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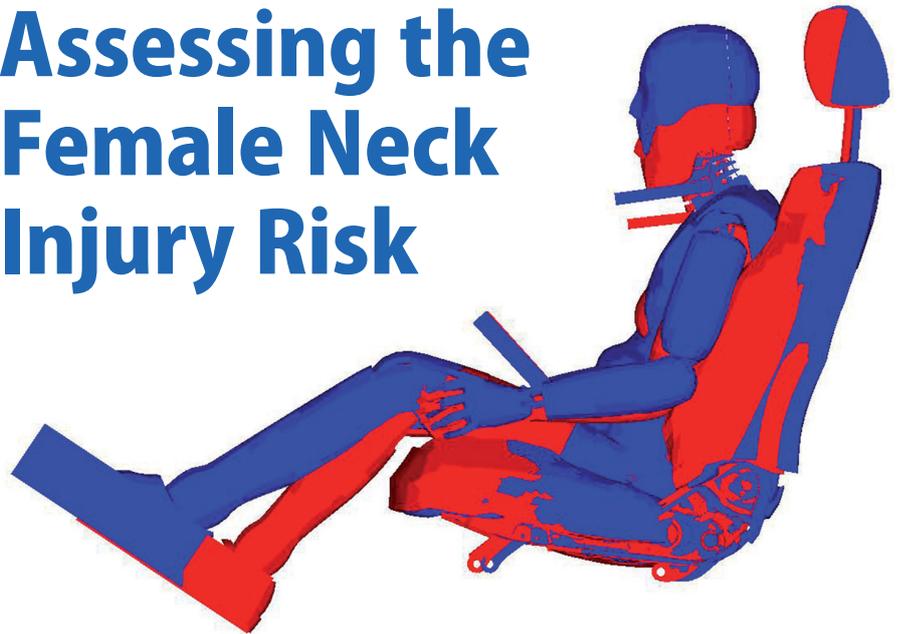
ADSEAT PARTNERS

- AGU – Stiftung Arbeitsgruppe für Unfallmechanik, CHE
- Chalmers University of Technology, SWE
- CIDAUT, ESP
- Faurecia Sièges d'Automobile, FRA
- Folksam Ömsesidig Sakförsäkring, SWE
- Graz University of Technology, AUT
- LMU – Ludwig-Maximilians-University, Munich, DEU
- LU – Loughborough University, GB
- Humanetics Europe GmbH, DEU
- UdS – University of Strasbourg, FRA
- Volvo Cars, SWE
- VTI – Swedish National Road and Transport Research Institute, SWE (project leader)

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More news on ADSEAT can be found on our website www.ADSEAT.eu. It features information on the project and links to project partners. You can also find abstracts and publications for downloading.

Assessing the Female Neck Injury Risk



Anthropometric difference between EvaRID and BioRID.

Within the ADSEAT project, one Work Package addressed the topic of injury criteria to assess the female neck injury risk. This recently completed Work Package raised some interesting approaches when considering the injury risk during test procedures.

Based on biomechanical experiments and accident statistics, the values of injury criteria should be linked to the real-life injury risk. This allows estimation of whether the value of an injury criterion obtained from a crash test is above or below the actual threshold for real injury. However, defining relevant female neck injury criteria is difficult due to the lack of available studies addressing this topic.

Therefore, real life accident data provided by an insurance company were used in the ADSEAT project together with studies on volunteer experiments to base the development of initial suggestions with regards to modifying some of the most common neck injury criteria. Today we know that the female injury risk is higher although differences in injury mechanisms between females and males have not been indicated. Consequently, it was

assumed that the injury criteria such as Neck Injury Criteria (NIC) and Nkm currently being used, could still be applied but would need to be adjusted somewhat to take female occupants into account. Based on theoretical considerations, initial suggestions for such injury criteria were derived from accident data and volunteer experiments. To analyse whether our suggestions were reasonable, computer simulations and sled tests were performed.

