Relationship of Sitting-Pressure Distribution and Driving Performance During Simulator Driving in Post-Stroke Drivers: A Pilot Study Results

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Abstract

We examined the relationship the sitting-pressure distribution and driving performance during a simulator driving in post-stroke patients. 4 post-stroke drivers participated in this study. In this study, we developed an assessment environment using a driving simulator to evaluate driving performancce of stroke patients. The driving scenario consists of 3.5km urban traffic conditions (3 minutes), 10km divided 4-lane straight highway (6 minutes), and 7km 2-lane curved or hilly rural roads (6 minutes). Performance parameters during the simulated drive were automatically generated by the simulator software. The parameters included time-to-collision (TTC), number of road edge excursions, centerline crossings, speed limit violations, collisions, reaction time, and runtime. Pressure data from the mat were divided into four (right buttox, left buttox, right thigh, left thigh) and calculate the average contact area ratio, average contact pressure ratio,and average peak contact pressure ratio.We suggest the posibility that sitting pressure distribution may be a predictable variable of driving performance of post-stroke drivers.

Keywords: Driving performance, driving simulator, sitting pressure, stroke

Introduction

Stroke is one of main the cause of death Due to life extension and a person of advanced age in Korea. Prime-age after the 40s, the incidence is increasing [1]. Stroke is the second leading cause of death in the country. Stroke cause a physical, functional disability more than 50%. [2] Due to these, patient is difficult to have a good posture. A good sitting posture should have normalization of muscle tension, reducing the impact of the primitive reflex, Minimizing deformities and contracture, increasing the range of motion, increasing the stability of the posture. As a result, equational weight distribution and comfort offer and they can improve the function [3]. Therefore, Patients with poor posture will probably affect driving ability. However those persons with disability want to drive themselves. Unfortunately, there is no guideline for assessment driving performance for stroke patients in South Korea.

The purpose of this study examined how symmetry affects driving ability. study-based, we want to find a better way to drive patients.

Methods

Participants

Four stroke patients with hemi-paretic stroke were recruited. Their mean age was 50.3 (SD 5.19) years, and the mean duration of illness was 15.3 (SD 2.83) months. Driver 1, 2 was left hemiplegia and driver 3,4 was right hemiplegia. Inclusion criteria were: (1) at least 1 year from the onset of stroke; (2) without ankle joint flexion contracture (3) possession of a valid state driver’s license. Exclusion criteria were: (1) severe spasticity of the ankle (modified Ashworth’s scale: > 2) or tremor; (2) visual problem to see the sine waves are displayed on a PC monitor at 80 cm distance or severe cognitive impairments (scoring < 25 on the Mini-Mental State Examination). (3) visual problem or severe cognitive impairment(scoring <25 on the Mini Mental State Examination). Informed consent form was obtained from the all subjects prior to study.

Measuring instruments

Study patients want to drive again after a stroke, was prepared exactly the same as the actual car. The experiment was conducted in a fixed-based driving simulator. That connected STISIM Drive software and a fixed car. Graphical updates to the virtual environment were computed using STISIM Drive™ based upon inputs recorded from the accelerator, brake and steering wheel with tactile force feedback. The virtual roadway was displayed on a wall-mounted screen at a resolution of 1024 x 768.

Force Sensitive Application (FSA) 4.0 software was used to analyze the distribution of the pressure on the driver's seat. FSA is a flexible pressure-sensitive mat. It includes module to connect computer and 256 sensors. The incoming data into the sensor can be output the maximum pressure and the average pressure on the computer through FSA software [3].

