MISUSE OF AIRBAG DEACTIVATION WHEN CHILDREN ARE TRAVELLING IN THE FRONT PASSENGER SEAT

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Paper Number 09-0351

ABSTRACT

Within the process of integrating passenger airbags in the vehicle fleet a problem of compatibility between the passenger airbag and rearfacing child restraint systems was recognised. Especially in the US several accidents with children killed by the passenger airbag were recorded. Taking into account these accidents the deactivation of a present passenger airbag is mandatory if a child is carried in a rearfacing child restraint system at the front passenger seat in all member states of the European Union. This rule is in force since the deadline of 2003/20/EC at the latest.

In the past a passenger airbag either could not be disabled or could only be disabled by a garage. Today there are a lot of different possibilities for the car driver himself to disable the airbag. Solutions like an on/off-switch or the automatic detection of a child restraint system are mentioned as an example. Taking into account the need for the deactivation of front passenger airbags two types of misuse can occur: transportation of an infant while the airbag is (still) enabled and transportation of an adult, while the airbag is disabled, respectively. Within a research project funded by BASt both options of misuse were analysed utilising two different types of surveys amongst users (field observations and interviews, Internet-questionnaires). In addition both analysis of accident data and crash tests for an updated assessment of the injury risk caused by the front passenger airbag were conducted.

Both surveys indicate a low risk of misuse. Most of the misuse cases were observed in older cars, which offer no easy way to disable the airbag. For systems, which detect a child seat automatically, no misuse could be found. The majority of misuses in cars equipped with a manual switch were caused by reasons of oblivion.

Also the accident analysis indicates a minor risk of misuse. From more than 300 cases of the GIDAS accident sample that were analysed, only 24 children were using the front passenger seat in cars equipped with a front passenger airbag. In most of these cases the airbag was deactivated. When misuse occurred the injury severity was low. However, when analysing German single accidents the fatality risk caused by the front passenger airbag became obvious.

From the technical point of view, there were important changes in the design of passenger airbags in recent years. Not only volume and shape were modified, but also the mounting position of the entire airbag module was changed fundamentally.

Even if these findings do not allow obtaining general conclusions, a clear tendency of less danger by airbags could be identified. For future vehicle development a safe combination of airbags and rear faced baby seats seems to be possible in the long term. This would mean that both types of misuse could be eliminated. For parents an easier use of child seat and car would be the result.

INTRODUCTION

During the integration of passenger airbags into the vehicle fleet a problem of incompatibility between the passenger airbag and rearfacing child restraint systems was recognised. Especially in the US several accidents with children killed by the passenger airbag were recorded. Taking into account these accidents the deactivation of a present passenger airbag is mandatory in all member states of the European Union if a child is carried in a rearfacing child restraint system on the front passenger seat. This rule is in force since the deadline of 2003/20/EC (April 2008) at the latest.

In recent years the possibilities of airbag deactivation have changed considerably. While the only way to disable the airbag was the general deactivation by a garage several years ago, some techniques are offered today allowing the deactivation and reactivation in a simple way. The most common one is an on/off-switch integrated in the car. It can be designed as a key switch, which is used with the car key to switch off the airbag. This comparatively simple way to deactivate the airbag for the front passenger seat facilitates the use of that seat for rearfacing child restraint systems (CRS), which is an important relief for parents.

However, with this method two types of misuse can occur: transportation of an infant while the airbag is enabled (first kind of misuse) and the transportation of an adult, while the airbag is still disabled (second kind of misuse). With systems of automatic airbag deactivation, which are able to detect the presence of a child restraint system, both types of misuse should be prevented.

ACCIDENT DATA

This analysis is based on data from the GIDAS (German In-Depth Accident Study), NHTSA as well as data of a small number of single accidents. In 337 GIDAS cases with children in cars 58 were transported on the passenger seat. In 24 of them an airbag was present. In 15 accidents the airbag was not deployed, which can be caused by deactivation or by technical failure. In one out of the 9 cases in which the airbag deployed the child was transportted in a baby shell. This is the only clear documentted case of misuse out of 337 situations with children transported in a car. In this accident the child received only minor injuries, which were classified as AIS 1.

