



### Statistical Analysis

A paired students' t-test was used to identify the difference between human responses (muscle activation and moment) in low-speed, rear-end collision with/without brake force applied to stationary lead vehicle.

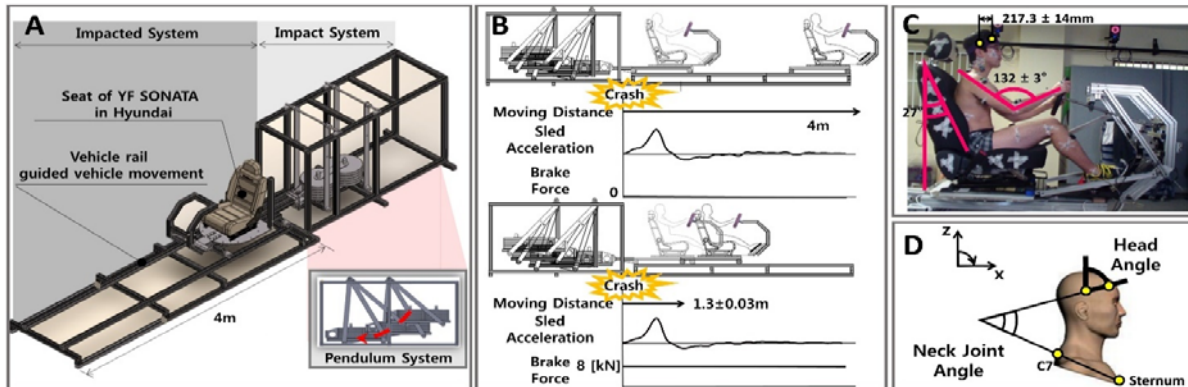


Fig. 1. (A) Low-speed, rear-end collision test platform; (B) conditions for low-speed, rear-end collision tests with/without brake force applied to stationary lead vehicle; (C) actual experimental configuration; (D) definition of neck joint angle.

### III. INITIAL FINDINGS

Maximum muscle activation and moment at the neck joint were increased roughly 1.4 and 1.3 times, respectively, in the low-speed, rear-end collision with brake force applied to stationary lead vehicle ( $p < 0.05$ ) (Fig. 2). The muscle activation and moment were generally distinguished after the retraction phase (initial phase in low-speed, rear-end collision) and maximized for extension-flexion phase (phase occurred after retraction phase in low-speed, rear-end collision). Particularly, the moment was increased rapidly after the retraction phase by sudden, simultaneous increases of agonistic and antagonistic muscle activations.

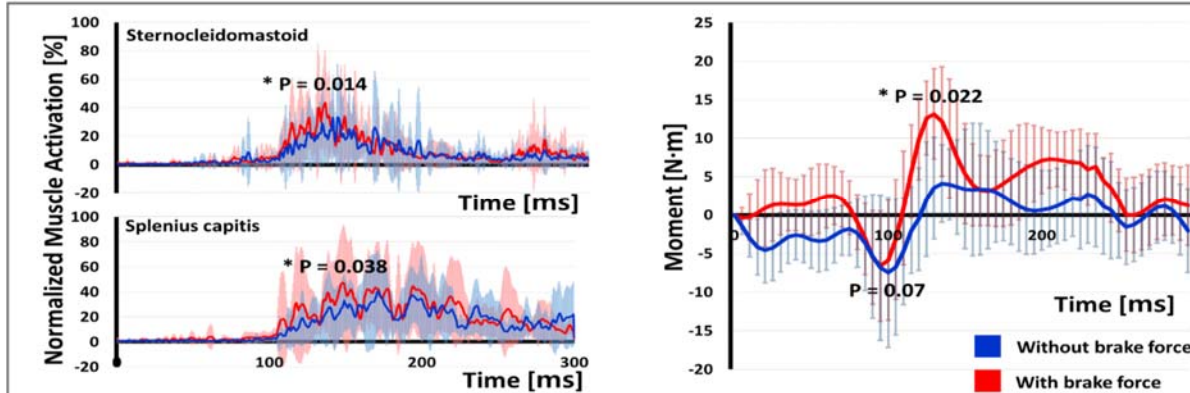


Fig. 2. Alteration patterns of muscle activations (*left*) and moment (*right*) at the neck joint.

### IV. DISCUSSION

The results show that the muscle activation and moment characteristics at the neck joint may be altered due to brake force applied to a stationary lead vehicle in a low-speed, rear-end collision. This indicates that brake force applied to stationary lead vehicle may increase the possibility of injury occurring (e.g. whiplash injury) at the neck joint in the low-speed, rear-end collision. However, our findings must be validated through various low-speed, rear-end collision tests by controlling the parameters (a degree of brake force, habitation, awareness, etc.) influencing the muscle activation and moment at the neck joint.

### V. REFERENCES

- [1] Siegmund, G. P., *Traffic Inj Prev*, 2009.
- [2] McConville, T., *USA*, 1980.
- [3] Kroonenberg, A. van den., SAE paper 983158, 1998.
- [4] Blouin, J. S., Springer, 2003.