The computer simulations carried out in this part of the project made use of finite element (FE) models of a female rear-impact dummy, EvaRID (also developed within the ADSEAT project), and the male rear-impact dummy, BioRID, which is already being used in whiplash research. Both dummy models were seated in the same seat and the different crash pulses were applied followed by a comparison output of



the models. Additionally, FE simulations using the head-neck system of a male and a female human body model were conducted. Similarly, crash pulses of different severities were applied to investigate differences in the response of the models. Generally the results from the computer simulations confirm that a higher injury risk is to be expected for females than for males, which is reflected in the discussed injury criteria.

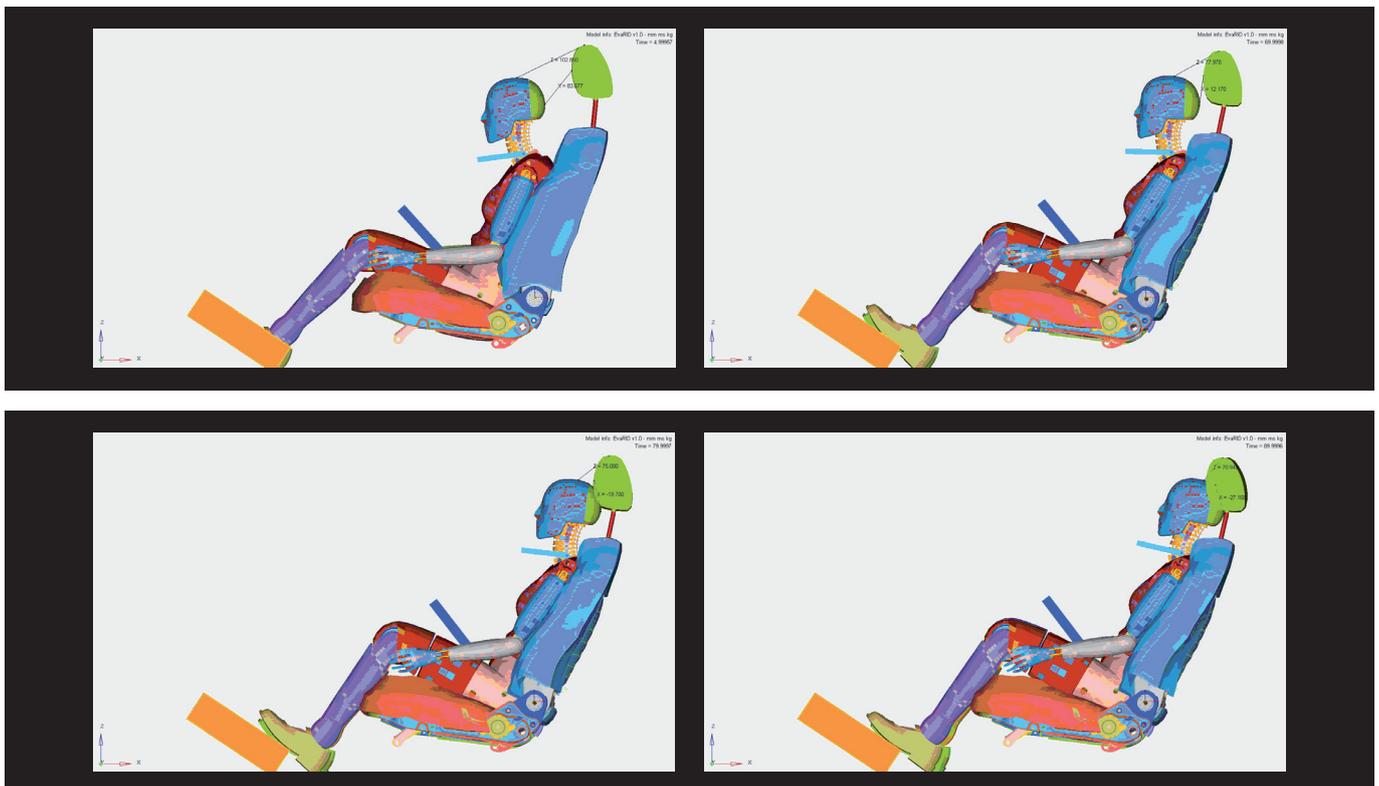
Furthermore, sled tests were performed using different seat models, some of which were equipped with an anti-whiplash system and all tests were conducted in accordance with Euro NCAP test procedures. Before performing the tests, a new loading device called BioRID50F crudely representing the anthropometry of a 50th percentile female, was developed. The development of this loading device was deemed necessary and was thus included in the Work Package. Although the developed loading device needs

