

CASE REPORT

Rehabilitation for Hallux Deficit Patient Treated by Conservative Therapy: A Case Report

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Received: 10 March 2022; Accepted: 20 March 2022; Published: 27 March 2022

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ABSTRACT

INTRODUCTION

Hallux deficit is common in congenital diseases and in diabetic patients. Since the hallux is important for stabilizing the movement of the center of pressure in the anterior-posterior direction, most of the treatments for the hallux deficit are surgical reconstructions.

CASE PRESENTATION

In this study, we report a 21-year-old patient belonging to the equestrian club who had a hallux deficit with residual MP joint due to injury with conservative therapy. Rehabilitation was started because the load on the thenar was anxious due to the hallux deficit, and there was instability during walking and reduction of the balance. The contents of rehabilitation were mainly balance training and ankle flexibility in order to improve balance ability. Furthermore, since he experienced fatigue after exercise associated with muscle weakness, muscle trainings of the lower limbs were added. After 10 weeks of rehabilitation, his gait improved. Especially the proportion of load response and single support phase increased from 46.9% to 49.3%, the pre-swing phase decreased from 14.6% to 11.6% in the standing phase on the affected side. The second peak of floor reaction force vertical component also increased from 599.8N to 647.5N.

CONCLUSION

It is considered that reduction of anxiety by balance training and increase of muscle strength led to improvement of walking and balance ability. Even with conservative therapy, the gait and balance ability were improved. This

study suggests that it may be useful to take an approach focusing on load in such cases. It is recommended to investigate the effects of conservative therapy on high intensity exercise in the future.

KEYWORD

Hallux deficit; Rehabilitation; Conservative therapy; Case report

INTRODUCTION

The toes contribute to postural stability during standing and walking. Among them, the hallux is involved in controlling the movement center of gravity in the anterior-posterior direction [1]. Therefore, it has been reported that the fingers reconstruction was using 2 to 4 of the toes [2], and the thumb reconstruction was using the second toe [3]. In addition, there are case reports for hallux amputation following [4], but there have been no case reports of conservative therapy for hallux deficit. Therefore, the purpose of this study was to report a case study of conservative therapy for a hallux deficit patient.

CASE PRESENTATION

Patient Information

A 21-years-old male student [177 cm, 58 kg, body mass index (BMI) 18.5] and equestrian club member. He experienced a right toe injury during a club activity accident. The accident severed his right toe above the IP joint. He was treated with conservative therapy without surgery. He had no other history of injury.

There was pain around the injured site for about two months after the injury, and the pain appeared mainly during walking. He also felt pain inside the right knee joint while riding or walking one month after the injury, so we started rehabilitation. The pain of the hallux deficit area may make it difficult for him to apply a load to the thenar. Consequently, his stance-phase balance ability was reduced. For these reasons, as an evaluation before and after rehabilitation, walking cycle, temporo-spatial gait parameter, foot pressure distribution, ground reaction force during walking, walking cycle, floor reaction force, toe grip force and one leg standing test were performed.

Gait Analysis

The center of pressure (COP) during comfortable walking was recorded using force plates (Kistler Japan Co., Ltd. Tokyo, Japan) at a sampling rate of 1,000Hz and was low-pass filter (20 Hz) [5].

The walking cycle and foot pressure while comfortable walking was recorded using a Zebris plantar pressure platform (FDM; GmbH, Munich, Germany; number of sensors: 11.264; sampling rate: 100 Hz; sensor area: 149 cm × 54.2 cm) [5-7].

One Leg Standing Test

The one leg standing test is a common tool as assessment of static balance ability. This test evaluated whether or not to stand on one leg for 10 seconds with eyes open [8].

Diagnostic Assessment

A decrease in foot pressure during walking is observed not only in the hallux but also in the head of the metatarsal bone of 2 toes to 5 toes on the affected side (Figure 1). The left foot COP migrated to the left toe in late stance, while the right foot COP migrated to the second toe, and with greater spatial variability (Figure 2).

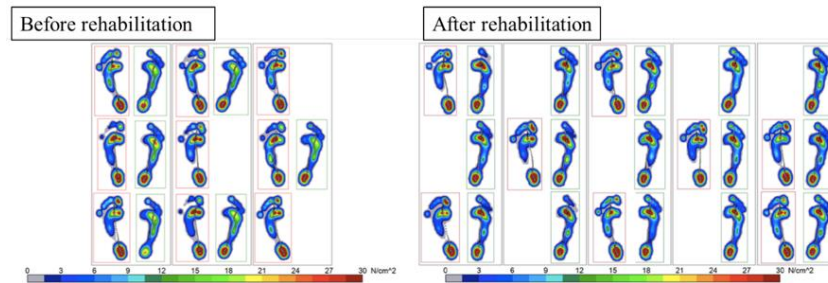


Figure 1: Foot pressure during gait before and after rehabilitation. **A)** Before-rehabilitation measurements showed that less foot pressure on the thenar and the inside of the right foot with hallux deficit. **B)** After-rehabilitation measurements showed that the foot pressure on the thenar and the inside of the right foot is higher and improved the movement loading on the thenar.