Second data retrieval to the GIDAS data was related to the second type of misuse. However, no accident with a non-deploying airbag was detected.

Comparing the injury severity for with and without airbag deployment indicates a higher injury risk with airbag deployment, see Figure 1. However, the accident severity is also an important factor influencing the injury risk. In cases with active airbag the airbag deployment depends on the accident severity. That means that the cases with airbag deployment are generally of higher accident severity than those without. Looking at the GIDAS data the average delta-v for the cases with airbag deployment is higher than for those cases without. Furthermore the injury severity in this sample did not exceed AIS2.

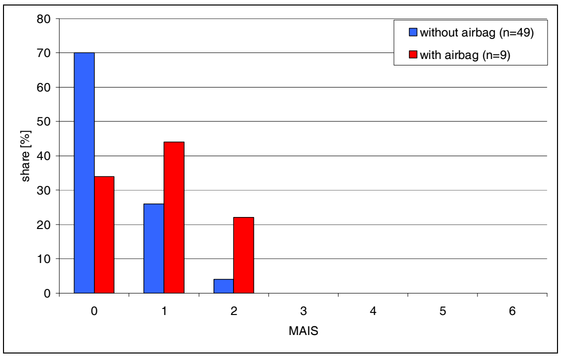

Figure 1. Comparison of injury severity for children with and without deployed airbag.

In addition the risk associated with the front passenger seat compared to the rear seats was analysed, see Figure 2. There seems to be a slightly higher risk at the front seat compared to the rear seats. However, in the sample the injury severity did not exceed AIS 2 for both configuration and the sample is rather small. Therefore the results are not significant.

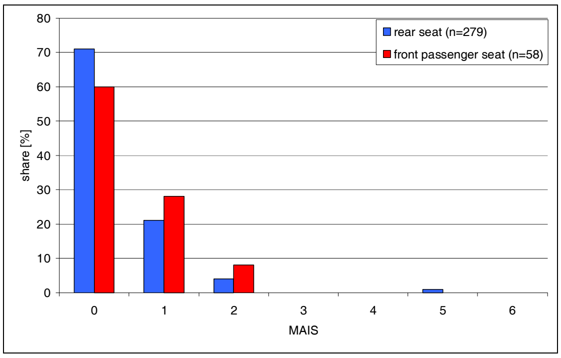

Figure 2. Comparison of injury severity for children using a rear seat or the front passenger seat.

Lesire et al. [Lesire, 2007] also compared the injury severity for children in the front seat with those in the rear seat. Based on French and UK data they came to the conclusion that there is no difference between front and rear seats with respect to the injury severity. However, the UK data indicates a higher CRS usage in the front seat compared to the rear, which may not be neglected when comparing the injury risk.

The analyses of single accidents showed two fatal accidents in Germany, both with low accident severity and cars equipped with the first generation of passenger airbags. In one case the low mount Eurobag deployed even so it was disabled by a garage, while in the other case there was no possibility to deactivate the mid mount full-size airbag. In both accidents the babies received fatal head injuries due to the deploying airbag.

NATIONAL CENTER FOR STATISTICS AND ANALYSIS
SPECIAL CRASH INVESTIGATIONS
CHILDREN FATALLY INJURED BY PAB
NORMALIZED BY VEHICLE REGISTRATIONS
Confirmed and Unconfirmed*
January 1, 2008

Vehicle Model Year (in millions of vehicles)

	1987-88	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Registered Passenger Air Bag Equipped Vehicles	0.000	0.061	0.144	0.037	0.405	1.311	5.918	9.987	10.240	13.690	14.491	16.070	17.065	16.402	16.883	15.575	15.570	15.516	15.516	15.516	15.516	215.913