further validation, it can be highlighted that a first step towards the development of a female rear-impact dummy was made. This represents a significant advancement in whiplash injury protection which was achieved in this Work Package. The BioRID50F, a prototype dummy model, complements the computer model EvaRID, also developed in the ADSEAT project.

The sled tests clearly demonstrated differences in the seat performance when comparing the results obtained for the BioRID50F and the BioRID. Due to the design of the seats, the performance of some seats deteriorated significantly when loaded with a smaller and lighter prototype dummy model. Consequently, the seat performance rating in consumer tests, for example, must also be expected to differ for male and female occupants. Furthermore, the test conditions need to be adjusted so that the seated posture of a female occupant is considered.

In summary, the different approaches used in this Work Package have shown that female neck injury criteria based on the same biomechanical principles as for males should be used. In particular, modified versions of NIC and Nkm are important for future investigation. A NIC threshold of 12, and reduced intercept values for Nkm are suggested. Furthermore, a reduction to 60 per cent of the male intercept values is suggested. Sled tests and computer simulations indicate that such criteria/threshold values seem a reasonable starting point. However, for future work related to test procedures, a proper physical female rear-impact dummy model is needed for evaluating the seat performance in sled tests. The loading device BioRID50F can serve as a first step towards such proper physical female rear impact dummy model.

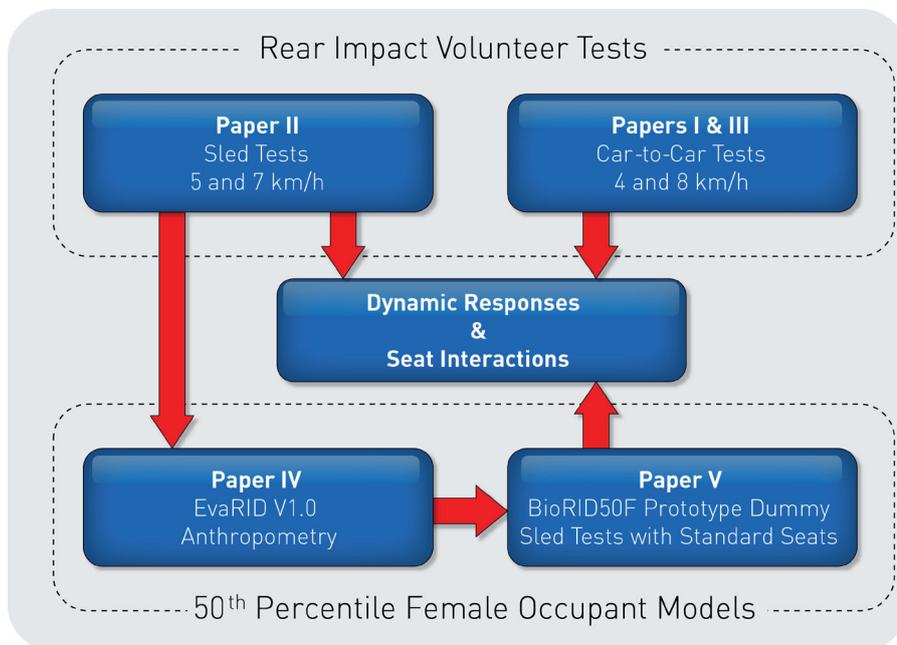
Sequence: EvaRID, I1WPG 16 [km/h], high head restraint.





