IRTRACC and RibEye performance comparison in far-side test configurations

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I. INTRODUCTION

Rib intrusion is the main injury metric to evaluate thoracic injury in front and side impacts. For years, the WorldSID ATD has evaluated this metric with an IRTRACC system. This system tracks the distance and the angle in the transverse plane between two points: one on the spine, and one on the rib. In recent years another technology has appeared: the RibEye. This technology is able to track in space up to nine points per rib, generating a tridimensional representation of the rib deflection at multiple points. By measuring displacement at multiple points in each rib, this technology has the potential to improve the capture of deformation of the dummy's chest in load cases that may result in maximum displacement oblique on the chest, away from the central measurement location (e.g. far-side tests with belt loading). The aim of this study is to compare the performance of IRTRACC and RibEye in far-side sled tests with WorldSID in order to determine if the measurement systems are interchangeable when measuring at the same location.

II. METHODS

For the present study, 16 sled tests were conducted with the WorldSID in four different impact configurations selected from Forman *et al*. [1]. Two repetitions were run for each configuration and for each rib measurement technology. The results shown here cover two of the four impact configurations:

TABLE I
TEST CONFIGURATIONS SELECTED FOR COMPARISON

Conf.	ΔV (km/h)	Dummy Test #	Technology	Impact Direction	Seat-belt
Low speed	16	S0398/S0399	IRTRACC	60 deg	Pretensioner 4 kN–2.5 kN digressive load limiter
		S0406/S0407	RibEye		
High speed	34	S0402/S0403	IRTRACC		
		S0408/S0409	RibEye		

The IRTRACCs were located between the thorax and the centre of each rib, according to the standard procedure for the WorldSID. The data extracted from the system were processed to evaluate rib intrusion in the y-direction in the transverse plane: $\Delta y = l_0 - (l_0 - \Delta l)\cos\theta$.

Three RibEye LEDs were located on each rib of the WorldSID. For each rib, one LED was placed at the same location as the measurement location of the IRTRACC. The other two LEDs for each rib were placed on either side of the IRTRACC location, anteriorly and posteriorly. The rib intrusion information was extracted from y-displacement of the centre LED, intended to be directly comparable to the y-displacement calculated for the IRTRACC. The resulting displacement curves were then filtered with a CFC 180 filter definition.

III. INITIAL FINDINGS

The y-axis rib displacements are presented below in time history plots, where a negative number represents rib intrusion. Results for the low speed tests (Fig. 1) show that IRTRACC and RibEye exhibit similar results in most locations, except for the first thoracic rib and the second abdominal rib, where the measure differs. In the first

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thoracic rib the IRTRACC gives 0 mm intrusion, while the RibEye captures some rib elongation. In the second abdominal rib the RibEye measures a larger rib intrusion compared to the IRTRACC towards the end of the test.

RibEye and IRTRACC measures differ in the second and third thoracic ribs and second abdominal rib for the high speed test (Fig. 2). In this case, the second thoracic and abdominal ribs show more intrusion with RibEye, while the third thoracic rib shows some kind of noise, making the signal fluctuate around ±20 mm.

