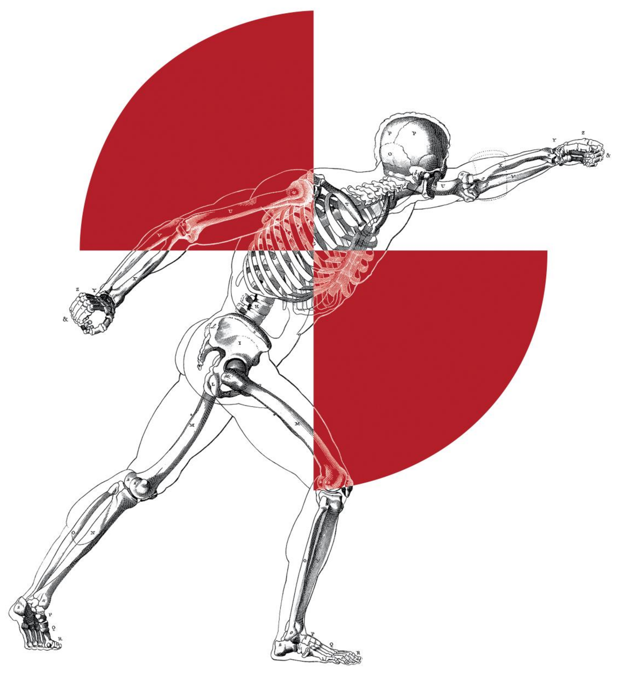

Evaluation of Head and Cervical Spine Kinematics of a GHBMC M50 Occupant Seated in a Production Seat in a Moderate-Speed Rear Impact Scenario

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INTRODUCTION

- The risk of Maximum Abbreviated Injury Scale (MAIS) 3+ injuries is higher in moderate-speed than in low-speed rear impacts [1].
- Global Human Body Models Consortium (GHBMC) was only validated in low speed rear impacts [2].
- Previous studies investigated the responses of head and cervical spine of post-mortem human subjects (PMHS) seated in a production seat in a moderate-speed rear impact scenario [3].
- This study focused on (1) the validation of a FE sled test environment and (2) investigation of differences in the head/neck kinematics between the GHBMC M50 occupant model and PMHS in a moderate-speed rear impact.

METHODS

- A baseline simulation was run with the GHBMC 50th male simplified (M50-OS) model seated on the FE model of 2012 Toyota Camry seat.
- Since the seat has not been validated in rear impact conditions, the seat frame properties were modified to match the seatback rotation observed in the PMHS studies (Figure 1).

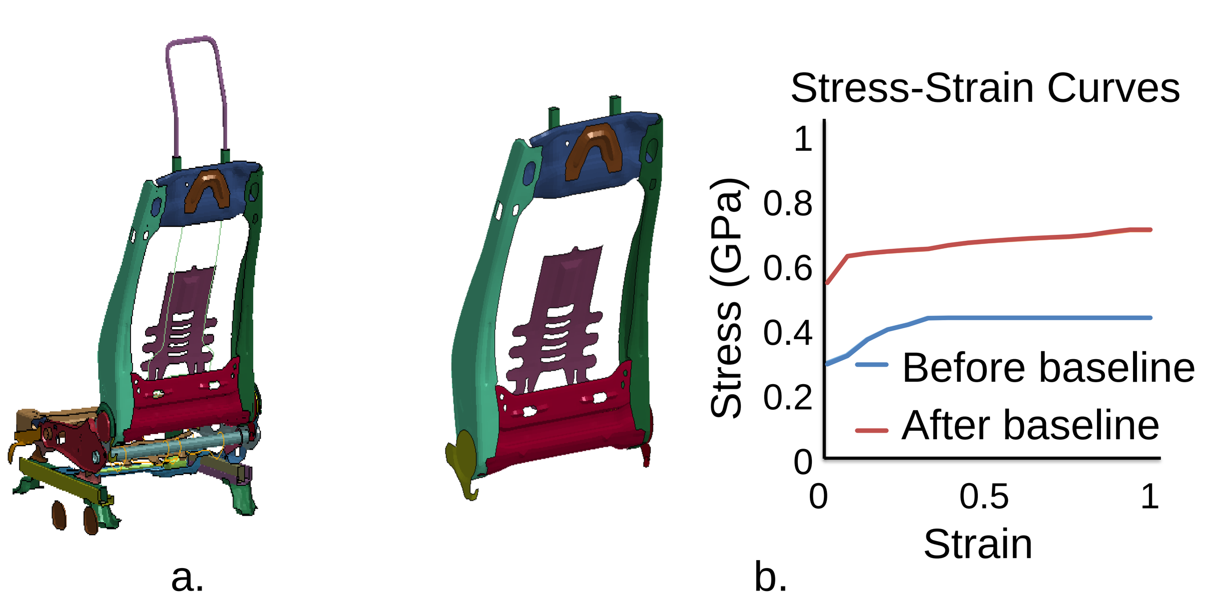

Figure 1: a. Seat frame; b. Components for which the material properties were modified and corresponding stress-strain curves

- The head restraint in the seat was modified using FARO points obtained from the head restraint of the production seat used in the PMHS studies (Figure 2).