PhD thesis | Addressing Female Whiplash Injury Protection – A Step Towards 50th Percentile Female Rear Impact Occupant Models

The ADSEAT project has resulted in Dr Anna Carlsson successfully defending her thesis and receiving her PhD on 20 April 2012. The study was divided in two major parts; rear impact volunteer tests (Papers I–III) and data for the development of 50th percentile female occupant models (Papers IV–V).



Overview of the PhD thesis.

The initial part of the work was primarily funded by the Swedish Governmental Agency for Innovation Systems (Vinnova), Sweden; additional funding was provided by the Insurance Institute for Highway Safety, (IIHS), USA, Folksam Research Foundation (Folksam) Sweden, and The Swedish National Road and Transport Research Institute (VTI), Sweden. The latter part of the thesis describes research performed within the ADSEAT project.

The overall objective of the thesis was to improve the understanding of why females are at greater risk of sustaining whiplash injuries in rear impacts, compared to males. A review of the literature was performed, which was presented in the Introduction of the thesis. One rear impact study involving ~50th percentile female volunteers was performed and the results compared to responses of male volunteers earlier tested under similar test conditions (Paper II); Data provided by MEA Forensic Engineers &

Scientists (Canada) from previously performed test was further analysed (Papers I & III). Within the ADSEAT project a 50th percentile female rear impact dummy Finite Element (FE) model, EvaRID V1.0, was developed from an existing BioRID II model. The EvaRID model was based on anthropometric data found in the literature compiled and analysed by Dr Carlsson.

A rear impact study involving ~50th percentile male and female volunteers was performed and the data used for tuning of the stiffness of the EvaRID model (Paper IV). In addition, injury statistics from the ADSEAT partners AGU and Folksam were extracted in order to investigate the stature and mass distributions of females sustaining WAD in rear impacts. Furthermore, in the ADSEAT project, a scaled-down rear impact dummy prototype – BioRID50F – was developed using modified BioRID II dummy components. The scaled-down dummy was representative of a 50th percentile female in mass and crude size and intended to be used as a seat loading device. The BioRID50F was evaluated against new volunteer test results from low-speed rear impact sled tests including female volunteers close to a 50th percentile female in size (Paper V). A series of rear impact tests with the



BioRID50F were performed in four different seats from four different car models as described earlier in this newsletter.

It was found that the overall bio-fidelity of the EvaRID V1.0 was acceptable at low velocity changes (7 km/h) (Paper IV). However, further improvements of the EvaRID V1.0, is required with regards to the stiffness of the thoracic spine. The results from the rear impact test series comprising volunteers and the BioRID50F supported the findings from earlier publications, indicating

that there may be characteristic differences in the rear impact dynamic seat back interaction between males and females. A mechanical or computational model of a 50th percentile female would be an important complement to the existing 50th percentile male BioRID II occupant model when evaluating seat performance. These models can be used, not only as a tool when designing protective systems, but also in the process of further evaluation and development of injury criteria.

