INTRODUCTION

- Restraint systems found in motor vehicles are designed to increase the safety of occupants involved in motor vehicle accidents.
- In frontal motor vehicle accidents the interaction of the thorax with the vehicle’s restraint system and components help dictate the kinematic behavior of the head, neck, and spine.
- Effectiveness of restraint systems is evaluated using anthropomorphic test devices (ATD).
- The response of the ATD thorax to an applied anterior compressive force is imperative to its ability to accurately represent a vehicle’s occupant.
- The more biofidelic an ATD’s thoracic force-deflection characteristics, the better the restraint system can be designed.

OBJECTIVE

To compare the frontal compressive response of the adult hybrid III 50th% male ATD thorax with an adult post mortem human surrogate (PMHS) thorax in an effort to improve the biofidelity of the ATD thorax.

METHODS

Nonparametric System Identification

- Characterize nonlinear biological systems through linear operating points [1,2,3].
- Make no assumptions about system’s structure.
- Perturbation analysis.
  - Using small perturbations, the thorax is operating within a linear region and experiment is un-injurious.

Test Device (TAPPER)

- Thoracic Apparatus for Producing PERturbations
- Cam actuated 9.5 mm perturbations anteriorly. Six-axis load cell on seat back.
- Using the compliance model for parameter estimation, input/output are reversed, Figure 2.

RESULTS & DISCUSSION

Table II: Rate Averaged PMHS and III System Characteristics.

<table>
<thead>
<tr>
<th>Perturbation Velocity (m/s)</th>
<th>PMHS</th>
<th>Hybrid III</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.98</td>
<td>0.96</td>
</tr>
<tr>
<td>1.0</td>
<td>340.18</td>
<td>320.89</td>
</tr>
<tr>
<td>1.5</td>
<td>26.92</td>
<td>25.86</td>
</tr>
<tr>
<td>2.0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2.5</td>
<td>269.22</td>
<td>258.68</td>
</tr>
</tbody>
</table>

Table III: Compression Level Averaged PMHS and III System Characteristics.

<table>
<thead>
<tr>
<th>Compression Level Effects</th>
<th>PMHS</th>
<th>Hybrid III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (kg)</td>
<td>Stiffness (N/mm)</td>
<td>Damping Ratio</td>
</tr>
<tr>
<td>5%</td>
<td>0.89</td>
<td>0.76</td>
</tr>
<tr>
<td>10%</td>
<td>1.30</td>
<td>1.00</td>
</tr>
<tr>
<td>15%</td>
<td>1.33</td>
<td>0.92</td>
</tr>
</tbody>
</table>

CONCLUSIONS

- Effective stiffness of 50th% male hybrid III ATD thorax is over four times greater than the PMHS effective stiffness.
- Effective stiffness increases with compression level for both PMHS and hybrid III.
- Hybrid III effective mass slightly higher than PMHS.
- Effective damping relationship not straightforward.

ACKNOWLEDGEMENTS

Yun Seok Kang, PhD, OSU
Rod Herriott, TRC
Jason Stammen, VRTC
The students of the IBRL