Verification of Occupant Posture Control Effectiveness in Collision after Autonomous Emergency Braking System

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I. INTRODUCTION

Automobile safety systems such as Autonomous Emergency Braking (AEB) and Whiplash Protection System (WHIPS) have developed to achieve reduction in the fatality number due to car accidents and studies have been conducted to determine its effect [1]. However, AEB cannot prevent every collision circumstances and WHIPS designed for rear-end collision only which is not appropriate to various collision situations. Therefore, the aim of this study is to identify and verify a new active seat control system while AEB is in operation.

II. METHODS

Subjects

Six healthy adult males were selected to participate in low acceleration AEB sled tests. These six males had no musculoskeletal or nervous system disorder, could move their cervical spine and lumbar spine freely and had no history of whiplash injury (average age, 25.6 ± 4.2 years; average height, 178.6 ± 2.6 cm; average weight, 70.5 ± 3.9 kg). The test was approved by *Sejong University Institutional Review Board* (IRB).

Test Protocol

The AEB simulating sled test platform (Fig. 1. (a)) which is similar with actual vehicle environment was designed to verify occupant's behavior. 0.4G acceleration reduction was applied by motor-based control. All subjects were positioned in the center of seat, pelvis pushed backwards, and feet centered on the foot plates [2]. Each volunteer was exposed to braced and relaxed condition. To analyze effectiveness of seat control, test was conducted with and without seat control in two sitting posture (Fig. 1. (b)). Three-dimensional motion capture system with sixteen infrared cameras (T-10s, Vicon Motion Systems AG, UK; sampling rate: 200 Hz), 74 reflective markers and two speed cameras (Q-MIZE HD v2. AOS technologies Ltd., Switzerland) were used to quantify kinematic characteristics by measuring several anatomically based segments.

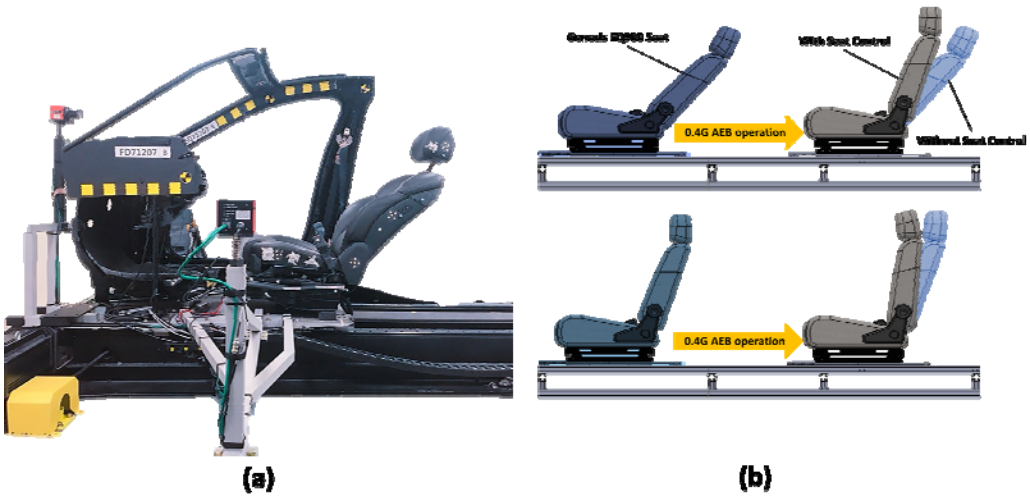

Fig. 1. (a) AEB simulating sled platform; (b) Comparison of the Seat control to obtain occupant's safe position while AEB operating in posture 1 (*Upper*) and posture 2 (*Lower*).

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III. INITIAL FINDINGS

The forward excursion of selected segments was normalized to the respective movement of seat and compared by test condition and posture. When volunteers were braced, there was no different tendency of behavior according to seat control, but there was significant difference in amount of forward excursion within AEB operating range ($p<0.05$). However, when volunteers were relaxed, it showed a different tendency according to the seat control. Unlike conventional seat, which continuously increases forward excursion (Fig.2. (a), (b)), it shows a tendency to decrease after a certain period when seat control (Fig.2. (c), (d)) ($p>0.05$). In case of relaxed volunteers' head maximum forward excursion in two seated postures was decreased 37.4%, 31.9% respectively when seat was controlled (posture 1: 154.6mm to 96.7mm, posture 2: 207.8mm to 141.5mm).

