports analyzing its effects on motor function. Therefore, the aim of this study was to investigate the effect of ELT on motor function by comparing changes in motor function with and without ELT in a single case.

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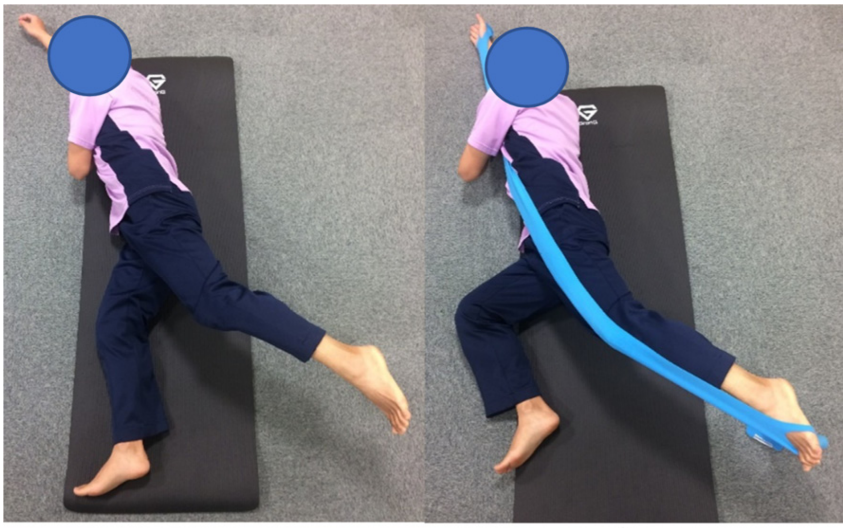
PARTICIPANT AND METHODS

The participant was a 90-year-old elderly male. As history of present illness, the participant had several falls at home and was diagnosed with Parkinson's syndrome. Past medical history included hypertension and type II diabetes. The score on Hasegawa's dementia scale-revised was twenty-eight points. The symptoms of Parkinson's syndrome were rest tremors and impairment of postural reflexes. The Functional Independence Measure was 118 points and the criteria for evaluating the degree of independence of disabled elderly persons in performing daily living activities were ranked as J1. As per ethical considerations, we explained this study and obtained written consent from the participant. Additionally, it was approved by the Ethics Committee of the Nanto Home Visit Nursing Station (approval number: 2018.NHS.01).

An ABA-type single case design was used for this study. In the reference period ('A' period), normal lower limb exercise without an elongation band was performed, and during the intervention period ('B' period), the same exercise performed in 'A' period was conducted using an elongation band as ELT. The exercises performed involved hip extension in a side-lying position (Fig. 1) and hip abduction in a supine position (Fig. 2). In 'B' period, the hip joint was shifted from the hip flexion position to the hip intermediate position, and at that time, the participant was instructed to extend the elongation band located in the distal part of the lower limb as far as possible in the longitudinal direction. This position was set as the starting position.



a b

Fig. 1. Hip extension exercise of 'A' period (a) and 'B' period (b).

a b

Fig. 2. Hip abduction exercise of 'A' period (a) and 'B' period (b).

During the ‘B’ period exercise, the hip extension and abduction exercises were performed by keeping the band extended from the starting position as much as possible (Figs. 1-b, 2-b). As the elongation band has low resistance and high extensibility, the participant can safely adjust the exercise load by themselves. In exercise load in ‘B’ period, the participant performed hip extension and abduction exercise while extending the elongation band distally until resistance occurred in the lower limb on the exercise side. The total implementation period included 6 weeks (2 weeks of ‘A’ period, 2 weeks of ‘B’ period, and followed again by 2 weeks of ‘A’ period). The exercise was performed every day as voluntary exercise, and each exercise was performed for 8 seconds as one set, with five sets performed per day. The motor function was evaluated every week. The motor function was evaluated at the home of the participant. In order to ensure that there was no error in the ELT method, instructions were repeated before the start of ‘B’ period. The evaluation parameters measured included the range of motion of the left and right hip extension and abduction, muscle strength of the left and right hip extension and abduction (measured by manual muscle testing [MMT]), one-leg standing time of each side, Timed Up and Go Test (TUG), 10 m comfortable walking speed, and 2-step value. The 2-step value was the value obtained by dividing two steps by the height. Each evaluation was performed thrice, and the average was used as the representative value.

