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Is the Kneebag Save in Out of Position Situations?

Abstract

Nowadays airbags are part of the standard equipment in almost all new cars. While airbags are saving an increasing number of people from severe injuries and death in moderate and high speed crashes, they do not completely prevent dashboard injuries. The most common mechanism in dashboard injuries is a posteriorly directed force to the proximal tibia with the knee flexed. This may occur during a motor vehicle frontal impact accident when a knee of the driver or the front-seat passenger strikes the dashboard. The posterior force can be combined with a abducting or rotational force leading to concomitant lateral or posterolateral injury.

Car and airbag manufacturers therefore develop special inflatable systems to reduce the impact force in dashboard injuries.

Every new inflatable system, however, has to be evaluated in out of position situations in which the system might cause injuries to certain body areas.

Therefore, we investigated a new kneebag system in different critical seating positions of post mortem test subjects (PMTS).

The tested knee airbag module is a folded airbag (18 litre volume) which is installed below the lower section of the instrument panel of a passenger car. Using four PMTS (2 male, 2 female, age 36–67) the following positions were tested: normal seating position, knee flexed >90 degrees and knee flexed <60 degrees in static deployment tests with direct contact. In addition a dynamic test (48.8kph, AAMA-pulse) was carried out with the PMTS belted in a normal seating position. The inflation phase and the impact of the system on the knee/lower leg were analysed by high speed videos. After the test the lower legs of the PMTS were examined by X-ray and autopsy. All soft tissue injuries and bone fractures were recorded.

All the tests could be evaluated. Except some superficial skin lesions in the impact area no fracture of the bones around the knee and no knee ligament and tendon injuries were observed.

Neither video analysis nor autopsy of the PMTS showed any critical contact injuries caused by the inflation process of the bag. Therefore, it can be concluded that in the tested seating positions which are the most critical for the knee area the knee bag system is safe.

Introduction

Nowadays airbags are part of the standard equipment in almost all new cars. While airbags are saving an increasing number of people from severe injuries and death in moderate and high speed crashes, they do not completely prevent dashboard injuries. The most common mechanism in dashboard injuries is a posteriorly directed force to the proximal tibia with the knee flexed. This may occur during a motor vehicle frontal impact accident when a knee of the driver or the front-seat passenger strikes the dashboard. The posterior force can be combined with a abducting or rotational force leading to concomitant lateral or posterolateral injury.

Car and airbag manufacturers therefore develop special inflatable systems to reduce the impact force in dashboard injuries.

Every new inflatable system, however, has to be evaluated in out of position situations in which the system might cause injuries to certain body areas.

Therefore, we investigated a new kneebag system in different critical seating positions of post mortem test subjects (PMTS).

Methods

The tested knee airbag module, with its folded airbag (18 litre volume), is installed below the lower section of the instrument panel in the area of the jacket tube. In the event of deployment, the airbag tears open a seam on the instrument panel and expands in the form of a bolster, which stretches from the side door covering to the dome, in front of

Fig. 1: Location of the inflated knee bag system

the knee impact area on the instrument panel. The fabric is made of Polyamide. Figure 1 shows the location of the bag after the inflation.

Using four PMTS (2 male, 2 female, age 36-67) following positions were tested: normal seating position, knee flexed >90 degrees and knee flexed <60 degrees in static deployment tests with direct contact. In addition a dynamic test (48.8kph, AAMA-pulse) was carried out with the PMTS belted in a normal seating position. The inflation phase and the impact of the system on the knee/lower leg was analysed by high speed videos. After the test the lower legs of the PMTS were examined by x-ray and autopsy. All soft tissue injuries and bone fractures were recorded.