Vehicle Model Year

Crash Date	1987-88	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Sep 87 to Aug 88																						0
Sep 88 to Aug 89																						0
Sep 89 to Aug 90																						0
Sep 90 to Aug 91																						0
Sep 91 to Aug 92																						0
Sep 92 to Aug 93						1																1
Sep 93 to Aug 94						1	1															2
Sep 94 to Aug 95						1	2	4														7
Sep 95 to Aug 96					1		6	9	3													19
Sep 96 to Aug 97							4	12	7	5												28
Sep 97 to Aug 98							4	15	5	8	2											34
Sep 98 to Aug 99							2	7	3	3	3	1										19
Sep 99 to Aug 00							1	4	6	2	2	1										16
Sep 00 to Aug 01							1	5	5	2		1		1								15
Sep 01 to Aug 02						1	1	1	2	2			1									8
Sep 02 to Aug 03								2	2	4			1	1								10
Sep 03 to Aug 04							1	1		3		1				1						7
Sep 04 to Aug 05							1		1	3	1		1									7
Sep 05 to Aug 06					1		1	3	1			1										7
Sep 06 to Aug 07							1				1											2
Sep 07 to Aug 08																					0	0
Total	0	0	0	0	2	4	26	63	35	32	9	5	3	2	0	1	0	0	0	0	0	182
Fatalities/Million Vehicle Years	0.000	0.000	0.000	0.000	0.402	0.254	0.382	0.572	0.329	0.242	0.070	0.038	0.024	0.019	0.000	0.014	0.000	0.000	0.000	0.000	0.000	

*Confirmed cases are those where the air bag has been confirmed to be the injury mechanism. Unconfirmed cases are crashes under active investigation where the air bag is suspected of being the injury mechanism.

Figure 3. US children killed due to airbag deployment [NHTSA, 2008].

Finally NHTSA data show that fatal injuries in children due airbag deployment has significantly reduced by information campaigns (resulting in a general decreasing trend since 1995) and airbag improvement (resulting in lower figures for newer cars compared to older ones), see Figure 3.

AIRBAG TECHNOLOGY

In the beginning of the introduction of airbags these were developed for the frontal impact of the driver only. The driver airbag was an important step towards reduced injuries, which were often caused by the small distance between the occupant and the steering wheel resulting in a hard contact even for belted drivers. The airbag needs to inflate rapidly after the detection of a severe accident to have the airbag completely inflated before the occupant contacts it.

As a second step airbags for front seat passengers were introduced. Due to the larger distance between the passenger and the instrument panel front seat passenger airbags need to be larger and faster than the driver airbags. In addition the seating position of the front seat passenger is not as well defined as for the driver, who needs to operate the car. The combination of the more aggressive size and inflation procedure of passenger airbags on the one hand and the risk of dangerous position of front seat passengers on the other hand resulted often in serious injuries. Therefore NHTSA introduced regulations (modification of FMVSS 208) aiming at reducing the risk caused by airbags. Both low risk deployment and automatic detection of dangerous situation and disabling of airbags are addressed. For assessing the low risk deployment several static airbag deployment tests need to be conducted. One of them utilises a CRABI 1 YO dummy using rearfacing CRS. The CRS is positioned in a way that it is just not touching the instrument panel.

While the driver airbag is mounted at the steering wheel since its introduction the mounting position of the front seat passenger airbag changed during time. In the beginning most passenger airbags were mounted in the low mount position and replaced the glove box. Due to package requirements and the low risk deployment strategies the mounting position changed to the mid mount and later top mount position. Today almost all new cars are equipped with front seat passenger airbags in the top mount position. While the low mount position airbags inflated directly in the direction of the occupant, the top mount positioned airbag starts with the inflation in the direction of the wind screen and the movement in the direction of the occupant follows with a lower energy input.

Finally it is important to note that there are considerable differences in the airbag design depending on the region of use of the car. While airbags are meant to be an additional safety device for belted occupants in Europe they are designed to be used without the seat belt in the US: This difference requires larger airbags for the US market.

