The Effects of Neck Immobilization on Driving Performance
: A Pilot Study Results
Kwansub Lee, Susanna Yang, Hanseong Choe, Hwakyung Shin
Department of Physical Therapy, Catholic University of Daegu, Daegu, Korea
Corresponding Author : hkshin1@cu.ac.kr

Abstract
The purpose of this study was to investigate the effects of neck immobilization with collar orthosis a driving performance. Previous studies have not investigated the effects of neck immobilization on driving performance during the simulation driving. The driving scenario consists of straight and right rotation. The parameters of driving performance included the number of road edge excursions, centerline crossings, and steering angle. Data was analyzed with the Wilcoxon signed-rank test to compare collar group and non-collar group. As a results of simulator driving, steering angle of with-collar group was significantly higher than the without-collar during right rotation. We suggest that neck immobilization has negative effect on driving performance because of substitute motion. We suggest that patients wearing neck collar orthotics should be careful when they drive on road.

Key words: Driving Simulator, Driving performance, Neck collar.

1. Introduction
Driving is a complex task that requires adequate cognitive, psychomotor, and visuoperceptual motor function that work together. Impairment of these functions can be compromised to a greater and lesser extent in patients with reduced head and neck mobility. However, the impact of the these dysfunction on the activity of daily living, such as driving motor vehicles is not well established[1,2].

The present study aimed to preliminarily investigate actual driving performance using a virtual reality driving simulator in a group of neck immobilization by wearing the neck collar orthosis.

2. Method

Subject
Ten healthy subjects were recruited. All patients net the following initial criteria in the study: (1) chronological age 20 years or older; (2) corrected or uncorrected visual acuity of no worse then 20/30 based on a brief vision screening using a Snellen eye chart; (3) possession of a valid state driver’s license, (4) no history of neurological musculoskeletal disorder.

Apparatus & Procedure
In the UC-win/Road(Forum8, Japan) almost similar to real driving environment, minimize errors, the program can be measured to digital map data, satellite data and 3D model data. This study used simulator, included main computer, 27-inch monitor, automatic gear, three-wheel pedal(figure 1).
In this study, using a Philadelphia collar, neck flexion, extension, rotation, lateral flexion of neck movement was limited. Philadelphia collar limited less than common neck collar of neck lateral flexion and rotation.

Subjects performed the simulation driving collar and non-collar after performing 5 times practice. The tester provided a feedback through verbal instructions “Go straight and turn right”. In this study, the time it takes to turn right, rotation distance and handling angle were measured while driving. (figure 2).

![Figure 1. Simulator equipment](image1)

![Figure 2. Experiment setting](image2)

**Statistical analysis**

We used Wilcoxon signed rank test to compare collar group and non-collar group. The level of significance was verified to be 95%.

**3. Results**

Dependent variables included right turning time, distance, handling angle for driving performance (Table 1). All 10 subjects represents neck collar group longer than non-neck collar group in right turning time. In the neck collar groups at a distance longer than non-neck collar group. However, the handling angle of non-neck collar group was larger than angle of handling neck collar group. But all variables were not statistically significant (0>0.05).

![Table 1. Driving performance](image3)

**4. Discussion**

The results of simulation driving showed that neck collar groups represented the decrease of driving performance. The present investigation indicate that driving ability with impaired neck mobility was limited at the visual organization, navigation, observation, spatial relationship, and speed of the visual process[3,4]. Therefore handling angle of the neck collar group was larger due to the lack of visual information. Thereby, distance and time will be longer. We predicted that the limited mobility of the neck caused to increased substitute motion. Also, the psychological pressure became involved with lack of selective focus, continuous focus, decision-making, and safety of judgment, problem solving and planning, insight, commitment and the ability to change[5].

Our study had several limitations. First, the findings cannot be generalized to all disabled due to small sample size. Second, there was a difference between reality responsive steering and brake. Finally, the driver’s seat does not fit the individual characteristics of the subjects did not take the situations that can occur while driving. Research is also needed to determine objective indicators with appropriate and effective program. In future research, driving rehabilitation in order to identify the various characteristics of the driving simulator will be researched by securing a sufficient number of studies on the various typed of disability.

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Contact
More information is available at:
hkshin1@cu.ac.kr
(Assistant Professor at the Catholic University of Daegu)

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