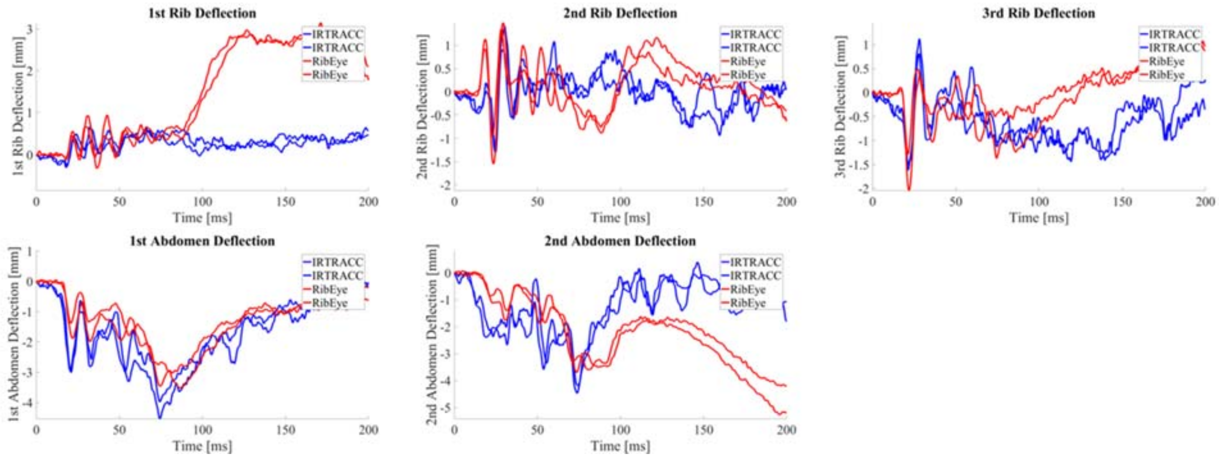

Fig. 1. IRTRACC and RibEye results for the low speed tests.

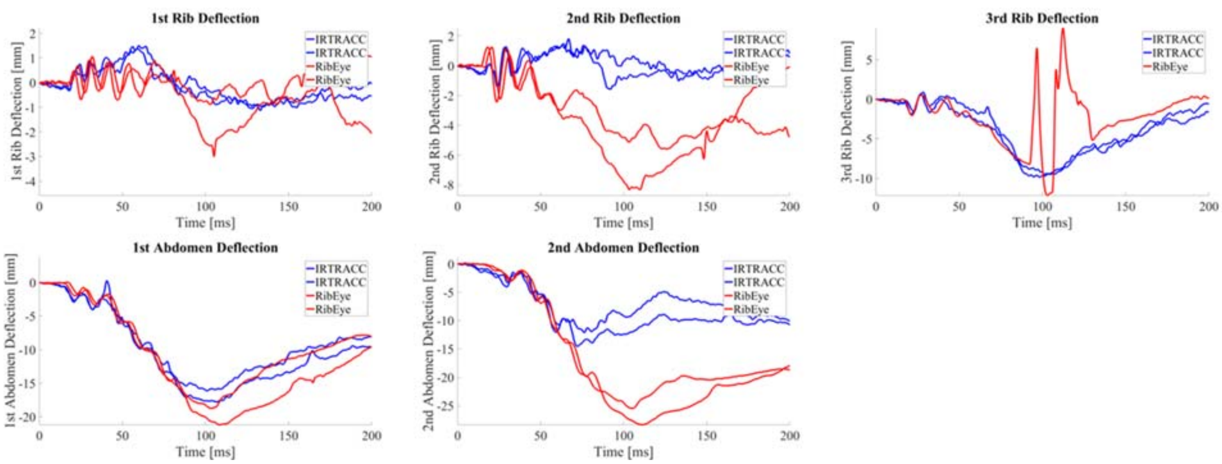

Fig. 2. IRTRACC and RibEye results for the high speed tests.

IV. DISCUSSION

No kinematic or kinetic differences were observed during the tests. It is safe to assume, therefore, that the measured differences are not due to actual differences in the test conditions, but rather to differences in how IRTRACC and RibEye measure chest deflection. At this point in the analysis it is difficult to conclude which technology is more accurate, as a third, independent deflection measurement system was not employed in these tests.

Through a preliminary examination of the high speed video of these tests, differences in the second abdominal rib seem to be due to the seat-belt intrusion in the area. There is no reason to believe that RibEye is not working correctly (blocked LED, blocked sensor, etc.), so this difference may be due to some mechanical limitation of the IRTRACC to operate under anterior-posterior/inferior-superior loads. This could also explain the differences shown in the second thoracic rib during the high speed test. However, as noted above, any discussion of relative accuracy and/or error mechanisms remains speculation. Additional study is needed to determine the mechanisms for the difference, and to determine which system is giving the true measure.

The noise present in the third thoracic rib in the high speed test was due to a blockage in one of the sensors. This represents a reliability issue that may be of substantial importance, since loss of a chest deflection data channel may invalidate a full-vehicle crash test where chest deflection is one of the evaluation measures.

V. REFERENCES

[1] Forman, J. L., *et al*., *Stapp Car Crash J*, 2013.