TECHNIQUES OF AIRBAG DEACTIVATION

In general, three different types of airbag deactivation are available: the deactivation using a switch, the automatic detection of a CRS and the permanent deactivation by a garage.

Deactivation by a switch

Today, this possibility to activate the airbag is the most common. Most of the European car manufactures offer this integrated systems in cars as a standard or it can be ordered as optional equipment. For the customer this system is easy to use: he can disconnect the airbag either by a key or manually himself. If the airbag is disabled, its status is shown to occupants by a warning light. Depending on the car, the switch is integrated in the glove compartment, dashboard or in the transmission tunnel.

Automatic detection

This system, called CPOD (Childseat Presence and Orientation Detection) detects the existence of a child seat in a car and its orientation. The system, which is available in Germany, is called AKSE (Automatische Kindersitzerkennung; automatic detection of CRS). Even if it is nearly identical to CPOD it is originally not designed to detect the orientation of the CRS. A special transponder at the CRS is necessary, which is identified by the AKSE. In Germany, there are two car manufactures which offer this system: Mercedes and Opel. Even if the systems of both manufactures are nearly equal, Opel seats can only be used in Opel cars and Mercedes seats in Mercedes cars only. There are ongoing activities by an ISO-working group to define an international standard for such systems.

Durable deactivation by a garage

A further possibility to disconnect the airbag is its deactivation by a garage. There the airbag is deactivated permanently. Thus, the airbag can’t be enabled by the driver himself if required. Usually, the occupants are informed by a warning decal. Today, this way of deactivation is less common than some years ago. Compared to the deactivation by a switch, with this method there is a high risk of an adult on the passenger seat while the airbag is disabled.

No possibility of deactivation

Even if it is mandatory to disable the front airbag if a child is transported in a rearfacing CRS on the passenger seat, there are still some car manufacturers not offering any possibility to switch-off the airbag. Even the deactivation by a garage is impossible. The outcome is that rearfacing CRS have to be mounted on the rear seat.

To summarise the available techniques for airbag deactivation the majority of old cars do not offer any possibility for deactivation or the durable deactivation by a garage, while recent cars normally offer the possibility by a switch. However, there are still models in production, which do not offer any possibility.

RISK POTENTIAL OF PASSENGER AIRBAGS

Due to recent developments with respect to the airbag geometry, size and mounting position a number of tests was conducted to be able to reassess the risk resulting from airbag deployment.

The first public available tests, e.g. published by GDV [GDV, 2003] mainly focused on video analysis. In contrast this study emphasised on dummy readings. The tests included a number of sled tests with a body in white of a recent mid-size class car with different airbags, one static airbag deployment test with the same car body and a number of dynamic and static tests with old cars offering the first generation of passenger airbag technology. All tests utilised the same ECE R44 group 0+ CRS and the same Q1.5 dummy.

One of the first problems recognised within this study was the question how to assess the dummy readings. Looking at the accident data described above the main problem seems to be head injuries. However, compulsory tests according to FMVSS 208 mainly rate the neck loads with a combined assessment of neck forces in Z direction and neck moments along the Y axis. This so called Nij (neck injury criterion) requires the knowledge of critical neck tension and neck compression forces as well as critical neck flexion and neck extension moments. These values were defined for the Hybrid III series of dummies including CAMI and CRABI. For the dummy used in the tests, the Q1.5, the Nij reference values have not been defined. Based on the results of the CHILD project [Palisson, 2007] critical neck tension force and neck flexion moments can be derived from the calculated injury risk functions for the Q3 using scaling technologies. As the critical neck tension differs from the critical neck compression and the critical neck extensions differs from the critical neck flexion the ratio as used for Hybrid III dummies was utilised for the Q1.5. The other IARV are based on the results of the CHILD project. Taking into account that the critical forces and moments for the used dummy have not been officially defined the used neck injury criterion is called Nij*.

