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Therapeutic Intervention for Restoration of Sensory and Motor Function after Central Nervous System Injury

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Abstract

The objective of this study was to investigate the effects of extracorporeal shock wave therapy on the expression of neurotrophin-3 and C-Fos in the central nervous system injury of rats. In this study, 16 eight-week-old, Sprague-Dawley-origin male white rats weighing 250-300g were tested. Magnetic-type extracorporeal shock wave therapy equipment (HAEMIL, Soltar, Korea) was used for low-intensity extracorporeal shock wave therapy. Extracorporeal Shock Wave Therapy (ESWT) was applied to the gastrocnemius muscle of the injured side hind limb. Western blot analysis was analyzed to evaluate the NT-3 and C-Fos. Before the experiment, the spinal cords of the experimental and control groups were extracted and pre-evaluated. Spinal cords were extracted after all experiments to extract neurotrophic factors from the experimental and control groups. The change in the amount of NT-3 and C-Fos expression was a statistically significant difference in the ESWT group that received shock waves compared to the control group. In comparing the treatment effects of the therapeutic methods, the experimental group showed a significantly more significant change than the control group.

Keywords: *Sensory, Motor, Function, Therapy, Restoration*

1. Introduction

Intracerebral Hemorrhage (ICH) sometimes develops voluntarily from continued chronic high blood pressure or secondarily develops due to cerebrovascular disease. Once intracerebral hemorrhage develops, blood accumulates inside the brain and destroys the Central Nervous System (CNS).

Primary brain damage occurs as pressure around the hemorrhage drastically increases. Secondary damage follows due to the change of brain parenchyma, including blood-brain barrier destruction, inflammation, and edema [1].

Like other adult diseases, intracerebral hemorrhage currently exhibits a decreasing incidence age and an increasing incidence rate. Hence, interest in methods for preventing intracerebral hemorrhage and therapy after its incidence is increasing. Recently, diverse therapeutic intervention methods have been introduced that are aimed at the recovery of symptoms due to intracerebral hemorrhage, including medicinal treatment, operative treatment, and physical therapy [2].

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However, patients' conditions vary according to their neurologic injury, and the progress of the disease differs because environmental factors influence it. Hence, finding efficient rehabilitation therapy methods for intracerebral hemorrhage patients is difficult [3].

This study aimed to investigate the effects of Extracorporeal Shock Wave Therapy (ESWT) on the expression of neurotrophin-3 (NT-3) and C-Fos in central nervous system injury of rats.

2. Subjects and methods

2.1. Subjects

This study used 16(eight-week-old, weighing 250-300g) male white rats. During the experiment, the laboratory environment maintained a temperature and humidity of 22±5℃ and 49±5%. Four rats were assigned to each cage to minimize stress in space.

The experimental group (n=8) received the ESWT after the intracerebral hemorrhage injury, whereas the control group (n=8) did not receive therapy after the intracerebral hemorrhage injury [Figure 1].

All surgical procedures and experimental protocols followed the Institution of Animal Care and Use Committee (IACUC).

2.2. Research methods

2.2.1. Extracorporeal shock wave therapy

This study used a magnetic-type shock wave device (HAEMIL, Soltar, Korea) to apply extracorporeal shock wave therapy. Extracorporeal shock wave therapy was applied to the gastrocnemius muscles on the injured side. In one treatment, extracorporeal shockwave treatments were used 1000 times (frequency of 1 Hz, energy flux density of 0.1 mJ/mm^2).

2.2.2. Western blot analysis

Western blot analysis was used to evaluate the NT-3 and C-Fos. Before the experiment, the spinal cords of the experimental and control groups were extracted and pre-evaluated. Spinal cords were extracted after all experiments to extract neurotrophic factors from the experimental and control groups.

2.2.3. Statistical analysis

For the statistical analysis in this study, the mean standard deviation was described through descriptive statistics using SPSS for Windows (version 18.0).