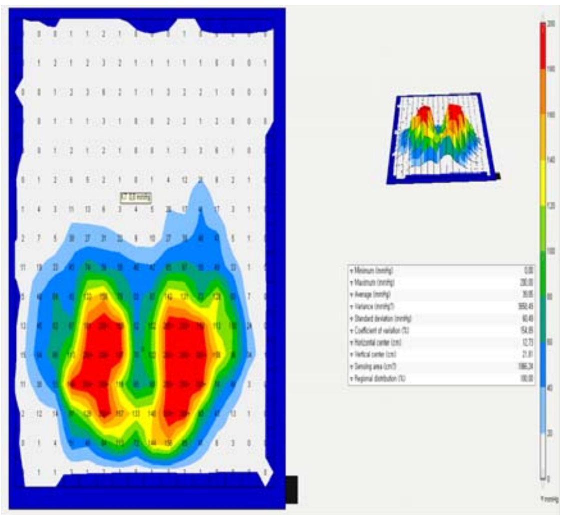

Fig.1 Body Pressure

Procedure

Turn the STISIM program, FSA, navigation and attached to the body pressure the driver's seat sit patients comfortably. The screen is installed to show the driving directions on the front. Following informed consent and completion of a pre-experimental questionnaire, the participants received 5 minutes of driving experience and adaptation time in the simulator. And body pressure measure twice for 30 seconds. Finally, the experiment is carried out (driving and body pressure). The driving scenario consists of 3.5km urban traffic conditions (3 minutes), 10km divided 4-lane straight highway (6 minutes), and 7km 2-lane curved or hilly rural roads (6 minutes).

Analysis

In order to analyze the paralyzed side and non-paralyzed side, we calculated the symmetry index.

Symmetry Index

$$= \frac{\text{non-paralyzed side} - \text{paralyzed side}}{\text{non-paralyzed} + \text{paralyzed side}} \times 2 \times 100$$

Results

Table1 described each driver's average speed, accidents, and line crossing (shoulder and center) in the urban, highway, rural.

As shown in Table1, St3(R) was most stable driving. On the other hand, St2(L) seems difficult to drive compared with others. Table2 shows the symmetry index of the experimenter. St3(R) is close to zero (-0.9%). On the other hand, St2(L) is 35%. Comparing Table1 and Table2, Symmetry index closer to 0, the driving ability is better.

Discussion

Stroke Patients suffered damage to the nervous system such as spinal cord injury, multiple sclerosis due to traffic accidents or disasters is limited to moving due to paraplegia and sensory loss of function. is selected the most wheelchair. Patients who drive until the accident want to back to the driving themselves.

Damage nerves and physical can affect sitting and posture [4]. So, we use the body pressure compared to the pressure on both sides. Compared to Symmetry index with the pressure and STISIM, we can confirm significance difference.

The purpose of this study was to compare Relationship of Sitting-Pressure Distribution and Driving Performance during Simulator Driving in Post-Stroke Drivers. As can be seen from the result, both sides more symmetrical, the driving ability is better.

Looking at the STISIM, St1(L) and St4(R) is no difference. However, symmetry index was many differences. Another limitation is subjects be small in number. Thus, additional experiments need to raise reliability.

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Reference

[1] Ponsford AS, Viitanen M, Lundberg C, et al., Assessment of driving after stroke, Accident analysis and prevention, 40:452-460, 2008.
[2] Lee IH, Shin AM, Son CS, et al. Association Analysis of Comorbidity of Cerebral Infarction Using Data Mining, 8(1): 12-16, 2010.
[3] Kyung G and Nussbaum MA. Driver sitting comfort and discomfort (part II): Relationships with and prediction from interface pressure, International journal of Industrial ergonomics, 38:526-538, 2008.
[4] Schulthesis MT, DeLuca J, Chute DL. Handbook for the assessment of driving capacity. Handbook for the assessment of driving capacity, Elsevier, 2009

Table 1. Average speed, accident, line crossing (shoulder, center) on driving scenario

STISIM	average speed			accident			line crossing(shoulder)			line crossing(center)		
	Ur	Hi	Ru	Ur	Hi	Ru	Ur	Hi	Ru	Ur	Hi	Ru
St1(L)	45.1	96.0	66.0	1	0	0	0	0	0	0	0	1
St2(L)	44.9	79.7	58.0	0	0	1	0	7	9	0	0	3
St3(R)	39.2	89.9	50.3	0	0	0	0	0	0	0	0	0
St4(R)	49.6	88.8	56.7	1	0	0	0	1	0	1	0	0
Mean	44.7	88.6	57.7	0.5	0	0.25	0	2	2.25	0.25	0	1

Ur: Urban, Hi: Highway, Ru:Rural

Table 2. Symmetry Index

	non-paralyzed side	paralyzed side	symmetry index
St1(L)	44.7	47.3	-5.6
St2(L)	123.8	86.9	35
St3(R)	70.1	70.8	-0.9
St4(R)	63.1	75.9	-18.4