Table 1.
Injury criteria and corresponding load limits used for assign the different tests

Criterion	IARV
Head a_{3ms}	79 g
HIC15	585
Neck tension force	1550 N
Neck compression force	1126 N
Neck flexion moment	61 Nm
Neck extension moment	27 Nm
Nij*	1.0

The static airbag deployment tests with cars offering the first generation of passenger airbags showed different results for different cars – or to be more precise between cars with different airbag sizes, see Table 2. The results indicate that the risk resulting from the small airbags in car1, car2 and car3 is relatively low, while it is high for the cars with the larger airbags (car4 and car5). However, one needs to take into account that only one CRS has been tested and that the results of the static airbag deployment does not necessarily represent realistic loading conditions.

Table 2.
Results of static airbag tests

criterion	car1	car2	car3	car4	car5
position	low	low	low	mid	mid
size	~ 50 l	~ 65 l	~ 65 l	~ 110 l	~ 130 l
head a_{3ms}	8 g	12 g	14 g	30 g	49 g
HIC_{15}	1	6	6	43	137
neck F_Z	148 N (comp.)	371 N (comp.)	299 N (tens.)	730 N (comp.)	322 N (comp.)
neck M_Y	4 Nm (flex.)	11 Nm (flex.)	10 Nm (flex.)	22 Nm (flex.)	54 Nm (ext.)
Nij*	0,15	0,44	0,29	0,99	2,86
chest a_{3ms}	3 g	10 g	6 g	9 g	38 g

The video analysis clearly shows the differences between the tests with low dummy loadings and those with high dummy readings. While the smaller airbags hit the CRS directly from the front when the airbag is almost completely inflated, the larger airbags caused two impacts (firstly from the front with high energy input and then from the top). Figure 4 shows the airbag when it is completely inflated for car1 and car5 as an example.

Figure 4. Maximum airbag deployment: car 1 (top) and car 5 (bottom).

As a next step car model 2 was used for dynamic tests with and without the passenger airbag. Due to the age and therefore different histories of the two cars there were slight differences in the car acceleration but overall the tests are comparable. The main characteristics of the tests are listed below:

- full frontal, rigid wall,
- 55 km/h,
- front passenger seat in mid position.

Table 3.
Results of dynamic tests with old cars

criterion	with airbag	without airbag	static airbag test
head a_{3ms}	92 g	93 g	12 g
HIC_{15}	1061	989	6
neck F_Z	677 N (comp.)	2020 N (tens.)	371 N (comp.)
neck M_Y	21 Nm (ext.)	39 Nm (ext.)	11 Nm (flex.)
Nij*	0,96	3,06	0,44
chest a_{3ms}	73 g	83 g	10 g

Although the CRS and Q1.5 kinematics was completely different in both tests the dummy readings, except the neck are almost the same, see Table 3.

The neck loads within this comparison are much higher without airbag deployment than with. Looking at the kinematics the babyshell turns after the impact of the airbag by 90° along the Y axis while it stays stable in the test without the airbag.

When comparing the tests with the fatal injuries recorded in German accidents it becomes evident, that the chosen test severity might be too high. It could be that the airbag mainly causes harm in accidents with a moderate severity level and does not changes much in high severity accidents. Within the tests described above the dummy readings already exceeded the proposed load limits for the head.

Finally recent and future airbag designs have been tested in sled tests in a body in white of a mid size car of today. The main characteristics of these tests are listed below:

- 60 km/h,
- pulse according to NPACS frontal impact protocol,
- front passenger seat in most forward position.

Non of the airbag tested in this series have been calibrated for the car, therefore better results can be expected in the field. The following airbags have been tested:

Airbag A
- designed for the European market
- volume 60 l
- 1 gas generator

Airbag B
- designed for the US market
- volume 120 l
- 2 gas generators

Airbag C
- based on airbag B
- prototype
- special venting technology with additional vents, which are open at the beginning of the inflation and will normally be closed except the airbag get in contact to anyone or anything
- volume 120 l
- 2 gas generators

Airbag D
- prototype

- special venting technology with additional vents, which are open at the beginning of the inflation and will normally be closed except the airbag get in contact to anyone or anything
- 2 chambers connected in the centreline resulting in a geometry which emphases at restraining the shoulders and reducing the loads at the head
- volume 100 l
- 2 gas generators

In addition to the airbag tests two reference tests without airbag and one static airbag deployment test with airbag D were conducted.