RESULTS

The results of this study are shown in Table 1. In ‘A’ period, there was no change in any of the evaluation parameters. In ‘B’ period, the muscle strength of the left and right hip extension and abduction, range of motion of the left and right hip extension and abduction, one-leg standing time of both sides, and 2-step values improved, while values of TUG and 10 m comfortable walking speed decreased. In the second ‘A’ period, the muscle strength of the left and right hip extension and abduction and range of motion of the left and right hip extension and abduction did not change, but the one-leg standing time of both sides and 2-step value decreased, and TUG and 10 m comfortable walking speed values increased.

DISCUSSION

The aim of this study was to investigate the effect of ELT on motor function by comparing changes in motor function with and without ELT in a single case. In the ‘B’ period of the ABA design in this study, the range of motion of the left and right hip extension and abduction, muscle strength of the left and right hip extension and abduction, one-leg standing time of the left and right, and 2-step values improved. These results suggested that ELT contributed to the improvement of the motor function in this case.

The changes in the range of motion and muscle strength in this case were attributed to ELT. In the ELT performed in this case, the hip joint was shifted from the hip flexion position to the hip intermediate position, and this position was set as the starting position. Therefore, the muscle activity of the hip flexors was decreased by the reciprocal innervation[9, 10] accompanying the muscle activity of the hip extensor when shifting from the hip flexion position to the intermediate position. In the hip flexor, the iliopsoas consists of two muscles, the iliacus and psoas[11, 12]. Since the psoas attaches to the thoracic and lumbar vertebrae, it is known to be involved in trunk movements[12], such as the lumbar vertebrae lateral flexion[13, 14] and extension[15]. Therefore, the lumbar vertebrae extension and lumbar vertebrae lateral flexion during hip extension and abduction were less likely to occur due to decreased iliopsoas activity in ELT. Similarly, extension of the elongation band in the longitudinal direction decreased the muscle activity of the erector spine and quadratus lumborum on the extension side, and the lumbar vertebrae lateral flexion was less likely to occur during hip abduction. Therefore, it is thought that the hip extensor and abductor could be activated efficiently during each exercise by suppressing these lumbar vertebrae movements; hence, the range of motion and muscle strength of hip extension and abduction improved.

The changes of TUG, 10 m comfortable walking speed, and 2-step value were considered. Burnfield et al.[16] reported that

Table 1. Evaluation results for each parameter

	A1	A2	B1	B2	A3	A4
Hip extension angle (°) (right/left)	10/10	10/10	15/15	15/15	15/15	15/15
Hip abduction angle(°) (right/left)	15/15	15/15	20/20	20/20	20/20	20/20
Hip extension muscle strength (MMT) (right/left)	2/2	2/2	3/3	3/3	3/3	3/3
Hip abductor muscle strength (MMT) (right/left)	3/3	3/3	4/4	4/4	4/4	4/4
One-leg standing time (sec) (right/left)	1.1/1.1	1.0/2.0	3.3/6.3	4.0/6.0	2.3/3.7	2.0/3.1
Timed Up and Go Test (sec)	10.2	10.8	8.3	8.1	9.1	9.3
10 m comfortable walking speed (sec)	12.7	12	9.9	9.0	11.5	11.5
2-step value (two strides length/height)	1.0	1.0	1.2	1.3	1.1	1.1

A1: 1st week of A, A2: 2nd week of A, A3: 3rd week of A, A4: 4th week of A.
B1: 1st week of B, B2: 2nd week of B.
MMT: manual muscle testing.

hip extension muscle strength affected walking speed and stride length. Furthermore, Rodacki et al.[17] reported that improvement of the range of motion of the hip extension contributed to the improvement of walking speed and stride length. The results of this study showed that the walking speed and 2-step value improved due to improvement of the gluteus maximus strength and range of motion of hip extension by ELT. Regarding the one-leg standing time, it has been reported that lateral stability in one-leg standing is controlled by muscles around the hip joint[18, 19]. Moreover, in this study, the improvement of the muscle strength of the hip extensor, including the gluteus maximus, using ELT improved the lateral stability in one-leg standing and increased the one-leg standing time.

ELT uses an elongation band with low resistance and high extensibility[7, 8]. Therefore, it is considered that the ELT was able to perform the exercise safely without causing excessive load on each joint of the lower limbs and no new obstacles such as pain were experienced. Therefore, the results of this study suggest that ELT is an effective method to improve the motor function safely even in the elderly.