Chosen Seating Positions

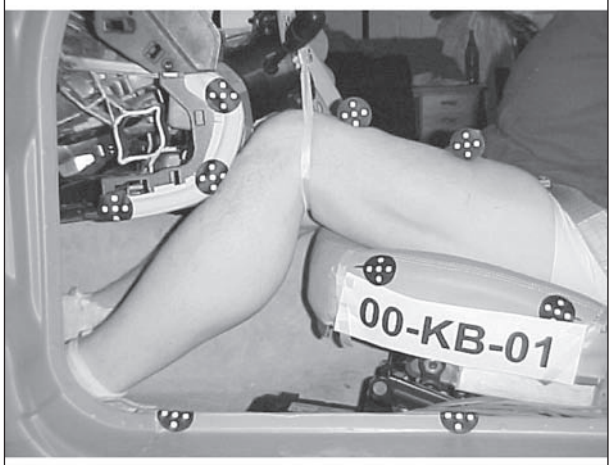
Tables 1 to 3 give an overview about the chosen seating positions.

In addition to the static test series one dynamic test was carried out. A specially prepared body-in-white was put on a sled and was driven at 48.8 kph against brake tubes to simulate the AAMA-pulse. The PMTS was belted and seated in a normal driver position (table 4).

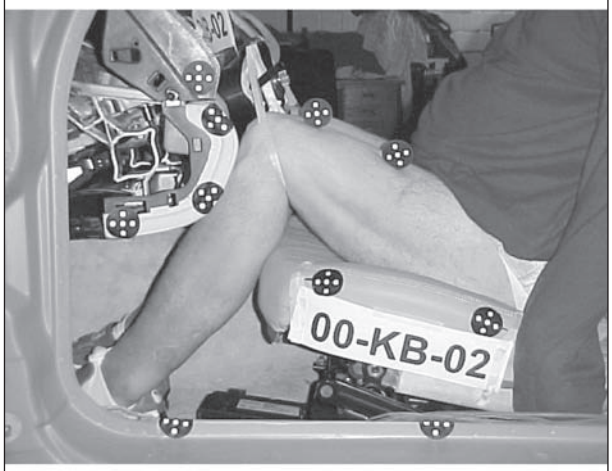
Test Conditions and Medical Examination

The post mortem test subjects were seated in the car as seen in the tables 1 to 4. All PMTS were belted. No additional instrumentation in the lower leg area was used. Next to the test an autopsy of the lower leg area was carried out, starting with an optical examination of the hip, the knee joints, the thighs and the lower legs. Beyond that X-rays of the bony structure were taken to identify possible fractures.

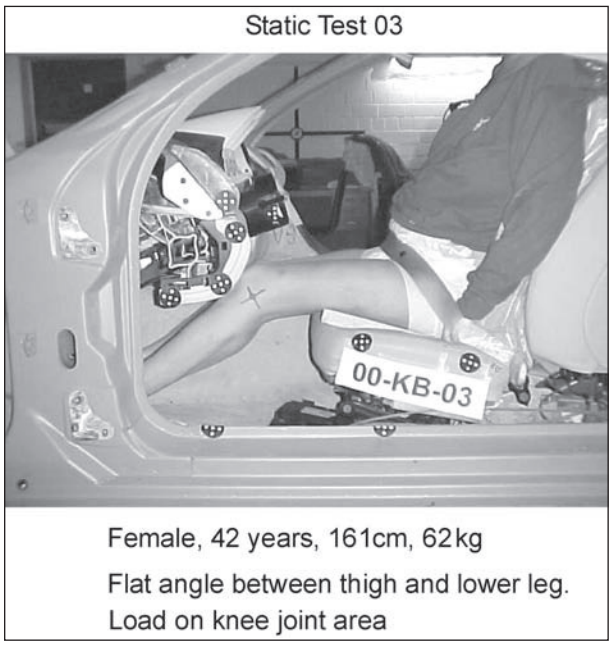
After that the knee area was opened to examine in detail the cruciate ligaments and the collateral ligaments. Figure 2 shows the location of the ligaments (ROHEN, 1988).