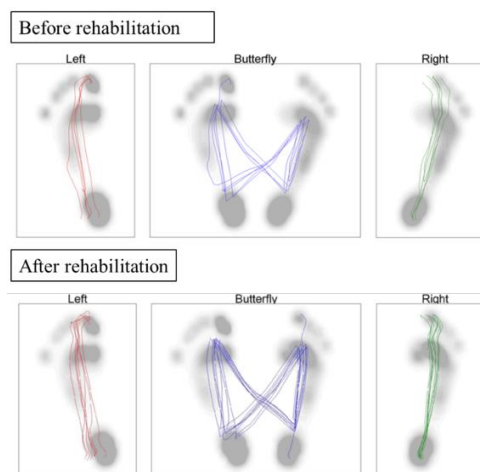


Figure 2: Gravity shift during gait before and after rehabilitation. **A)** The line indicates the locus of the center of gravity during walking. In the before-rehabilitation measurement, the center of gravity varied in the terminal stance phase on the right foot and escaped to the second toe. **B)** In the measurement after-rehabilitation, there was little variation in the locus of the center of gravity.

In the walking cycle, the load-response period and the single support period were shortened, while the pre-swing period was prolonged (Figure 3).

As for walking, it decreases to the right at the second peak of floor reaction force vertical component. Only about 70% of the left force in the anterior force in the second half of the stance phase (Figure 4).

For one leg standing, it could not be performed for 10 seconds on the right foot.

As for pain, he rated Toe and Knee as 5 pains out of 10 pains on a numerical rating scale (NRS).

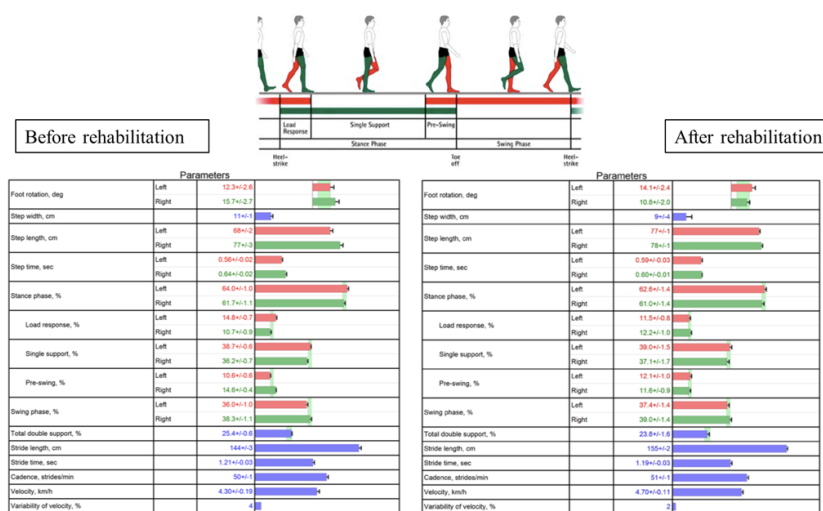


Figure 3: Walking cycle before and after rehabilitation. **A)** The percentage of time occupied by each phase of the walking cycle is shown. Before-rehabilitation measurements showed a decrease instance phase on the right foot. **B)** In particular, there was a decrease in the load response phase and single standing phase of the right foot increased, and the left-right difference decreased.

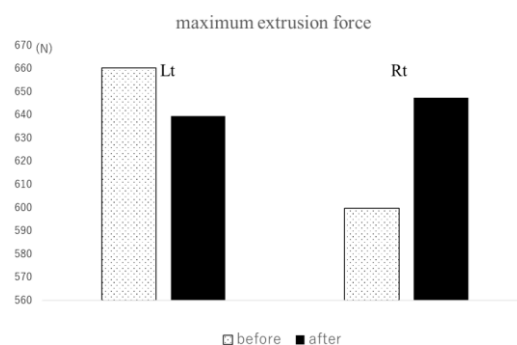


Figure 4: The vertical direction of floor reaction force. **A)** It shows the floor reaction force in the anterior-posterior direction in the terminal stance phase. Before-rehabilitation on the floor reaction force when pushing forward with the right foot was lower than with the left foot. **B)** After-rehabilitation, the floor reaction force when pushing forward with the right foot improved and the left-right difference has disappeared.