The limitation of this study was that the only method for measuring muscle strength was MMT, and the objectivity of muscle strength evaluation was poor. Therefore, it is necessary to investigate the relationship between changes in muscular strength and changes in movement ability in ELT using an objective evaluation method, such as a manual dynamometer. Additionally, since only one case was studied in this study, it is necessary to investigate the effect of ELT by analyzing more cases. Since we did not directly evaluate the degree of lumbar and hip movements and muscle activity during ELT in this study, it is necessary to investigate the differences between ELT and regular training.

In conclusion, this study investigated the effect of ELT on motor function by comparing the changes in motor function with and without ELT in a single case. The results showed that ELT was effective in improving the motor function in this case. Future studies with more number of cases investigating the effect of ELT on motor function are required.

Conflict of interest

No potential conflicts of interest are disclosed.

REFERENCES

1) Hsu M, Yamada T: Population aging, health care, and fiscal policy reform: the challenges for Japan. RIETI Discussion Paper Series, 2017, 38: 1–57.
2) Suzuki T, Kim H, Yoshida H, et al.: Randomized controlled trial of exercise intervention for the prevention of falls in community-dwelling elderly Japanese women. J Bone Miner Metab, 2004, 22: 602–611. [Medline] [CrossRef]
3) Fiatarone MA, O'Neill EF, Ryan ND, et al.: Exercise training and nutritional supplementation for physical frailty in very elderly people. N Engl J Med, 1994, 330: 1769–1775. [Medline] [CrossRef]
4) Judge JO, Whipple RH, Wolfson LI: Effects of resistive and balance exercises on isokinetic strength in older persons. J Am Geriatr Soc, 1994, 42: 937–946. [Medline] [CrossRef]
5) Saiki T, Aoki T, Kuruma H: A new exercise to transverse abdominal muscle. World Confederation for Physical Therapy Congress, 2015, Singapore, PR-PO-09–07-sat.
6) Saiki T, Kurihara T, Tsuji K, et al.: Examination of the acute effects of antagonist stretching on the flexibility and balance of elderly persons. World Confederation for Physical Therapy Congress, 2015, Singapore, PR-PO-14–08-sat.
7) International Elongation Training Association: https://www.elongation.info/ (in Japanese).
8) Interim report on the effect verification experiment of the regional development model "Health Elongation Training". http://www.shigaplaza.or.jp/cms/wp-content/uploads/2017/02/elt.pdf (in Japanese).
9) Liddell EG, Sherrington C: Further observations on myotatic reflexes. Proc R Soc Lond, B, 1925, 97: 267–283. [CrossRef]
10) Eccles RM, Lundberg A: Integrative pattern of Ia synaptic actions on motoneurones of hip and knee muscles. J Physiol, 1958, 144: 271–298. [Medline] [CrossRef]
11) Agur AM, Lee MJ: Grant's atlas of anatomy. Baltimore: Williams and Wilkins, 1991.
12) Oatis CA: Kinesiology: the mechanics & pathomechanics of human movement. North America: Lippincott Williams & Wilkins, 2004.
13) Juker D, McGill S, Kropf P, et al.: Quantitative intramuscular myoelectric activity of lumbar portions of psoas and the abdominal wall during a wide variety of tasks. Med Sci Sports Exerc, 1998, 30: 301–310. [Medline] [CrossRef]
14) Santaguida PL, McGill SM: The psoas major muscle: a three-dimensional geometric study. J Biomech, 1995, 28: 339–345. [Medline] [CrossRef]
15) Bogduk N, Pearcy M, Hadfield G: Anatomy and biomechanics of psoas major. Clin Biomech (Bristol, Avon), 1992, 7: 109–119. [Medline] [CrossRef]
16) Burnfield JM, Josephson KR, Powers CM, et al.: The influence of lower extremity joint torque on gait characteristics in elderly men. Arch Phys Med Rehabil, 2000, 81: 1153–1157. [Medline] [CrossRef]
17) Rodacki AL, Souza RM, Ugrinowitsch C, et al.: Transient effects of stretching exercises on gait parameters of elderly women. Man Ther, 2009, 14: 167–172. [Medline] [CrossRef]
18) Reimer RC 3rd, Wikstrom EA: Functional fatigue of the hip and ankle musculature cause similar alterations in single leg stance postural control. J Sci Med Sport, 2010, 13: 161–166. [Medline] [CrossRef]
19) Bisson EJ, McEwen D, Lajoie Y, et al.: Effects of ankle and hip muscle fatigue on postural sway and attentional demands during unipedal stance. Gait Posture, 2011, 33: 83–87. [Medline] [CrossRef]