

6th International Conference
Protection of Children in Cars
Munich, December 4th and 5th 2008

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Misuse in the combined use of airbags and rearfacing Child Restraint Systems

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Abstract

This paper is based on the findings of the research project “Misuse of Airbag Deactivation During the Transportation of Children in CRS” funded by BASt. The goal of this project was to assess the risk of misuse that may occur during the combined use of passenger airbags and rearfacing child restraint systems (CRS). Additionally the danger of deploying airbags for rearfacing baby shells was assessed. The results of both assessments are presented in this contribution.

In the past, passenger airbags could at most be disconnected by a garage. Today there are several possibilities for the car driver himself to deactivate the airbag. Possible solutions are an on/off switch or the automatic detection of a child restraint system. Today, these systems are integrated in cars as a standard or can be ordered as optional equipment. Two types of misuse can occur: transportation of an infant while the airbag is switched off and transportation of an adult while the airbag is still disconnected.

The study used accident analyses and two types of survey amongst users in order to analyse the two cases of misuse. In both surveys, it was difficult to gather data about misuses in transporting children on the passenger seat. Apparently these cases of misuse are the exception. Two reasons can account for that: The high number of passenger airbags disabled and the preference of parents to seat their infants on the back seat. Most of them were found in older cars, which offer no simple way to disable the airbag. For systems that detect a child seat automatically, no misuse was found. The majority of misuses in cars equipped with a manual switch were caused by errors of omission.

The second type of misuse is also prevented successfully by automatic systems. However, it is a general problem if the airbags are deactivated expensively by a garage. The resulting danger for adults following from a deactivated airbag is assessed to be lower than the danger of an active airbag for children by the car drivers. In the case of using a manual switch, however, the problem of oblivion remains.

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 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 on the 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.

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 unable 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 baby shell 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 baby shells have to be mounted on the rear seat.

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.

The survey has been conducted in Munich, Berlin and Saarbrücken. The interviews were carried through 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 115 interviews took place (54 in Munich, 21 in Berlin, 40 in Saarbrücken). Almost 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 115 cases the airbag was not deactivated, which corresponds to a rate of 17.4% 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 11% of the interviewees consciously accepted the risk of a deploying airbag.

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 (see Figure 1).

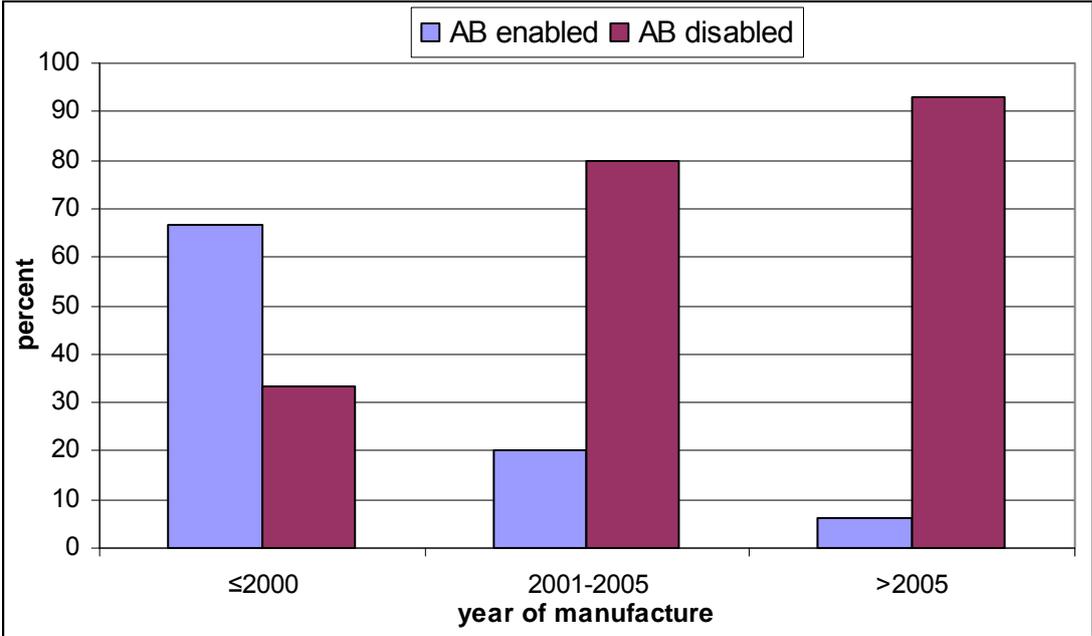


Figure 1: misuse depending on year of manufacture

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 cars, in which the airbag could deactivated at most by a garage. As Figure 2 shows, there is a 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.

