COMPARISON OF DRIVER HEAD POSITIONS — VOLUNTEERS VERSUS DUMMIES

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INTRODUCTION

TO ASSESS THE POSTURAL COMPARABILITY between BioRID II and people of similar size, volunteers were recruited for a driving study. In each vehicle, the positions of volunteers' heads relative to the head restraint and the preferred seatback angle were compared with the position of BioRID II's head and prescribed seatback angle. A further comparison was made with the position of the Head Restraint Measuring Device (HRMD).

METHODS

Men and women close to the standing height of an average male were recruited through advertisements in local newspapers. Twenty volunteers (8 women and 12 men) ages 21-55, ranging in height from 175 to 180 cm and weighing less than 93 kg, participated in the study. The average volunteer's height was 178 cm, 3.0 cm taller than the 50th percentile male standing height.

Volunteers were videotaped while driving each vehicle along a 21-km course that included signalized intersections, stop-sign intersections, and rolling turns. Measurements were made from videos of each volunteer's head relative to the restraint. Vehicles and the number of volunteers observed in each are listed in Table 1.

Table 1 Study Vehicles and Number of Drivers

Vehicle	Type	Number of Drivers
2001 Ford Focus	Small four-door car	20
2001 Volkswagen Jetta	Small four-door car	16
2002 Ford Explorer	Midsize four-door utility vehicle	14
2002 Mitsubishi Lancer	Small four-door car	14
2002 Chevrolet TrailBlazer	Midsize four-door utility vehicle	14

Before each driving session, the driver seat was adjusted to the position prescribed by the Research Council for Automobile Repairs (RCAR, 2001) for measuring head restraint geometry with the H-point machine and HRMD. The restraint was positioned to the uppermost and rearmost position. Volunteers adjusted the seat to a comfortable driving position but were instructed not to adjust the head restraint. After each trip, the volunteer's seat position was recorded, and the seatback angle was measured with an inclinometer placed on the head restraint post or, in the case of a fixed restraint, a rigid bar on the seatback. This procedure was chosen to provide a reliable straight edge along which to easily measure changes in position relative to the ground as the seatback was repositioned by different drivers and for different anthropometric test devices (ATDs).

The H-point machine with HRMD and BioRID also were seated and measured in each vehicle. The H-point machine with HRMD was positioned according to the RCAR procedure. BioRID was positioned according to the University of Michigan Transportation Research Institute (UMTRI) procedure. The UMTRI procedure, developed from a survey of hundreds of subjects sitting in dozens of vehicles, was designed to seat ATDs in the position most representative of what same-size humans would choose (Reed et al., 2001).

RESULTS

Seatback angles chosen by volunteers were often more upright than seatback angles prescribed by RCAR or UMTRI. The RCAR seatback angle gives the torso of the H-point machine with HRMD a 25 ±1 degree angle. The UMTRI measured angle gives the ATD a 12-degree angle in the side view between the line connecting the head's center of gravity to the H-point and the vertical plane (Reed et al., 2001). The relationship between RCAR and UMTRI seatback angles varied among vehicles. The UMTRI seatback angle was more upright than RCAR in the Mitsubishi Lancer and Ford Explorer, more reclined than RCAR in the Volkswagen Jetta and Chevrolet TrailBlazer, and the same as RCAR in the Ford Focus. Most volunteers who chose seatback angles different from RCAR chose ones ranging from 2 degrees reclined of RCAR to 11 degrees upright of RCAR. Most of these seatback angles were 4 degrees reclined of UMTRI to 11 degrees upright of UMTRI.

To put these ranges in perspective, it is helpful to know that seats with an incremental seatback adjustment typically move 2 degrees per notch. For all 78 car/volunteer combinations in the study, 75 percent of the seatback angles chosen by volunteers were within ±4 degrees of both UMTRI and RCAR. Thus, although volunteers tended to sit somewhat more erect in most cars, both the RCAR and UMTRI prescribed angles were not very different from those chosen by a majority of drivers.

Figures 1a and 1b show for the Ford Focus and Explorer the positions of the head restraints relative to the heads of HRMD in the RCAR position, BioRID in the UMTRI position, and volunteers. Figure 1a, the Ford Focus, shows a volunteer distribution representative of four of the five vehicles in the study. Figure 1b, the Ford Explorer, is the exception to the normal distribution of volunteers observed in the vehicles.

Despite a large range of backsets among the volunteers, median backsets were close to those for HRMD in the RCAR position, except in the Ford Explorer. Backsets for HRMD were closer to median backsets for

volunteers than for BioRID, except in the Ford Explorer. Backsets for BioRID tended to be 1-2 cm greater than volunteers' median backsets. Restraint heights for HRMD in the RCAR position and BioRID in the UMTRI position were consistently higher (by about 3 cm) than median restraint heights for volunteers, except in the Ford Explorer. That is, compared with volunteers, HRMD and BioRID tended to sit lower in the seat.