An independent sample t-test was used to examine the intergroup differences. The statistical significance level of all data was $p<0.05$.

3. Results

Statistical analysis showed significant differences between groups of NT-3 and C-Fos expression levels ($p<0.05$).

The NT-3 and C-Fos expression change was statistically higher in the experimental group treated with extracorporeal shock waves than in the control group without any treatment [Figure 2][Figure 3].

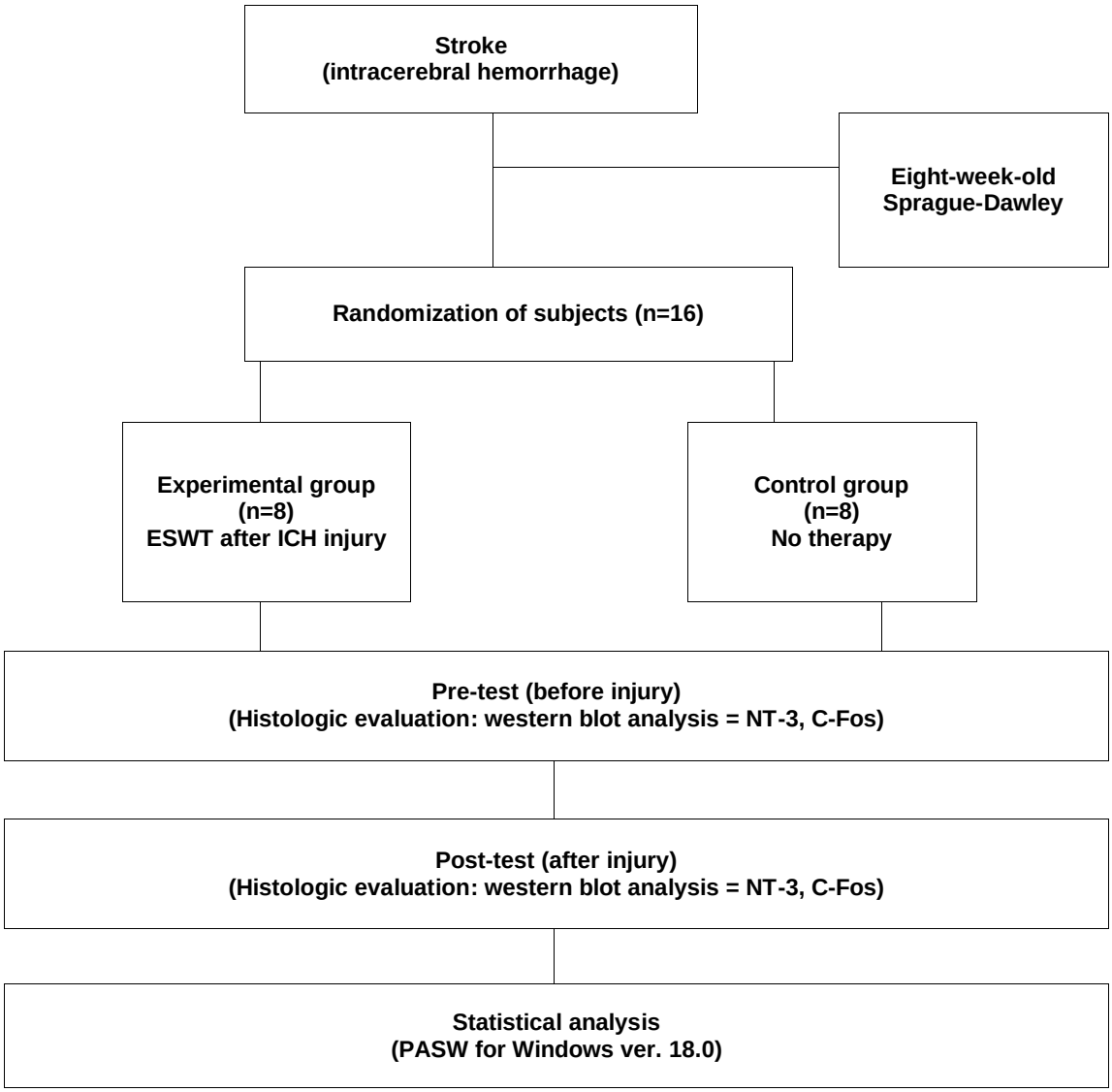

Figure 1. Flow chart

4. Discussion

Gait is a fundamental factor in human life, and patients with central nerve injury, such as damage to the descending motor pathway, have difficulties walking independently.