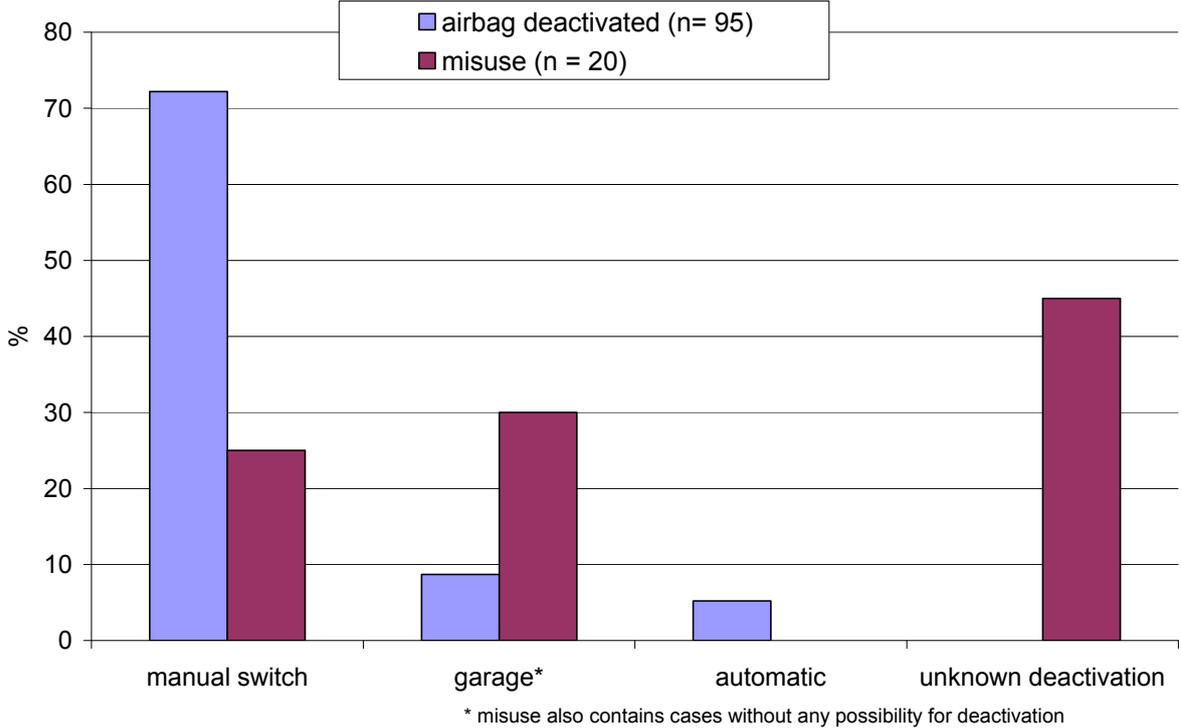


Figure 2: misuse compared to different airbag deactivation techniques

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. Drives that take place several times per week show a clearly lower misuse rate than drives which take place rarely. Apparently, it is more common to switch off the airbag if it is part of a daily routine procedure.

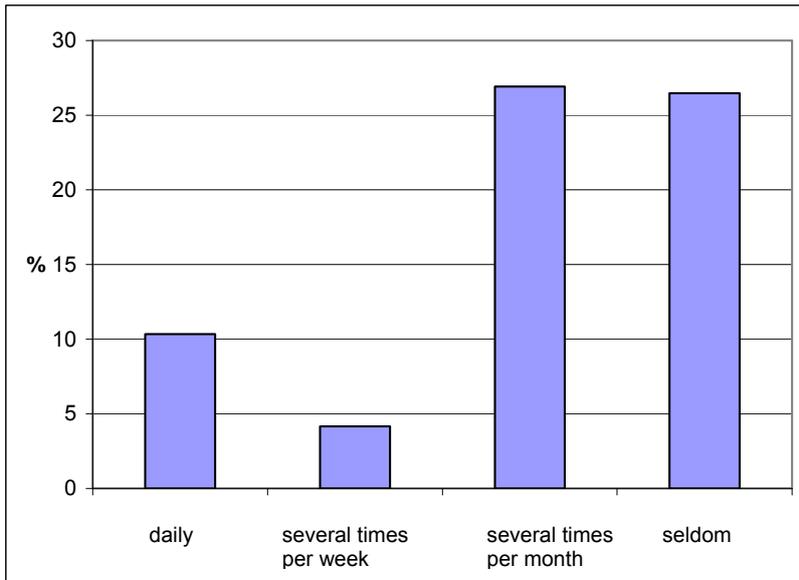


Figure 3: frequency of child transportation with enabled airbag

Surprisingly, the largest explicit effect is regional differences: there is a clear coherence between misuse and the city of survey (Figure 4).