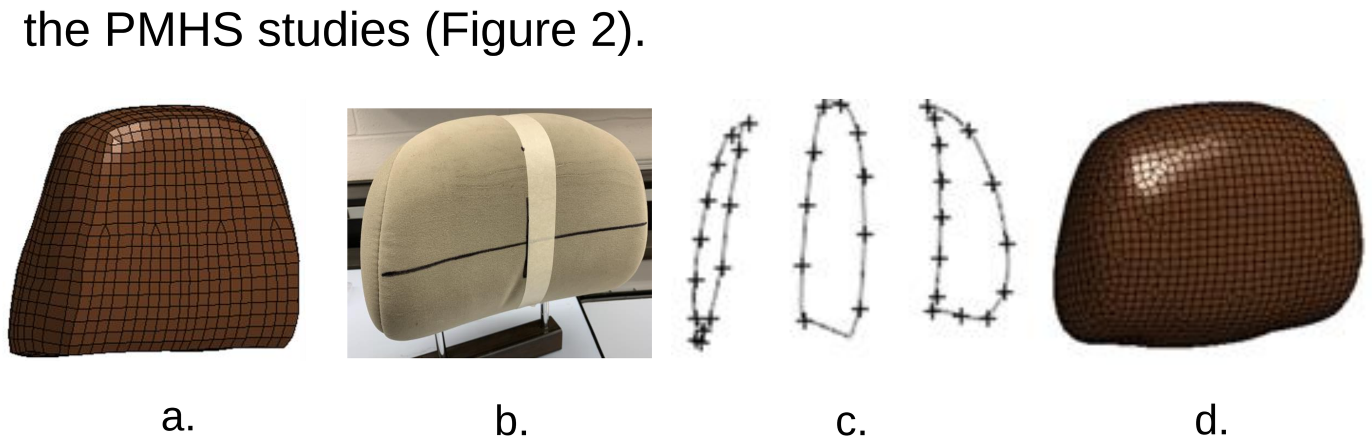

Figure 2: a. Original FE head restraint b. Head restraint of the production seat c. FARO points obtained from the head restraint of the production seat d. Updated FE head restraint

- The GHBMC was then positioned on the seat by controlling the distance between the head and head restraint, and the head center of gravity (CG) and the top of the head restraint (Figure 3).
- A local coordinate system (LCS) was defined for vertebrae C2 through T1 (Figure 4).

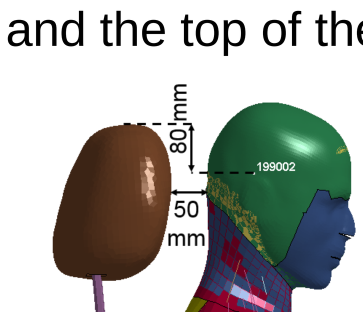

Figure 3: Positioning the GHBMC

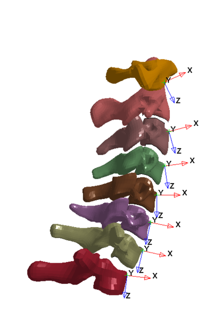

Figure 4: LCS for the vertebrae C2 through T1

- A moderate rear impact pulse (~10.5 g, ~24 kph) was prescribed to the floor of the sled in the x direction (Figure 5).
- Kinematics of the head, cervical spine and thoracic vertebra T1 were evaluated in the LCS.

