WHIPLASH INJURY PREVENTION WITH ACTIVE HEAD RESTRAINT

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INTRODUCTION

Previous epidemiological studies observed that a gap greater than 10 cm between the head restraint and back of the head was associated with higher neck injury risk and greater incidence of chronic symptoms in whiplash patients.[1] Active neck injury prevention systems, such as the active head restraint and energy abosrbing seat, have been developed for some automobiles. However, their implementation is without thorough understanding of their injury prevention mechanisms.

The goals of this study were to develop a new Human Model of the Neck (HUMON) for whiplash simulation, consisting of a neck specimen mounted to the torso of a rear impact dummy and carrying an anthropometric head, and to use the model to investigate the relation between the active head restraint (AHR) position and whiplash injuries.

METHODS

HUMON (**Figure 1**) consisted of a neck specimen mounted to the torso of BioRID II and carrying an anthropometric head stabilized with muscle force replication. HUMON was seated and secured in a Kia Sedona seat with AHR on a sled. The AHR was activated by HUMON's momentum pressing into the seatback during whiplash and rotated forward via a pivoting mechanism between it and the seatback. Rear impacts (7.1 and 11.1 g) were simulated with the AHR in five different positions followed by an impact with no AHR. Peak spinal motions were contrasted with physiologic ranges obtained from intact flexibility tests. Significant reduction ($P<0.05$) in the spinal motion peaks with the AHR, as compared to without, were determined. Linear regression analyses identified correlation between head/AHR gap and peak biomechanical parameters ($R^2>0.3$ and $P<0.001$).

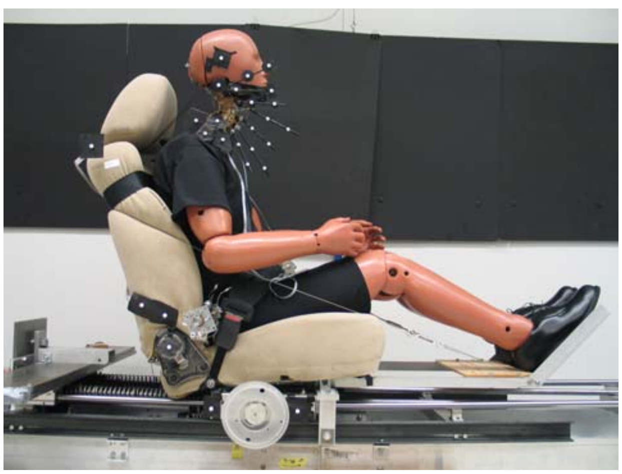

Figure 1. Photograph of the Human Model of the Neck (HUMON) and rear impact apparatus.

RESULTS AND DISCUSSION

The AHR significantly reduced average peak spinal motions throughout the middle and lower cervical spine, however these peaks exceeded the physiologic range in flexion at head/C1 and in extension at C4/5, C6/7, and C7/T1. The AHR position with the smallest gap generally allowed the least motion in excess of physiologic. Correlation was observed between the head/AHR gap and extension peaks at C4/5 and C5/6 (**Figure 2**). Based upon these correlations, motion beyond the *in vivo* physiologic range may occur at C5/6 and C4/5 due to head/AHR gaps in excess of 9.2 and 9.6 cm, respectively, causing extension injuries. These results are consistent with previous epidemiological studies which observed higher neck injury risk[1] and greater incidence of chronic symptoms for a head restraint gap larger than 10 cm.

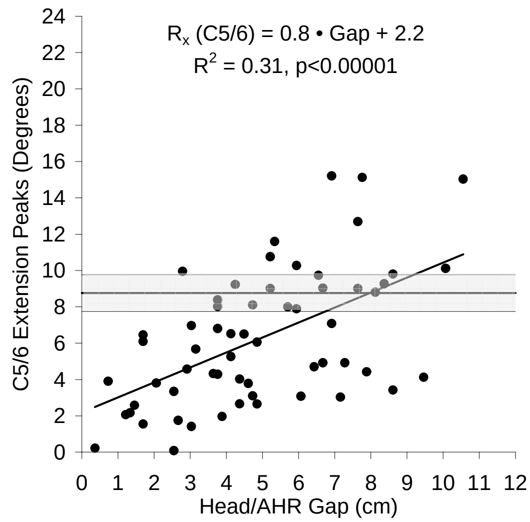

Figure 2. Correlation between head/AHR gap and C5/6 extension peaks. The *in vivo* physiologic rotation range is indicated in grey shading.

CONCLUSIONS

Neck injury due to spinal motion beyond the physiologic range may occur even in the presence of AHR. Correlation between head/AHR gap and peak spinal rotation indicated that a head/AHR gap in excess of 9.2 cm may cause hyperextension injuries at the lower cervical spine.

ACKNOWLEDGEMENTS

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REFERENCES

1. Olsson I, et al. An in-depth study of neck injuries in rear end collisions. Proceedings of IRCOBI. Bron, France, 1990.