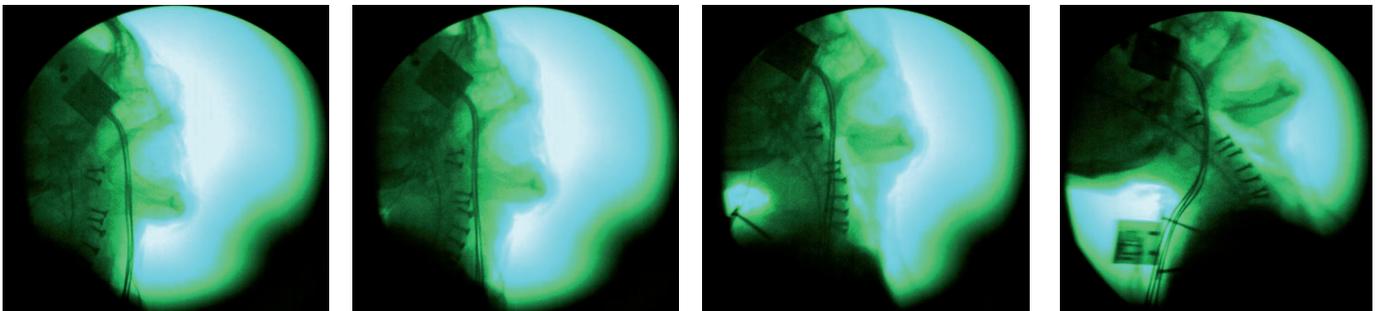
Read the thesis

Addressing Female Whiplash Injury Protection – A Step Towards 50th Percentile Female Rear Impact Occupant Models
[<http://publications.lib.chalmers.se/cpl/record/index.xsql?pubid=156181>]

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High Speed X-Ray Motion Analysis of the Cervical Spine during Rear-End Impact Sled Tests



Vertebra motion during rear-end sled test using markers for optimized contrast on high speed videos.

Detailed knowledge of the neck vertebra and head motion during whiplash trauma is important for identifying injury mechanisms and countermeasures.

A series of sled tests were performed in accordance with Euro NCAP whiplash test pulses on two male and two female, who had donated their remains to scientific research (referred to as the “subjects”). The subjects were immediately frozen deceased humans of the size close to 50th percentile. Each

subject was tested four times in total with and without a headrest, initially, at the lower severity and subsequently at the higher severity pulse.

The real time x-ray images on the image intensifier screen were recorded using a high speed camera system at a frame rate up to 1,000 frames per second. Screws were inserted into the vertebral body of the cervical spine in order to optimise the contrast on high speed cine x-ray. Additionally, accelerometers

were fixed to the T1 and sternum, and a further accelerometer was mounted to the skull at the centre of gravity.

The high speed cine x-ray analysis offers the potential to directly visualise the vertebra kinematics without extrapolation of motion tracking of external markers. Motion tracking of the markers provided useful data to characterise the displacement in x- and z-directions.



The ADSEAT Project

ADSEAT, short for Adaptive Seat to Reduce Neck Injuries for Female and Male Occupants, is an EU Commission funded project within the 7th Framework programme. The major focus is on whiplash injuries. Our vision is to improve safety for vehicle occupants by making recommendations for future evaluation of the effectiveness of anti-whiplash systems.

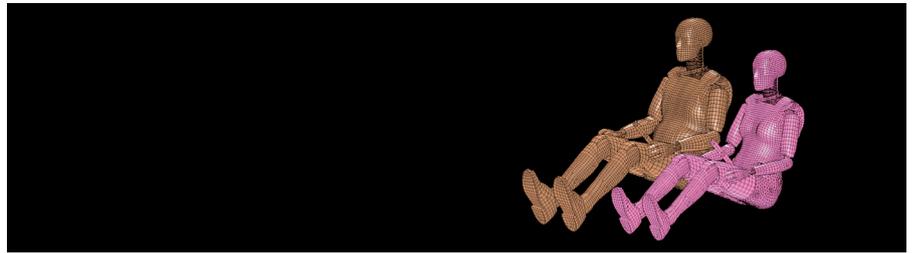
BACKGROUND

Whiplash injuries put a significant social and financial burden on the European society. For the insurance companies whiplash injuries account for approximately 70 per cent of the cost of all injuries leading to permanent medical impairment following a collision. Females have a higher risk of sustaining whiplash injuries in vehicle crashes than males.