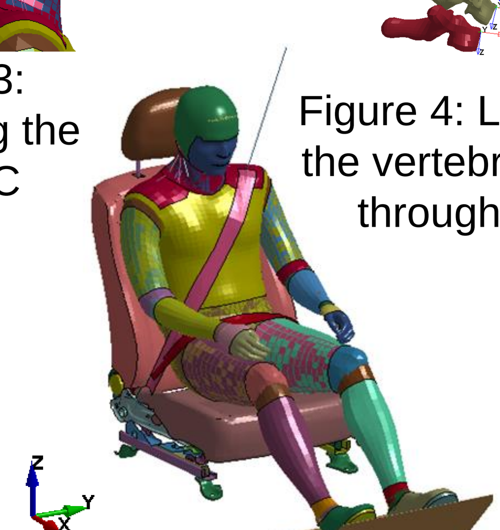

Figure 5: Seated position of the GHBMC

RESULTS & DISCUSSION

- The head acceleration in the x direction for the GHBMC was comparable to the PMHS, while the T1 acceleration in the x direction for the GHBMC was lower than the PMHS (Figure 6).
- Head to T1 rotation about the y-axis followed a similar trend for the PMHS and GHBMC, but the GHBMC showed a lower peak flexion (Figure 7).
- The peak intervertebral rotations for PMHS were primarily flexions while those for the GHBMC were primarily extensions, except for the C7-T1 level (Figure 8).
- The head contacted the head restraint earlier in the PMHS than in the GHBMC (Figure 9).
- Seatback rotation of the FE model of seat closely resembled the production seat used in the test, during the loading phase (Figure 9).