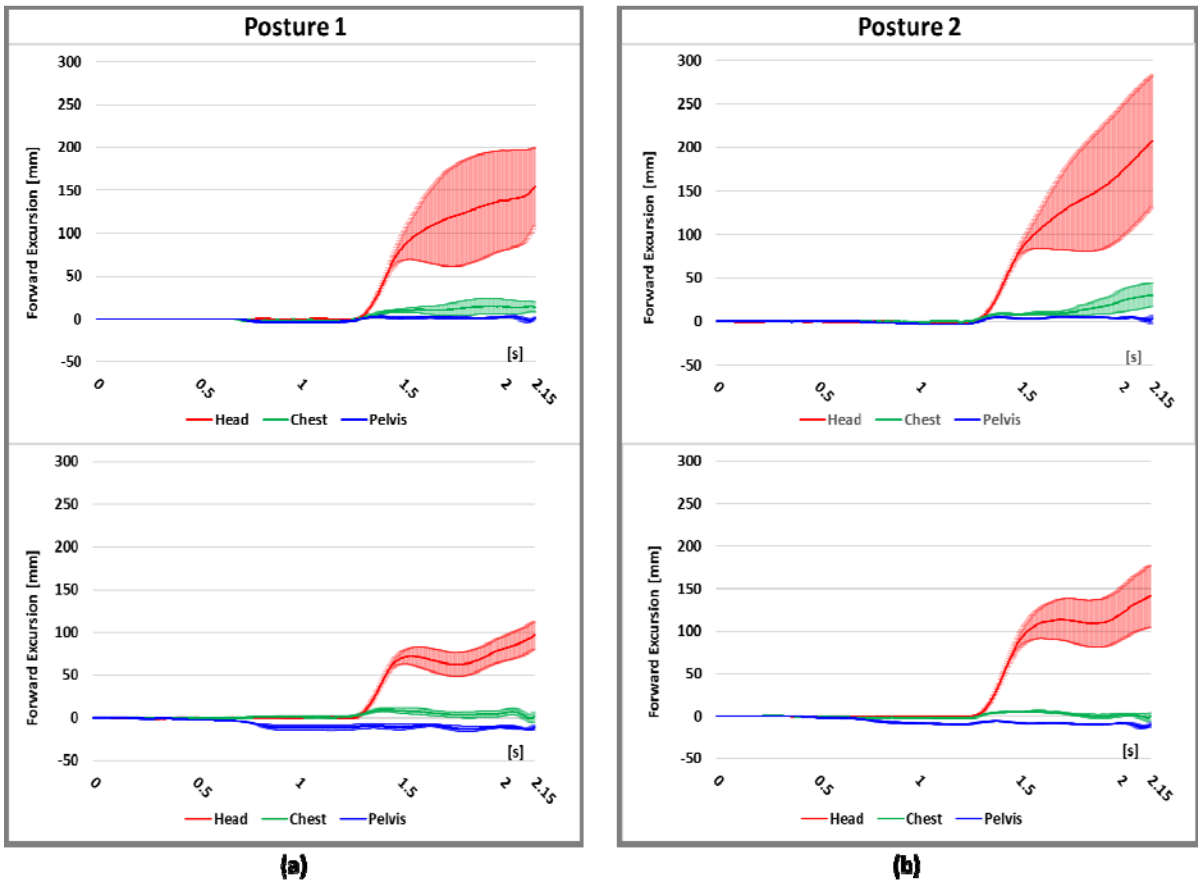

Fig. 2. Forward excursion of anatomical segments (Head, Chest, Pelvis) for relaxed volunteers in each test conditions (a) Posture 1 without seat control (*Upper*), with seat control (*Lower*); (b) Posture 2 without seat control (*Upper*), with seat control (*Lower*)

IV. DISCUSSION

The results show that possibility of achieving occupant's safe posture through seat control system while AEB operates. Additionally, it may be reduced potential injury risks such as clash with vehicle surroundings and submarine effects in collision after AEB operated. However, as energy is pushed forward, some uncertainty is remained about collision injuries. Therefore, it is hard to conclude that this system could get positive effect for occupant's safety in real world clash. Further study is suggested to conduct by computer simulations to ensure safety when clash occurs.

V. REFERENCES

[1] Jakobsson, L. et al, *Accident Anal Prev*, 2000.
[2] Beeman, S.M. et al, *Accident Anal Prev*, 2012.