Anti-whiplash systems for passenger vehicles on the market today can reduce the injury risk, however recent evaluation has shown that males, more so than females, benefit from the recently developed protective performance of the seats. Current commercially available crash test dummies for rear impact testing represents an average male.

OBJECTIVES

The overall objective of the ADSEAT project is to provide guidance on how to evaluate the protective performance of vehicle seat designs, aiming to reduce whiplash injuries for female as well as male motor vehicle occupants. During ADSEAT, a finite dummy model will be developed.



List of Papers Published

Linder A. Biomechanical Data for a Computational Model of an Average Female. (2010) 6th World Congress on Biomechanics, Singapore.

Carlsson A, Siegmund G P, Linder A, Svensson M. Motion of the Head and Neck of Females and Male Volunteers in Rear Impact Car-to-car Tests at 4 and 8 km/h. (2010) Int. IRCOBI Conf. on the Biomechanics of Injury, Hannover, Germany.

Kullgren, A, Krafft, M. Gender Analysis on Whiplash Seat Effectiveness: Results from Real-world Crashes. (2010) Int. IRCOBI Conf. on the Biomechanics of Injury, Hannover, Germany.

Schick S, Kullgren A, Tomasch E, Jakobsson L, Linder A, Gales N, Hell W, Schmitt KU. Basics for Developing a Female Occupant Model for Investigating Cervical Spine Distortion Injury (CSD). (2010) ESAR conference, Hannover, Germany.

Chang F, Carlsson A, Lemmen P, Svensson M, Davidsson J, Schmitt K-U, Zhu F, Linder A. EvaRID, A dummy model representing females in rear end impacts. (2010) Whiplash 2010 Neck Pain in Car Crashes, 3rd International Conference, Munich, Germany.

Tomasch E. Gleichberechtigung“ bei den Dummy modellen. (2010) Virtual Vehicle Magazin, Issue Number. 8, 2010-4.

Schick S, Thorsteinsdottir K, Horion S, Hell W. Risikofaktoren für die Inzidenz des WAD (Whiplash Associated Disorder) – Unter-

schiede zwischen Mann und Frau? (2010) Jahrestagung der Deutschen Gesellschaft für Rechtsmedizin, Berlin, Germany.

Linder A. Tool for evaluation of adaptive seat to reduce neck injuries for female and male occupants. (2011) IQPC 6th International Conference Innovative Seating, Frankfurt, Germany.

Linder A, Svensson M, Carlsson A, Lemmen P, Chang F, Schmitt K-U, Kullgren A. EvaRID – Anthropometric and biomechanical specification of a finite element dummy model of an average female for rear impact testing (2011). 22nd ESV Conference, 13–16 June Washington, USA.

Linder A. EvaRID – a crash test dummy model of an average female. (2011) Gender Summit, 8 October, Brussels, Belgium.

Carlsson A, Siegmund GP, Linder A, Svensson MY. Motion of the Head and Neck of Female and Male Volunteers in Rear Impact Car-to-Car Impacts. (2012) Accepted for publication in Traffic Inj. Prev.

Carlsson A. Addressing Female Whiplash Injury Protection. (2012) PhD thesis, Chalmers University.

Linder A, Schick S, Hell W, Svensson M., Carlsson A, Lemmen P, Schmitt K-U, Tomasch E. (2012) ADSEAT – Adaptive Seat to Reduce Neck Injuries for Female and Male Occupants. TRA Conference, 23–26 April, Athens, Greece.

Coming Events in the Traffic Safety Area

Congress of the European Society of Biomechanics (ESB2012)

1–4 July 2012:

Technical University of Lisbon, Portugal
[www.esbiomech.org]

IRCOBI Conference 2012

12–14 September 2012:

Trinity College, Dublin, Ireland

[www.ircobi.org/conference.php]

ADSEAT has a special session on 12

September: Rear-end impact/Spinal injuries

Stapp Car Crash Conference

29–31 October 2012:

Savannah, Georgia, USA

[www.stapp.org]