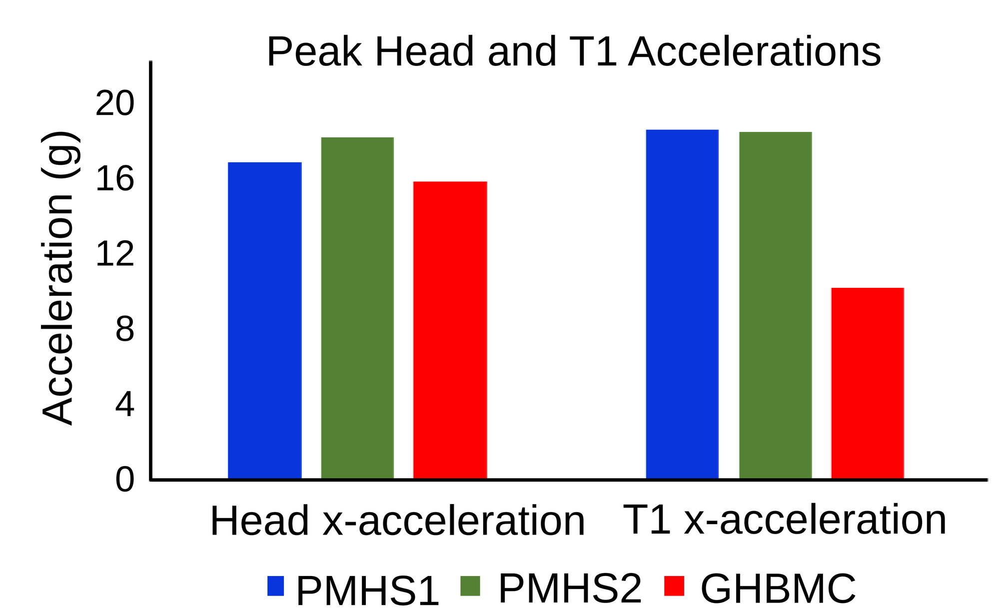

Figure 6: Comparison of peak head and T1 accelerations of PMHS and GHBMC

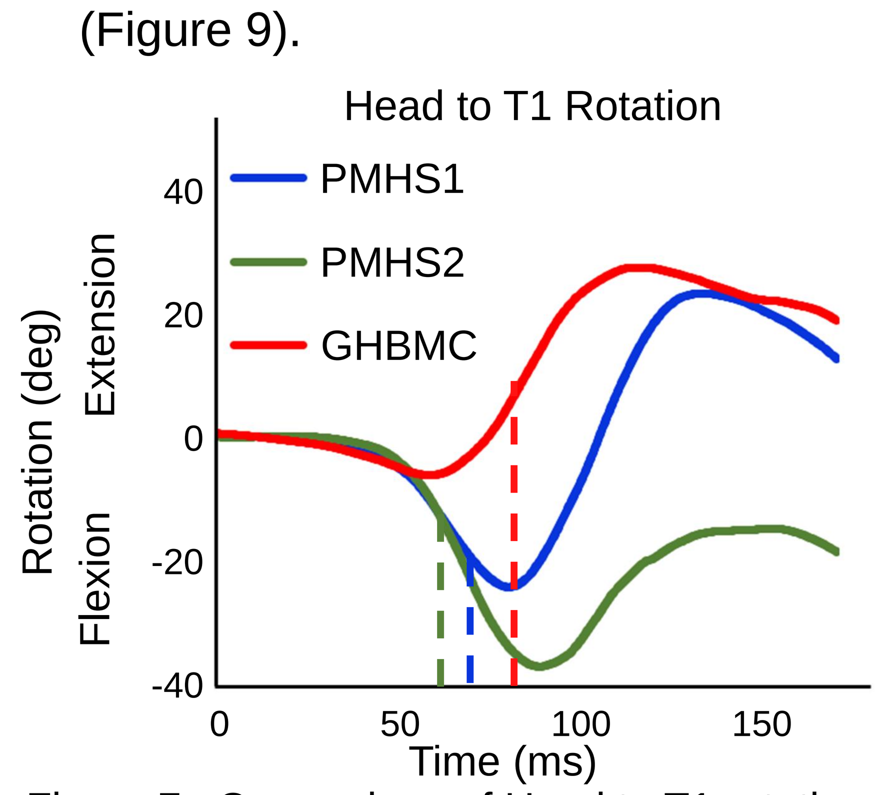

Figure 7: Comparison of Head to T1 rotation of PMHS and GHBMC; Dashed lines represent head contact timing (same color code as for the curves)