Figure 1 Head Restraint Heights and Backsets for HRMD, BioRID, and Volunteers

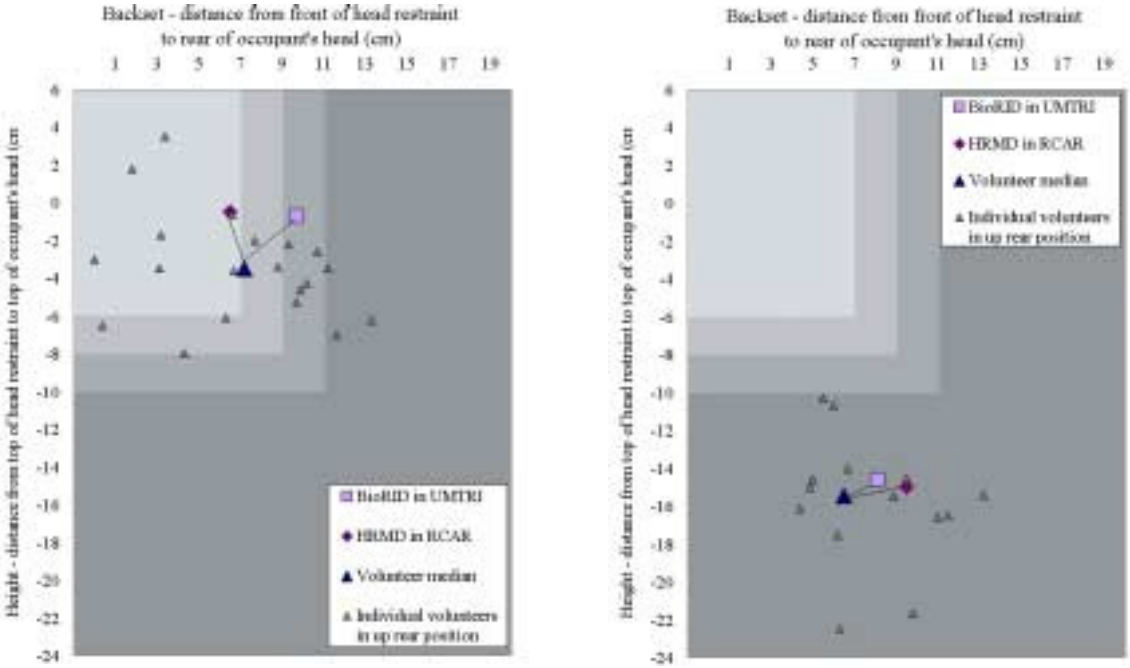

Fig. 1a – 2001 Ford Focus **Fig. 1b – 2002 Ford Explorer**

CONCLUSION

The volunteer data in this study reveal wide variation in the seating postures and head positions of drivers of nominally similar stature. Given these variations, BioRID and HRMD generally are good representations of the volunteers in this study, although some differences were observed. The heads of BioRID and HRMD were consistently lower than volunteers' heads relative to the top of the head restraint. Both BioRID and HRMD are designed to have the seated height of the 50th percentile male, whose standing height is 175 cm. However, the volunteers averaged a standing height of 178 cm. This difference might account for the head restraint being closer to the top of BioRID and HRMD heads than the median volunteer head. However, the not all of the standing height difference will be seen in the seated height since the difference is distributed between the torso and the legs. The proportion of erect sitting height to standing height in one anthropometry study was 53 percent for midsize males (Schneider et al., 1983), so on average about 1.6 cm of the 3.0 cm difference between BioRID and HRMD height and volunteer height is likely accounted for by erect sitting height. The remaining difference likely results from posture differences between volunteers and BioRID and HRMD. Analysis of the median restraint height of the shortest volunteers (<178 cm) showed that the median head restraint height did not decrease appreciably compared with the whole study population, suggesting that posture is as responsible as sitting height for the differences in head-to-head-restraint height among the volunteers.

On average, BioRID's backset was about 2 cm greater than the median volunteer backset in each car model. In dynamic tests, this larger backset will likely contribute to an indication of higher whiplash injury risk than some occupants would actually experience. However, there were volunteers with still greater backsets than measured for BioRID II. Thus, to the extent that backset is important, BioRID is measuring a risk that is relevant to a significant proportion of drivers of similar size.

Volunteer height and backset measurements in this study confirm that both BioRID and HRMD have postures reasonably representative of humans of the same size, and most volunteers chose seatback angles within 4 degrees of those specified by RCAR and UMTRI. The results of this study support the appropriateness of HRMD and BioRID and their seating positions.

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