Therapeutic Intervention

Based on the above results, the goal was to promote the medial foot load and improve foot pressure during walking and standing. The rehabilitation process is shown in Figure 5.

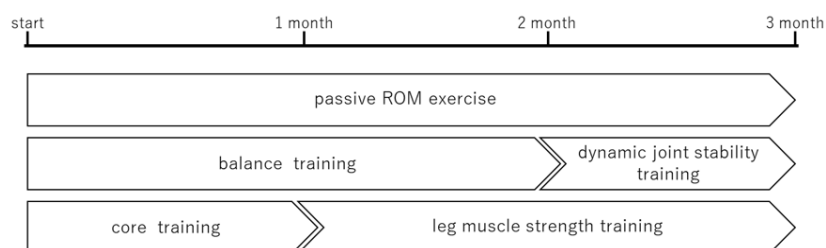


Figure 5: Rehabilitation process.

For one month after the start of rehabilitation, balance training and trunk strength training were performed. From the 5th week, he focused on lower limb strength training. From week 9 onwards, dynamic joint stability training was adopted for neuromuscular coordination to stabilize the movement [9].

FOLLOW UP AND OUTCOMES

Regarding the foot pressure and the movement of the COP during walking, the pressure of 2 toes to 5 toes and the metatarsal head increased, and the maximum pressure also increased (Figure 1). The foot pressure is stably released from the second toe in the right foot (Figure 2).

The walking cycle has improved from the previous time. Improvements have been seen in the pre-leg phase (Figure 3).

As for walking, there is almost no left-right difference in the vertical direction and the anterior-posterior direction (Figure 4).

For one leg standing, the right foot can be stably performed for 10 seconds even on the balance mat.

As for pain, he rated Toe and Knee as a 0 out of 10 pains on an NRS.

DISCUSSION

In this case, we focused on the abductor hallucis muscle remaining because all MP joint of the toe is left. Previous studies suggested that the toe is important in balance performance [1] and that the abductor hallucis muscle is involved in maintaining the medial longitudinal arch [10]. This may indicate that the medial longitudinal arch is maintained when standing on one leg. In addition, he felt pain inside the knee joint. However, the ability to smoothly apply the inner load when walking or standing on one leg may have reduced the inversion of the knee joint due to ankle supination during operation [11]. It is suggested that this led to pain relief.

Next, we focused on the posture during movement about walking. The posterior COP is observed by lumbar lordosis and thoracic kyphosis during standing. Previous studies suggested that the hip flexion moment during walking with sway back was longer during the stance phase. It is considered that the tensor fasciae latae muscle activity was higher than that of the gluteus medius muscle [12]. It is also suggested that Trendelenburg's sign is seen when the muscle activity of the tensor fasciae latae muscle is higher than that of the gluteus medius [13], which is considered to be the cause of instability of the COP while walking. In this study, he trained trunk muscles and stretched lower limbs in order to gain dorsiflexion of the ankle joint and hip range of motion, and to control the spine by strengthening the trunk muscle strength. Five weeks after the start of lower limb strength training. Furthermore, the increase in muscle strength may have led to the acquisition of anterior thrust during walking.

Regarding treatment of the hallux deficit, there are reports about reconstructive surgery but no reports about rehabilitation. In this case report, the hallux deficit due to an injury was treated with conservative therapy. As a result of rehabilitation, the abilities of gait and balance were improved. Therefore, it is suggested that rehabilitation may be effective for conservative therapy in patients with hallux deficit.

CONCLUSION

In this study, we treated the hallux deficit with conservative therapy and observed changes in gait and balance ability before and after rehabilitation. Even with conservative therapy, the gait and balance ability were improved. It is recommended to investigate the effects of conservative therapy on high intensity exercise in the future.

DECLARATIONS

Authors' Contributions

ND carried out the all studies and drafted manuscript. TP and HT analyzed gait. All authors interpreted results. All authors read and approved the final manuscript.

Acknowledgement

We would like to thank the subject who participated in this study.

Competing Interests

The authors declared that they have no competing interests.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for Publication

A consent form signed by the patient allowing the publication of this case report is available from the authors.

Ethics Approval and Consent to Participate

The author declares that he followed the World Medical Association Declaration of Helsinki in this study. Obtained consent from the patient to participate in the study.

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