Analysis of the test data shows that the test without airbag already has a considerable high severity and that the Nij* shows the worst repeatability, see Table 4. The head acceleration and HIC value is considerably higher in the airbag tests as in the reference tests. The best results amongst the airbag tests was obtained in the test with Airbag C. Especially the neck loads expressed by Nij* were lower in the test with Airbag C than the average of both reference tests. The static airbag deployment tests with Airbag C did induce minor loads only.

Again it is important to note, that the tests showed a considerable high impact severity, causing already critical neck loads in the reference tests. Probably a lower impact severity would be better to assess the risk resulting from the airbag.

SURVEY AND FIELD STUDY

To evaluate the risk of misuse of airbag deactivation during the transportation of children in rearfacing CRS it is important to include the user's point of view. Level of knowledge, stance on child safety and risk assessment should be considered as well as the marginal conditions which make misuse more likely.

For this analysis a field study and an internet survey were carried out and accident data were evaluated.

Field study – first type of misuse

The central approach of this study was to interview people on the spot, who were just transporting a child in their car. Typical interview mistakes and response biases were excluded by this real time procedure. Furthermore, the interviewer had the possibility to check the airbag state in the car himself. Because of the more frequent use of the back seat for child transportation, it was time-consuming for the interviewer to find the desired situation of transport. Based on results of Fastenmeier et al. [Fastenmeier, 2006] only one of seven children is using the front passenger seat.

The survey has been conducted in Munich, Berlin, Stuttgart and Saarbrücken. The interviews were carried out at places where parents with young children or babies could be expected, e.g.: nursery schools, baby swimming courses, etc. Using this procedure of different places at different times of day the interviewer could ensure that with the survey there was a variation in trip purpose. Within this survey 140 interviews took place (54 in Munich, 21 in Berlin, 25 in Stuttgart, 40 in Saarbrücken). More than three-quarter of the interviewees were women and in 97% the people asked were the parents of the child.

The most important aim of this investigation was to find out how often the airbag is activated when a child is transported on the passenger seat. In 20 out of 140 cases the airbag was not deactivated, which corresponds to a rate of 15% of misuse. If misuse was detected parents were asked whether they think that this combination is dangerous, which was confirmed by 62.5% of the parents. This suggests that 7% of all interviewees consciously accepted the risk of a deploying airbag.

Table 4.
Results of dynamic tests with new airbags

Criterion	reference 1	reference 2	airbag A	airbag B	airbag C	airbag D	airbag C static test
Head a_{3ms}	62 g	61 g	73 g	78 g	72 g	76 g	13 g
HIC_{15}	362	405	572	572	517	560	5
Neck F_Z	474 N (comp.)	400 N (comp.)	1126 N (comp.)	1255 N (comp.)	1121 N (comp.)	916 N (comp.)	207 N (comp.)
Neck M_Y	27 Nm (ext.)	36 Nm (ext.)	18 Nm (ext.)	15 Nm (ext.)	9 Nm (ext.)	20 Nm (ext.)	7.5 Nm (ext.)
Nij*	1,26	1,40	1,60	1,65	1,29	1,54	0,23
Chest a_{3ms}	63 g	67 g	74 g	68 g	65 g	69 g	3.6 g

The replies to further questions reveal a considerable coherence between airbag deactivation and age of the car: the newer the car the less misuse occurred (p<0.001, Chi-square-test), see Figure 5.