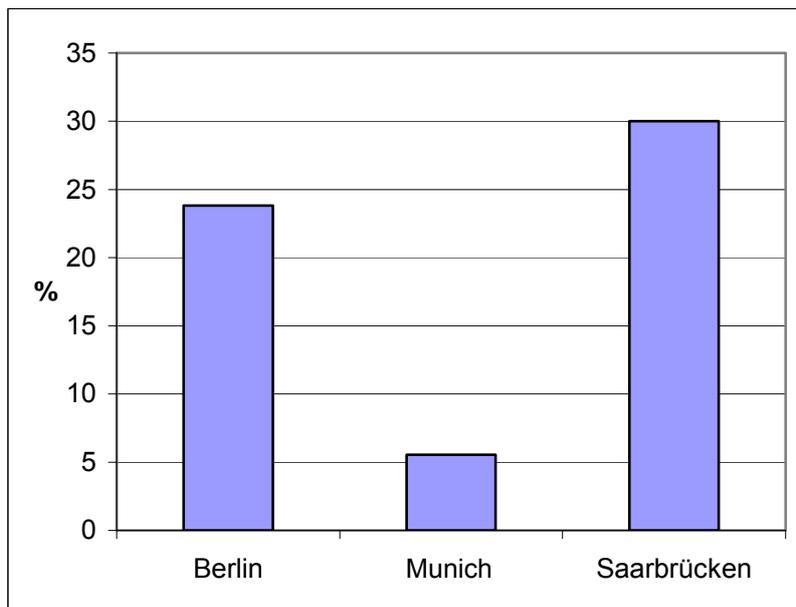


Figure 4: Percentage of misuse in different cities

While the rate of misuse is 5.6% in Munich, it is approximately 24% in Berlin and 30% in Saarbrücken. The possibility that these differences are due to differences in interview strategies can be excluded because of an exactly defined questionnaire 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.

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 115 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 June 2008. Links to the survey were placed on popular automotive websites like the automobile club “ACE” or the magazine “Auto Motor und Sport”. In total, 226 questionnaires were collected. All participants had transported a child on the passenger seat, which was equipped with an airbag. In 139 cases the child was seated in a rear-faced 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. 68% of the participants were men, while in the field study 74% of the interviewees were women. The education level of the participants was also above-average: 81% of the interviewed people had a general university qualification (Abitur), while only 3% had a low education level. This does not correspond to the average education level in Germany.

In 8 out of 139 analysed cases of rearfacing CRS on the passenger seat the airbag was not deactivated, resulting in a misuse (rate) of 6%. This quote is surprisingly low compared to the field study with 17.4% of misuse. On the other hand, this result is equal to the Munich misuse rate. There, the aberration from the average 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 cars. In 5 out of 8 cases misuses 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 13.5% 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.

Analyses of accident data

This analysis is based on data from the GIDAS (German In-Depth Accident Study) as well as data of some 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 transported in a baby shell. This is the only clear documented 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.

A 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.

The analyses of single accidents showed two fatal accidents in Germany, both with low accident severity. In one case the airbag deployed even so it was disabled by a garage, while in the other case there was no possibility to deactivate the airbag. In

both accidents the babies received a traumatic brain injury due to the deploying airbag.

Risk potential of passenger airbags

Few dynamic and static tests conducted in context with this project, demonstrated a risk depending on the test situation and the used airbags. Geometry, size and mounting position have a significant influence on test results as well as the position of the CRS.

The comparison of two static tests shows that differences in airbag size and deploying geometry lead to significantly different test results (Figure 5).



Figure 5: Maximum airbag deployment: car 1, car 2

It can be seen clearly that the large airbag on the right causes a higher impact to the baby shell. The test results shown in Table 1 confirm this impression.

Measurement	Car 1	Car 2
Head a_{3ms}	8 g	49 g
HIC15	1	137
Neck F_z	148 N (Compression)	322 N (Compression)
Neck M_y	4 Nm (Flexion)	54 Nm (Extension)
N_{ij}^* (special calculation for Q1.5 dummy)	0,15	2,86
Chest a_{3ms}	3 g	38 g

Table 1: results of static airbag tests

The impact in the second test was more severe than in the first one, even if the position of the CRS compared to the dashboard was equal.

Furthermore the accident severity has also important influence on the injury risk. It seems obvious that in accidents with moderate severity the influence of an airbag is much higher than in accidents with a high severity. There the high loads to the occupant are nearly independent of an airbag.

In total, the test results as well as the GIDAS analysis show that the general risk of front passenger airbags is slightly overestimated. While the fatality risk has been proven by single accidents and a number of crash tests there are also cars on the road where the deployment of the passenger airbag does not necessarily cause fatal injuries.

Conclusion

The field and online survey as well as the accident analysis showed that the rate of misuse is low. Due to simple deactivation possibilities and the fact, that most of the children are transported on the rear seat, there are only few cases in which a baby shell is mounted on a passenger seat while the airbag is activated. The main reason for misuse is older cars for which an airbag deactivation is either not offered or not possible by the driver himself but only by a garage. Due to the modernisation of vehicle fleet this problem will decrease in the future. For simple systems most cases of misuse occur due to reasons of oblivion. Both surveys have shown that parents have a risk awareness for the situation of rearfacing CRS in front of an airbag. The results have also shown that automatics systems seem to be an effective way to prevent misuse.