Comparison of WorldSID to PMHS kinematics in far-side impact

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I. INTRODUCTION

Far-side impacts represent 9.5% of all crashes and 8.3% of all MAIS3+ [1]. Consumer groups and manufacturers are gaining interest in evaluating vehicle performance in this crash mode, but there is a lack of information regarding the performance of the anthropomorphic test device (ATD) in this loading configuration. Current state-of-the-art dummies are designed to meet biofidelity standards for front, near-side or rear impacts. Very little has been done, however, in evaluating the biofidelity of these surrogates in far-side impact configurations. This study presents an initial kinematic evaluation of the WorldSID ATD in far-side impact conditions compared to previously published tests with post-mortem human subjects (PMHS) [2].

II. METHODS

For the present study, 19 sled tests were conducted with the WorldSID in six different impact configurations selected from Forman *et al*. [2]. This study shows an initial kinematic comparison between the WorldSID and PMHS for two of those test configurations (Table I).

TABLE I
TEST CONFIGURATIONS SELECTED FOR PRELIMINARY COMPARISON

Dummy Test #	ΔV (km/h)	Impact Direction	D-Ring Position	Seat-belt
S0403	34	Oblique (60 deg)	Intermediate	Pretensioner 4 kN–2.5 kN digressive load limiter
S0414	34	Lateral (90 deg)	Intermediate	Pretensioner 4 kN–2.5 kN digressive load limiter

The oblique WorldSID test was compared to tests with two PMHSs. Only one of them is shown here since they exhibited similar behaviour. The lateral WorldSID test was compared to a single PMHS test available in that configuration.

III. INITIAL FINDINGS

Results for the oblique case show how the WorldSID shoulder loses contact with the shoulder seat-belt at approximately 75 ms. As can be seen in Fig. 1, the left shoulder is pushed backwards by the seat-belt, forcing the upper body to rotate about the z-axis. This upper-body rotation occurs in a rigid body mode with little to no anterior posterior chest deflection.

In the lateral case, WorldSID also loses the shoulder belt at around 75 ms, but with less axial rotation of the upper body. The final position of the belt on the shoulder was similar to that observed with the cadaver. However, the WorldSID exhibited substantially less lateral bending in the thoracic and lumbar spine compared to the cadaver, and less penetration of the shoulder belt into the lower rib cage (see Fig. 2).

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Fig. 1. WorldSID vs PMHS comparison in oblique impact configuration at 50 ms (left), 100 ms (centre) and 150 ms (right).

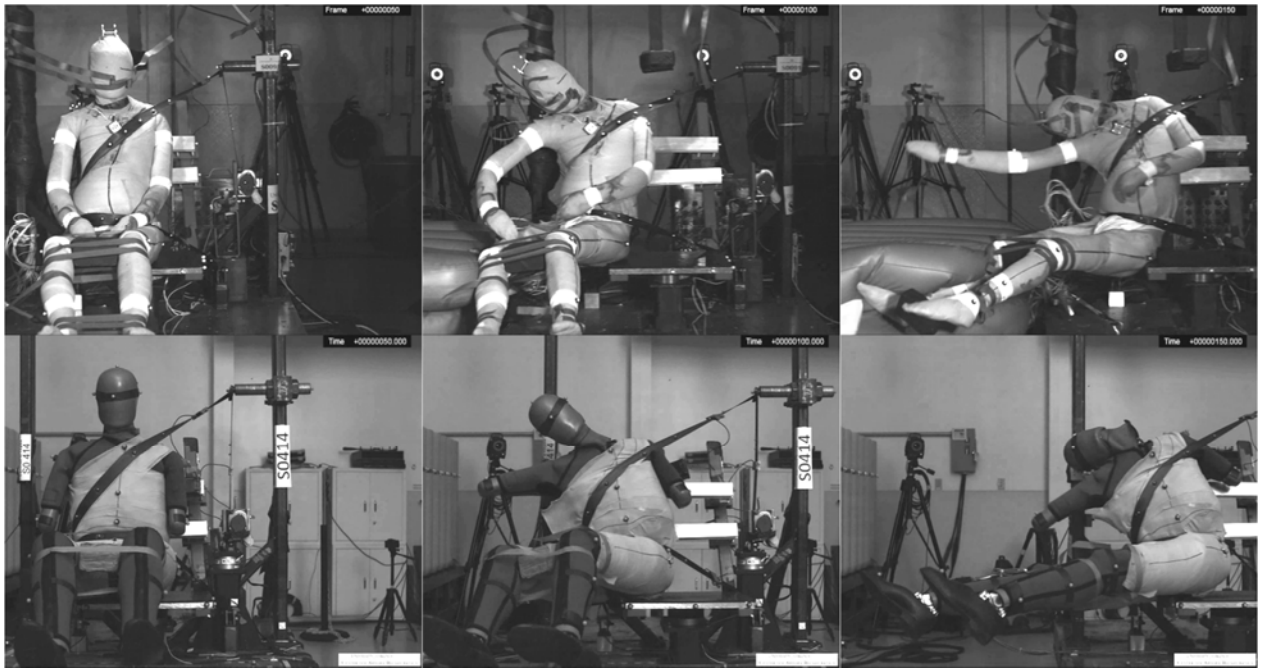

Fig. 2. WorldSID vs PMHS comparison in lateral impact configuration at 50 ms (left), 100 ms (center) and 150 ms (right).

IV. DISCUSSION

WorldSID tended to come out of the shoulder belt in a majority of the test conditions investigated (in addition to the two shown above). In contrast, the cadavers exhibited a greater sensitivity to initial conditions, such as D-Ring position and presence of a pretensioner, coming out of the belt in some configurations while staying engaged in others. The WorldSID also exhibited differences in thoracic kinematics, thoracic compliance and spine compliance compared to the PMHS. Future work should consider potential implications in restraint effectiveness evaluation, in-vehicle kinematics, injury mechanisms, and injury risk prediction.

V. REFERENCES

[1] Bahouth, G., *et al*., ESV, 2015.
[2] Forman, J. L., *et al*., *Stapp Car Crash J*, 2013.