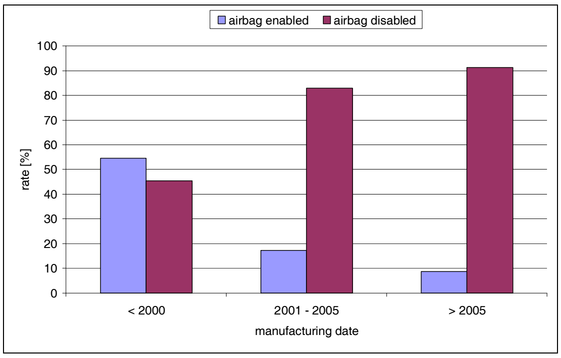

Figure 5. Misuse depending on year of manufacture.

This leads to the question of the airbag deactivation technique in dependence of the car's age. It seems obvious that newer cars offer easier deactivation possibilities, (e.g. a switch) than older ones, in which the airbag could deactivated at most by a garage. As Figure 6 shows, there is coherence between misuse rate and airbag deactivation technique. Especially the relation between deactivation and misuse in connection with the garage shows that this comparatively complicated way of deactivation leads to a high rate of misuse.

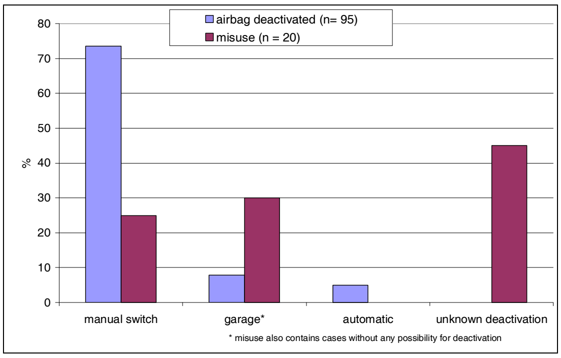

Figure 6. Misuse compared to different airbag deactivation techniques.

In cases of automatic airbag deactivation (CPOD) no misuse was detected.

The age of the interviewees had no significant influence on the misuse rate. Trip duration showed a tendency for increasing misuse for short distances. By contrast, the coherence of misuse and frequency of child transportation is highly significant (p < 0.01, Chi-square test). Trips that take place several times per week show a clearly lower misuse rate than trips which take place rarely. Apparently, it is more common to switch off the airbag if it is part of a daily routine procedure.

Surprisingly, the largest explicit effect is regional differences: there is a clear coherence between misuse and the city of survey (p<0.05, Chi-square test), see Figure 7.

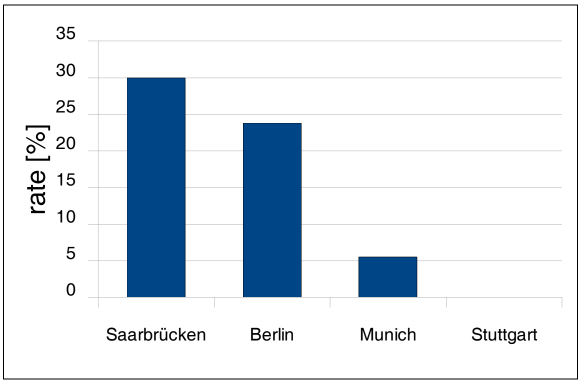

Figure 7. Percentage of misuse in different cities.

While the rate of misuse is 5.6% in Munich, it is approximately 24% in Berlin and 30% in Saarbrücken – in Stuttgart no misuse case was observed at all. The possibility that these differences are due to differences in interview strategies can be excluded because of an exactly defined questionnnaire and a defined interview situation. Possible reasons for these variations may be the following facts: in Munich the newest car fleet was part of the interview and the highest rate of female interviewees occurred. However, the car fleet does not show any important differences between Berlin, Saarbrücken and Stuttgart.

These varieties might be attributable to differences in social backgrounds of interview participants. Social differences usually lead to differences in educational standards, safety attitudes and knowledge structures. As social status was not controlled for in the interviews, differences in this respect may explain the large regional differences in behaviour.

Field study – second type of misuse

In 58 out of 140 cases an adult person was transported on the passenger seat after the first airbag deactivation. In 6 of these cases the airbag was not reactivated for the adult passenger, which results in a misuse quote of 10%.

