



Research paper

Effects of intravenous laser irradiation on respiratory physiology parameters of amyotrophic lateral sclerosis patients: An uncontrolled observational study



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ABSTRACT

Introduction: Respiratory dysfunction and complications are the most common causes of death in amyotrophic lateral sclerosis (ALS) patients. This study observed the changes of respiratory physiology parameters during intravenous laser irradiation (ILI) treatment on ALS patients.

Methods: Eighteen ALS patients received ILI treatment four times a week for 2 weeks. The end tidal carbon dioxide (EtCO₂), respiratory rate (RR), saturation of peripheral oxygen (SpO₂) and pulse rate were measured for 15 min before and during treatment by using capnography and oxymetry. For estimating the mechanism of ILI on respiratory function, we evaluated the LF (low frequency)/HF (high frequency) ratio of heart rate variability (HRV).

Results: The results showed that RR, SpO₂ and pulse were significantly reduced during ILI ($p < .001$). But the change of SpO₂ and pulse value during ILI were significantly increased ($p = .014 < .05$, $p = .003 < .01$). LF (low frequency)/HF (high frequency) ratio value was significantly increased during ILI ($p = .045 < .05$).

Conclusion: ILI led to a statistically significant difference in SpO₂ and pulse changes in ALS patients despite the supine position. These results seem to be caused by an ILI's action to stimulate the sympathetic nervous system and modulate hyperkinetic hemodynamics. But, in order to clarify these results, a well designed study is now required.

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1. Introduction

Amyotrophic lateral sclerosis (ALS) is an uncommon neurodegenerative disease in adults, with a prevalence of about 6 cases per 100,000 persons [1]. ALS begins in the limb or bulbar muscles and eventually reaches the respiratory myotomes. Survival ranges from months to decades but is usually less than 3 years from the time when symptoms first appear [2]. ALS is characterized by a progressive neuromuscular atrophy with early involvement of the respiratory system [3]. Most patients with ALS have progressive hypoventilation due to respiratory muscle weakness [1]. Eighty-four percent of ALS patients die from respiratory complications and respiratory insufficiency within 2–3 years after diagnosis. Thus, the time and degree of progressive respiratory

muscle weakness are important factors in determining the prognosis for ALS patients [4,5].

Intravenous laser irradiation (ILI) was originally put forward in the United States in 1982, but it was popularized in Russia in the 1980s and in China in the 1990s [6]. For this treatment, laser light is sent directly into the bloodstream through a one-way catheter. *In vitro* tests showed that biological soft-laser irradiation of white blood cells caused various positive effects, in particular the expression of immunoglobulins, interferons, and interleukins [7–9]. In Russia, it was reported that ILI had clinical effects on chronic suppurative lung disease and pulmonary tuberculosis [10,11]. Moges et al. found that motor function was significantly improved in the low-level laser therapy group for patients in the early stage of familial ALS [12].

Based on the results of the above-described studies, the present study was performed to observe the effects of ILI on various respiratory physiology parameters, EtCO₂, SpO₂, RR, and pulse. In addition, we attempted to determine the mechanism of ILI's effects on respiratory function by observing the changes in the balance of the autonomic nervous system.

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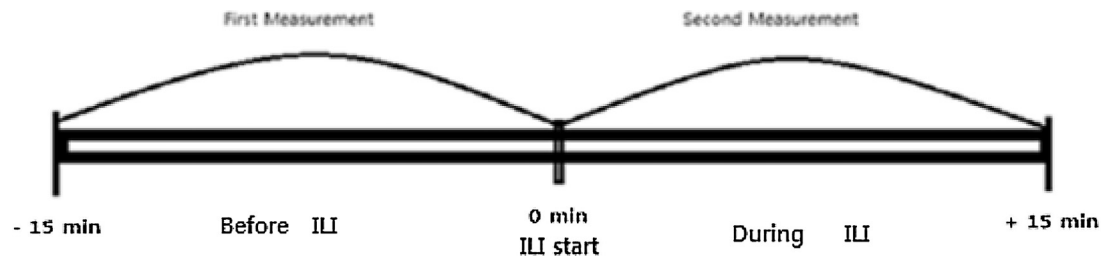


Fig. 1. Diagram representing a pair of measurements from the trial. Respiratory parameters (EtCO₂, SpO₂, RR, and pulse) were measured using capnography and oximetry.