After a stroke, patients show asymmetrical sensorimotor cortex activity due to diminished activity of the affected side hemisphere during walking and excessive excitability of the corticospinal [4].

Because of these reasons, the gait of patients with stroke is limited in walking quality due to several defects, including the decrease of the affected side stride length, stance phase time, cadence, gait speed, and increased spasticity [5].

Spasticity is a neurologic symptom that frequently develops after a stroke, and it is defined as the muscle tone that increases according to speed and excessive tendon reflexes [6].

As spasticity causes pain and postural abnormalities and limits daily living activities and regular movement, affecting patients' quality of life, appropriate therapy is required from the earliest stage of development [7].

Because central nerve injury is the leading cause of spasticity, most studies regard excessively increased spinal excitability as a cause of spasticity [8].

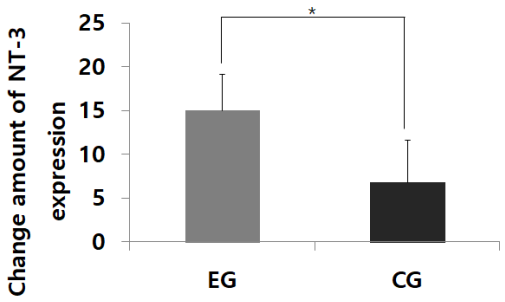

Figure 2. Comparison of NT-3 expression between groups *p<0.5, Mean±SD: Mean±standard deviation, NT-3: Neurotrophin-3, EG: Experimental group, CG: Control group

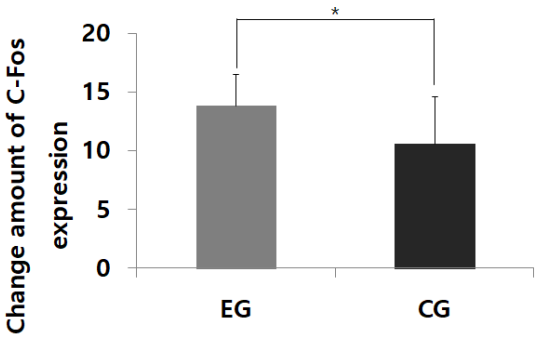

Figure 3. Comparison of C-Fos expression between groups *p<0.5, Mean±SD: Mean±standard deviation, EG: Experimental group, CG: Control group

This study examined the effects of applying ESWT to rats with central nerve injury on the expression of the NT-3 and C-Fos. In the study results, NT-3 expression was statistically significantly higher, and C-Fos expression was statistically significantly lower in the experimental group compared to the control group. That is, ESWT promoted the expression of NT-3 and C-Fos, which affected nerve regeneration, survival, and remodeling.

5. Conclusion

The chief goal of this study was to assess the effects of extracorporeal shock wave therapy for nerve regeneration on the expression of neurotrophin-3 (NT-3) and C-Fos in the central nervous system injury of rats.

To assess the effect of shock waves on improving nerve regeneration, the extracorporeal shock wave was applied to the gastrocnemius muscle using an extracorporeal shock wave therapy device.

In the results of this study, the expression level of nerve growth factor affecting nerve regeneration was increased due to the application of extracorporeal shockwave therapy. That is, extracorporeal shockwave treatment applied after nerve injury positively affects nerve regeneration.

In the following study, I hope that extracorporeal shock wave therapy will demonstrate the effectiveness of treatment for various diseases, symptoms, and sites.

Acknowledgments

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