Internet study – first type of misuse

The internet survey was online from January to March 2009. Links to the survey were placed on popular automotive websites like the automobile club "ACE" or the magazine "auto motor und sport". In addition child seat manufacturers were asked to link the questionnaire. In total, 309 questionnaires were collected. All participants had transported a child on the passenger seat, which was equipped with an airbag. In 194 cases the child was seated in a rearfacing CRS. The following data analysis is based on these cases.

Note that online surveys are less representative than compared to field studies, which was confirmed in the present study. 54% of the participants were men, while in the field study 75% of the interviewees were women. The education level of the participants was also above-average: 74% of the interviewed people had a general university qualification (Abitur), while only 4% had a low education level. This does not correspond to the average education level in Germany.

In 20 out of 194 analysed cases of rearfacing CRS on the passenger seat the airbag was not deactivated, resulting in a misuse (rate) of 11%. This quote is surprisingly low compared to the field study with 15% of misuse. However, the rate corresponds to the average of all analysed cities. The aberration from the average in Munich and Stuttgart was hypothetically explained by variables of social positions. According to the high education level of the respondents, this explanation is consistent with the results of the internet survey. The analysis of the survey shows that the rate of misuse decreases with increasing level of education. Considering the fact that participating in this online survey was voluntary and that it was impossible to control whether the participants answered honestly, the result above seems to be plausible. However, a detailed analysis of these correlations cannot be carried out due to a low number of cases.

With respect to the car's year of manufacture the results of the field study are confirmed: in newer cars with easier airbag deactivation devices less misuse occurs than in older ones. In five out of eight cases misuse occurred in cars where the deactivation was impossible or only practicable by a garage. There was only one case of misuse in which a switch was present.

Internet study – second type of misuse

In 14% of the situations in which an adult was transported on the passenger seat the airbag was not reactivated. This quote is slightly higher than in the field study. Interviewees justified this misuse with a supposedly low risk of a deactivated airbag and with the fact that the airbag could only be deactivated by a garage.

CONCLUSION

Looking at accident data and the results from the field investigation it becomes evident that children are transported on the rear seats in most of the cases – especially in those cars equipped with a passenger airbag. That is the main reason why the misuse risk with respect to the deactivation of the front passenger airbag is very low. If children are using the front passenger seat in cars with passenger airbag mostly the airbag is deactivated. The share of misuse mainly depends on the possibility of airbag deactivation. While minor rates of misuse where observed in cars offering a switch or automatic deactivation (the latter one without any case of misuse), misuse is more common in cars which do not offer any deactivation or require durable deactivation by a garage.

In several accidents the fatal risk resulting from the combination of rearfacing child restraint systems and deploying passenger airbags was proven. However, other accidents indicate that there is no certain risk coming from the passenger airbag. The real risk seems to depend on the airbag itself, the seating position and the accident severity. Looking at the airbag itself especially the mounting position and the size are important parameters defining the risk. Today's top mount airbags result in lower risk than the earlier airbags in low mount and mid mount position. Taking into account the differences with respect to the mounting position of the airbag larger airbags cause higher injury risks than smaller ones. It is obvious that proximate seating positions expose the passengers to a higher risk than farther seating positions. Finally there are indications that the main risk resulting from modern passenger airbags is connected with a moderate severity level.

Summarising the results of the study manual switches for the airbag deactivation are good practise. Within this study no evidence for the commonly feared misuse risk for the automatic deactivation (i.e., CPOD / AKSE) could be found. In contrast, no misuse occurred in the rare cases of cars offering automatic deactivation. Finally it seems to be possible to design airbags which avoid any risk in the long term.

ACKNOWLEDGEMENTS

The presented study has been funded by Bundesanstalt für Straßenwesen (BASt) under contract no. FE 82.310/2006 and supported by TAKATA-PETRI Berlin.

In addition the authors want to thank among others ACE Auto Club Europa", "ADAC", "auto motor und sport", "Britax Römer", "Concord", "Eltern", "Maxi Cosi", "Recaro" for "advertising" the online questionnaire.

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