Static Test 01

Male, 45 years, 167cm, 83kg Direct contact between lower leg/ knee joint and knee bag cover. Lower leg in drive position

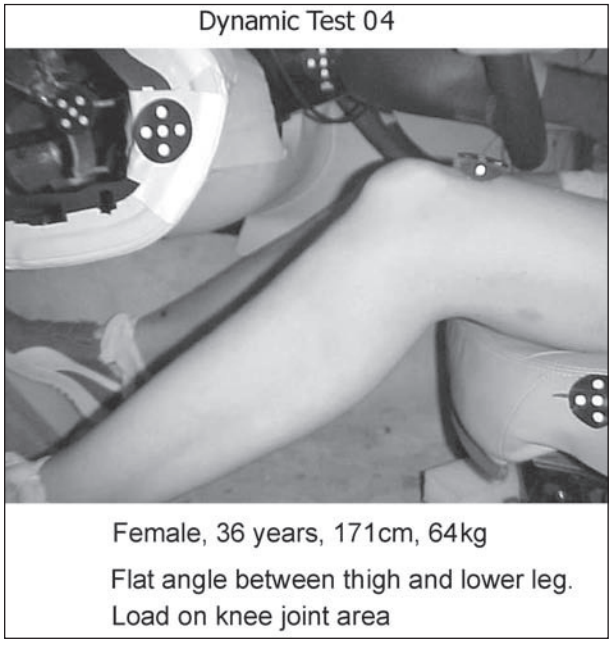
Tab. 1: Static inflation test 01

Static Test 02

Male, 67 years, 161cm, 85kg Lower leg nearly vertically. Load directly on lower leg underneath knee

Tab. 2: Static inflation test 02



Tab. 3: Static inflation test 03



Tab. 4: Dynamic test at 48.8kp/h with inflatio

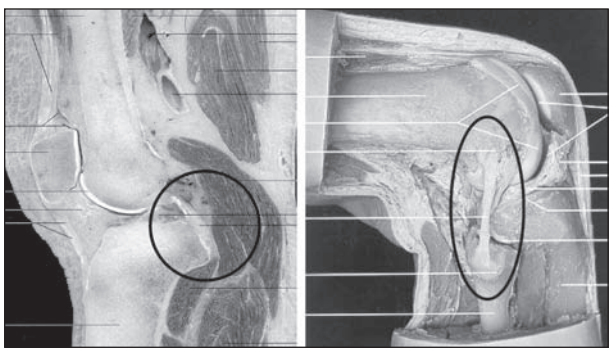


Fig. 2: Lig. cruciatum ant. Lig. cruciatum post. Lig. collaterale

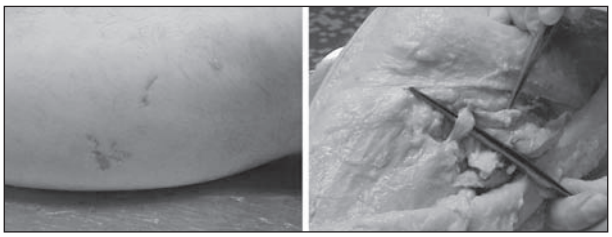


Fig. 3: Picture of typical superficial bruises Example of uninjured collateral ligament

Results

All the tests could be evaluated. Except some superficial skin lesions in the impact area no fracture of the bones around the knee and no knee ligament and tendon injuries were observed. This is shown as an example in figure 3.

Also the knee movements caused by the impacts were uncritical: in some cases a compression of the thigh could be observed without movement in the hip area. After the compression phase the knees were moved to the sides. In none tests additional injuries could be examined during the movements.

Conclusion

The goal of this investigation was focused to possibly direct contact injuries caused by the inflation process of the bag. Neither the level of injury nor the film analysis showed a potential for occupant risk. This result was confirmed by examinations of the lower extremities.

Therefore, it can be concluded that in the tested seating positions which are the most critical for the knee area no additional risk for the occupants can be derived.

References

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ROHEN, YOKOCHI: Anatomie des Menschen. Schattauer Verlag, Stuttgart – New York, 1988