The effect of weight-bearing exercise and non-weight-bearing exercise on gait in rats with sciatic nerve crush injury

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Abstract. [Purpose] The purpose of this study was to access the effect of weight bearing exercise (treadmill exercise) and non-weight-bearing exercise (swimming exercise) on gait in the recovery process after a sciatic nerve crush injury. [Subjects and Methods] Rats were randomly divided into a swimming group (n=3) with non-weight-bearing exercise after a sciatic nerve crush and a treadmill group (n=3) with weight bearing exercise after a sciatic nerve crush. Dartfish is a program that can analyze and interpret motion through video images. The knee lateral epicondyle, lateral malleolus, and metatarsophalangeal joint of the fifth toe were marked by black dots before recording. [Results] There were significant differences in TOK (knee angle toe off) and ICK (knee angle at initial contact) in the swimming group and in TOK, ICA (ankle angle at initial contact), and ICK in the treadmill group. In comparison between groups, there were significant differences in TOA (ankle angle in toe off) and ICA at the 7th day. [Conclusion] There was no difference between weight bearing and non-weight-bearing exercise in sciatic nerve damage, and both exercises accelerated the recovery process in this study.

Key words: Sciatic nerve crush injury, Weight-bearing exercise, Gait

INTRODUCTION

Owing to the development of transportation and increased leisure time, the frequency of damage in nervous tissue, especially in peripheral nerves, is on the rise. The clinical problems of peripheral nerve damage are motor paralysis of muscle, sensory paralysis, and functional loss, and such neurological injuries are mostly caused by strong crushing and cutting due to an external force. Additionally, pain from sciatic nerve damage can be caused by herniated nucleus pulposus (HNP), spinal stenosis, and piriformis muscle syndrome and may lead to hip pain and functional loss and paresthesia of lower extremities. Peripheral nerve damage eventually generates partial or total loss of the motor, sensory, and autonomic nervous systems including body segments.

Compensation for a functional disorder caused by neurological injury consists of reinnervation of neural paralysis by regeneration of damaged axon terminals, reinnervation from neighboring undamaged axon terminals to dendritic branches, and reformation of neural system circuits relating to lost functions. However, this mechanism does not come with satisfying functional restoration and it is hard to expect recovery in the case of severe neurological injury.

Microsurgical techniques such as neurorrhaphy and nerve grafting are used to repair severe neurological injury. Lundborg proved that acute electrical stimulation after sciatic nerve damage accelerated muscle reinnervation improvement and axonal regeneration. In addition, long-term moderate-intensity treadmill exercise with acute electrical stimulation in the beginning of nerve regeneration was found to be more effective. Previous studies reported that active and passive exercise using bicycle training was effective for sciatic nerve damage, treadmill exercise accelerated functional recovery and decreased neuropathic pain, and swimming exercise after a sciatic nerve crush injury accelerated muscle recovery. A number of recovery methods for peripheral nerve damage have been analyzed as mentioned above, but these analyses only focused on the exercise method or intensity, and there are few studies about weight-bearing and non-weight-bearing exercise. Therefore, the purpose of this study was to access the effect of weight-bearing exercise (treadmill exercise) and non-weight-bearing exercise (swimming exercise) on gait in the recovery process after a sciatic nerve crush injury.
and interpret motion through video images. The knee lateral sciatic nerve damage. Dartfish is a program that can analyze behavioral motion analysis according to recovery from the knee lateral sciatic nerve crush injury.

There were significant differences in TOK (knee angle at toe off) and ICK (knee angle at initial contact) in the treadmill group (p<0.05) and in TOK, ICA (ankle angle at initial contact), and ICK in the swimming group (p<0.05). In comparison between groups, there were significant differences in TOA (ankle angle at toe off) and ICA at the 7th day (p<0.05) (Table 1).

**DISCUSSION**

Peripheral nerves damage causes pain and deficits in sensory and motor nerves, and regeneration ability depends on damage level. There is no functional recovery method for severe nerve injury, and surgical repair is generally used. In addition, owing to natural reinnervation and damage to neural factors necessary for recovery of damaged function, active neural redistribution may not be expected. Therefore, proper intervention is needed to prevent severe nerve damage and paresthesia. There are many studies about intervention methods, particularly those using external stimulation.

In this study, a gait analysis was used as an effectiveness
evaluation for therapeutic intervention, and the effect of weight-bearing exercise using a treadmill and non-weight-bearing exercise (swimming) on gait in the recovery process after a sciatic nerve crush injury was assessed.

After peripheral nerve damage, axons in the damaged region are disconnected from nerve cell bodies and degenerated, and neural responses and chromatolysis form in the damaged nerves. Wallerian degeneration generates a micro-environment in the distal region and causes neural responses for regeneration and elongation and regrowth of surviving axons.

In the axonal regeneration process in the damaged nerve, Schwann cells proliferate in the damaged area and move to the distal region, followed by axonal contact and regeneration. Schwann cells proliferate until complete regeneration, and a myelin sheath is ultimately formed\(^\text{14}\).

Neurotrophic factors are involved in the growth and differentiation of nerve cells, and all neurotrophins have similar biochemical characteristics. The expression level of neurotrophins and their acceptors can change according to differentiation of nerve cells, and all neurotrophins have effective for nerve recovery.\(^\text{18, 19}\)

Previous studies showed that exercise interventions were effective for nerve injury\(^\text{18, 19}\). Gutmann and Jakoubek\(^\text{20}\) reported that swimming exercise for recovery from sciatic nerve damage increased axonal growth and that treadmill running exercise increased reinnervation, axonal elongation, and sprouting. These results are consistent with the results of this study, that is, that treadmill and swimming exercise were effective for nerve recovery.

There was a decrease in gait ability at the beginning of testing (first 7 days). This was a period of inflammatory response and recovery for other tissues and with Wallerian degeneration after 4 days, nerve function was considered to decrease\(^\text{21}\). The results of the present study showed no substantial difference between treadmill and swimming exercise. Therefore, there was no difference between the effects of weight-bearing and non-weight-bearing exercise on sciatic nerve damage, and both exercises accelerated the recovery process in this study. A limitation of this research is that only gait ability was measured, so neurotrophins expression should be evaluated in further studies.

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