2. Materials and methods

2.1. Subjects

This study was conducted at the Wonkwang University ALS clinic from November 2013 to April 2014. Twenty seven ALS patients were screened from the admitted patients. This study was approved by the institutional review board (IRB) of Wonkwang University Hospital, and written informed consent was obtained from all the participants. ILI is a certified therapy that was insured by the Korean National Insurance scheme.

In order to comply with research ethics, the following criteria were applied.

The inclusion criteria were as follows: patients were included if they (1) satisfied the El Escorial criteria [13] and were diagnosed with ALS by electromyography; (2) had signed a consent form; (3) cooperated with the study; (4) had not exercised within the previous 24 h; (5) had not smoked or drank alcohol, coffee, or green tea within the previous 8 h; (6) had eaten at least 1 h prior to testing; and (7) were not menstruating.

The exclusion criteria were as follows: patients were excluded if they (1) needed intensive care for respiratory insufficiency; (2) were not able to give basic information due to severe bulbar palsy; (3) had heart disease, such as ischemic heart disease; (4) had an internal secretion disorder, such as thyroid disease; (5) had renal disease, such as chronic renal failure; (6) had a fever; (7) had a seizure disorder, such as epilepsy; (8) had mental illness; (9) were addicted to drugs, such as alcohol, nicotine, or caffeine; or (10) were not eligible for this study at the discretion of the researcher.

2.2. Outcome measures

2.2.1. Capnography and pulse oximetry

Capnography and pulse oximetry (Nonin Medical, Japan) were chosen because they are easy and useful tools for observing changes in a patient's respiratory condition [14]. In this study, we measured the end tidal carbon dioxide (EtCO₂), respiratory rate (RR), saturation of peripheral oxygen (SpO₂) and pulse of each patient.

2.2.2. Low frequency/High frequency (LF/HF) ratio of HRV

We selected six participants for determination of the mechanism of ILI's effects on respiratory function; we evaluated TP (total power), VLF (very low frequency: 0–0.04 Hz), LF (low frequency: 0.04–0.15 Hz), HF (high frequency: 0.15–0.4 Hz), normalized HF, normalized LF to acquire the LF/HF ratio of heart rate variability (HRV) before and after ILI in a supine position by using an SA-6000 biophysical amplifier (Medicore, Korea).

2.2.3. Procedures

The experimental procedures were as follows. The subjects were encouraged to rest and not to undertake strenuous exercise before measurement. Each patient's respiratory parameters (EtCO₂, RR, SpO₂, and pulse) were measured by capnography and oximetry for 15 min, with the patient in a supine position. An intravenous catheter (BD Angiocath Plus™, 24 GA, 0.75 in.; BD, Singapore) was inserted into the cephalic vein near LU5 (acupuncture point, Chi Ze, at the cubital crease on the radial side of the biceps brachii tendon). The laser needle (24 G; SIR Medical, Korea) was infixed to the catheter. The laser used emits He–Ne laser light in a continuous wave, with a wavelength of 632.8 nm and an output power of 10 mW (LAPIA 107, Korea). It was kept in place for 15 min, and the EtCO₂, RR, SpO₂, and pulse were measured simultaneously. The data obtained from this process were considered to comprise one pair of measurements. Each patient received ILI treatments four times a week for 2 weeks (Fig. 1).

2.2.4. Scolopendrid and bee venom pharmacopuncture

Pharmacopuncture was injected uniformly to eighteen participants. It was applied 2–3 times a week to eighteen patients. It was difficult to implement only the ILI monotherapy during the experimental periods, as this study was conducted on hospitalized patients. Depending on the individual patients' symptoms, e.g., indigestion, constipation, muscle stiffness, or common cold, the herbal medicine was administered for a short time.

2.3. Statistics

A statistical analysis performed using SPSS 22.0 ver. for Windows was used to compare the changes in parameters. To compare the differences in values obtained before and during ILI stimulation, the paired t-test was conducted, using the mean values for data obtained over 15-min periods. Significance is represented by *p* values of <0.05 throughout.

Table 1
Baseline characteristics of ALS patients.

ALS patients	N = 18
Sex (male:female)	11:7
Age (years)	55.39 (±11.53) ^a
Age at onset (years)	52.39 (±12.16) ^a
K-ALSFRS-R score ^b	27.89 (±8.5) ^a
Distribution of K-ALSFRS-R score	
15–20	2
21–25	6
26–30	4
31–35	2
36–40	3
41–45	0
46–50	1
Site of onset	
Bulbar muscles	3
Upper limb muscles	9
Lower limb muscles	6

^a Data are means ± standard deviations.

^b K-ALSFRS-R, Korean ALS functional rating scale, revised.

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