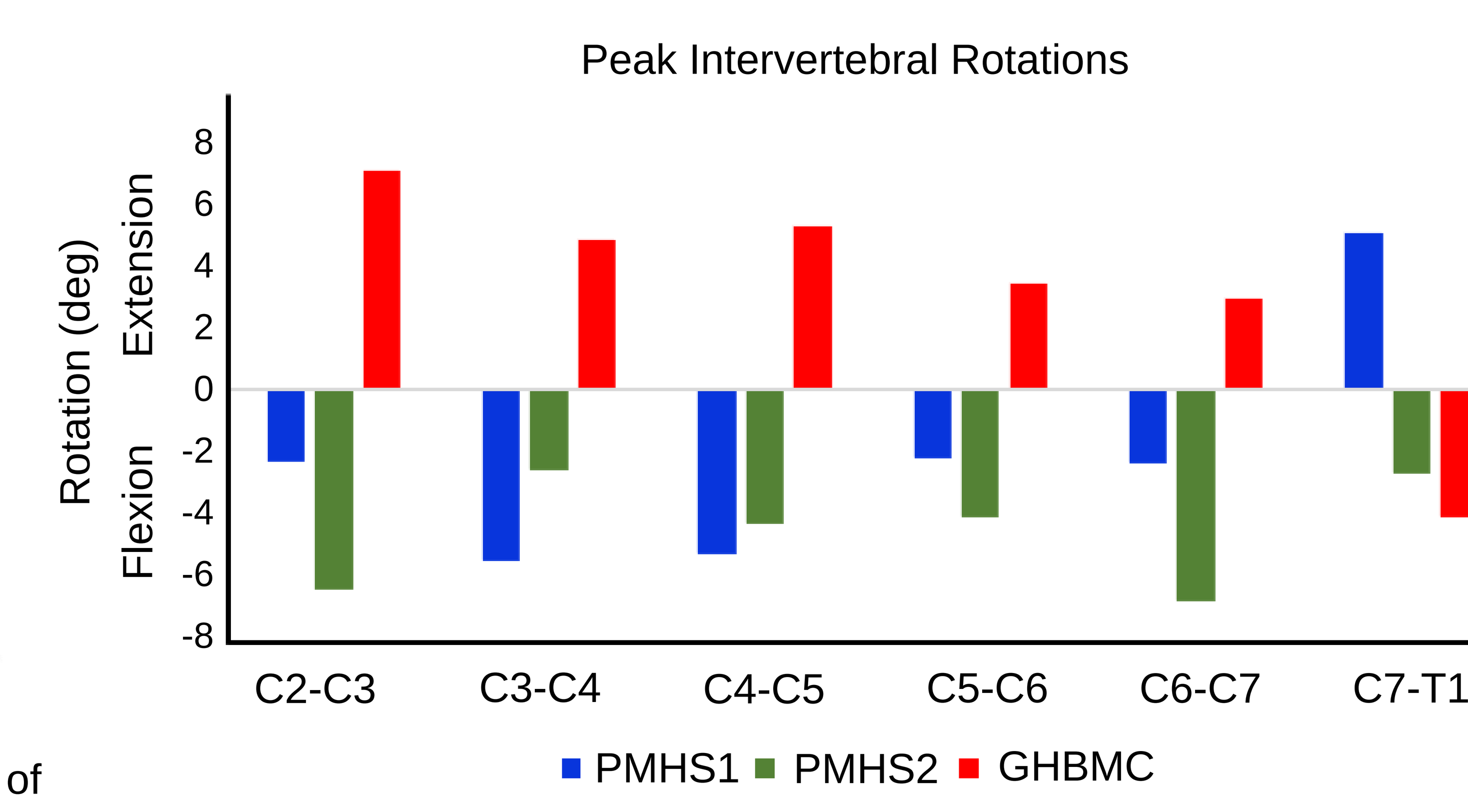

Figure 8: Comparison of peak intervertebral rotations of PMHS and GHBMC

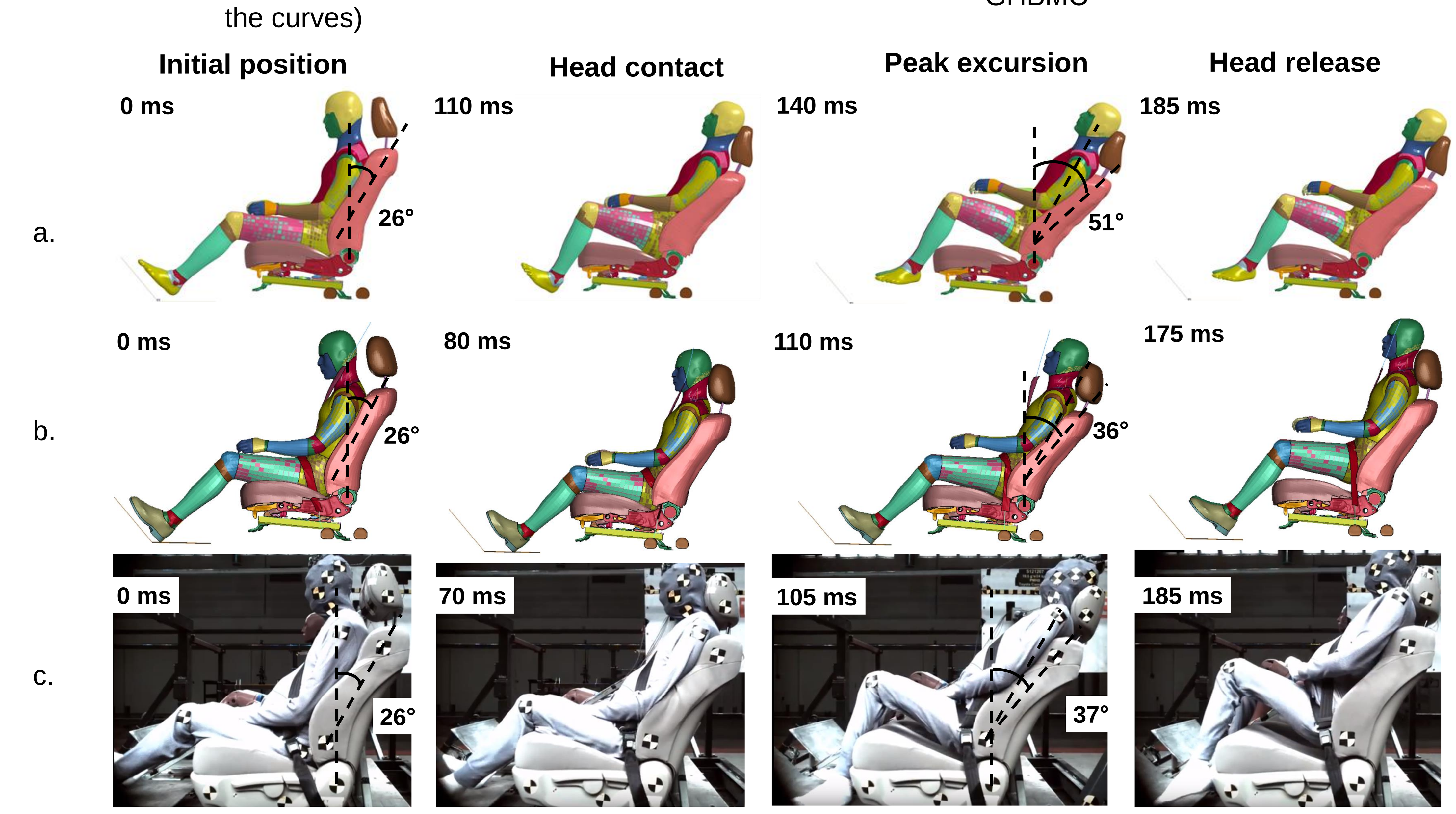

Figure 9: a. Baseline simulation; b. Improved simulation after optimizing the seat model; c. PMHS sled testing [3]

CONCLUSIONS

- An effort was made to validate the simulation environment by modifying the seat frame properties and the head restraint.
  - However, there was a phase issue in seatback rotation, with the FE seat model having a slower response than the production seat used in PMHS studies.
- In the current iteration of the study, intervertebral rotational characteristics were different between the GHBMC (i.e., extension) and PMHS (i.e., flexion).
- Future work includes material and component level experiments to further improve FE seat model.

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