Bicycle Toppling-over Tests with a Hybrid-III anthropometric test dummy of a Young Child on a Bicycle-mounted Child Seat

Our institute conducted tests, jointly with Shinya Miyamoto, a neurosurgeon at the Graduate School of Medicine, the University of Tokyo, regarding the head impact of a young child when a bicycle topples over with the child in the bicycle-mounted child seat. In the tests, we measured acceleration of the head of a Hybrid-III anthropometric test dummy of a 3-year-old child on a bicycle-mounted child seat when the bicycle was made to tip over. (Performance of the tests was commissioned to the Japan Automobile Research Institute and was conducted at the said institute on October 28th and 29th, 2004.)

BACK GROUND AND PROVISIONS

According to a survey carried out by Dr. Shinya Miyamoto, one in three parents of young children have had their children injured while using a bicycle-mounted child seat and more than 30% of the injuries were to the head. The Institute for Traffic Accident Research and Data Analysis also analyzed their data on traffic accidents and found that approximately 50% of the young children who were injured while riding a bicycle or sitting on a bicycle-mounted child seat, suffered a head injury. It has come to be recognized, therefore, as an urgent task to protect a young child from a head injury when riding on a bicycle-mounted child seat.

In August 2004, our institute prepared the leaflets that encouraged parents to have their children wear a helmet. We distributed them to consumers nationwide through, for example, bicycle shops, and directly to the purchasers by requesting that manufacturers should put a leaflet in the packages of their products, and distributed the leaflets widely to the public through spring traffic safety campaigns under the auspices of each prefectural Traffic Safety Association. We also requested the organizations concerned to append a recommendation of a helmet for a child passenger to the instruction manual for the product. Furthermore, jointly with bicycle makers, we have developed the bicycles that do not topple over easily, and have already started to produce and market them.

Anthropometric test dummy of a three-year-old child

Figure A: Low-back child seat

Figure B: High-back child seat

OBJECTIVES OF THE TESTS

The objectives of the tests were: (1) to provide consumers with information regarding how to safely use a child seat based on our findings of the effectiveness of the use of a helmet and/or a seat belt by way of measurement, evaluation and analysis of head impact; and (2) to provide the organizations concerned with information as elucidatory as possible, regarding the performance requirements of a bicycle helmet, for the goal of securing reduction of injuries.

OUTLINE OF THE TESTS

We mounted two kinds of child seats (Figure A and B) on the rear part of a bicycle, put an anthropometric test dummy of a three-year-old child with an accelerometer attached to its head (head circumference, 508 mm; weight, 15.46 kg) on the seat, made the bicycle tip over, and measured head acceleration on impact (maximum acceleration on impact, head injury criterion (HIC)).

Three measurements were taken for each kind of child seat under four conditions: with or without a helmet worn, and with or without a seat belt fastened. We used SG (Safety Goods) marked helmets which were certified by Consumer Product Safety Association.

Body dimensions of the anthropometric test dummy of a young child

Region of the body to be measured	Allowable measurements
Head girth	508 ± 7.6
Head width	135.9 ± 7.6
Shoulder width	244.1 ± 7.6
Chest girth	539.8 ± 12.7
Hip width	208.3 ± 7.6
Length from back waist line to the center of knees	256.5 ± 5.1
Height of knees	249.2 ± 7.6
Seated height	546.1 ± 7.6

Weight of the anthropometric test dummy of a young child

Region of the body to be weighed	Allowable weight (kg)
Head	2.7 ± 0.05
Neck	0.75 ± 0.05
Torso	6.54 ± 0.18
Upper arm	0.42 ± 0.05
Lower arm	0.48 ± 0.05
Upper thigh	0.97 ± 0.09
Lower thigh	0.61 ± 0.05
Feet	0.27 ± 0.05
Total weight	15.46 ± 0.82

RESULTS OBTAINED FROM THE TESTS

1. Falling dynamics

(1) An example of the condition when a dummy was placed on a child seat with the seat belt fastened and with a helmet worn.

The photo showing a setup before the test

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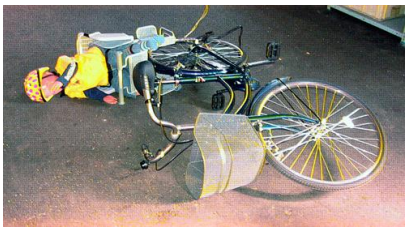

The photo showing a state after the fall

(2) An example of the condition when a dummy was placed on a high-back child seat with the seat belt not fastened and with a helmet not worn by the dummy.

The photo showing a setup before the test

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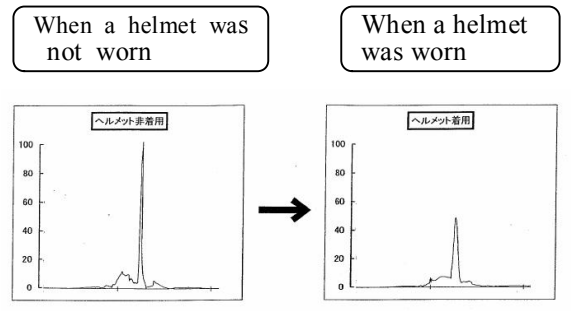
The photo showing a state after the fall

2. Changes in head impact

A typical example of changes in head impact according to whether a helmet was worn or not is shown in Figure C. The vertical axis represents a relative ratio (%) against the peak head impact value without a helmet.

Figure C:



SUMMARY

In this testing, when a bicycle fell over and a child sitting on a child seat hit the road surface on the head, the head impact exceeded 3000 m/s^2 (approximately 300 G) at which point it was generally thought that a serious head injury was induced. Since helmet reduced this head impact to 50%–60%, the risk of head injury was expected to be reduced by wearing a helmet.

With a high-back child seat with the seat belt fastened, the results showed that the initial impact on the road surface was not to the head of the dummy, though the test results were bound within the limits of the unique conditions of the test. When the seat belt was not fastened, however, centrifugal force threw the dummy out of the seat and the head hit the road surface directly. A high-back child seat with its high backrest, wide enough sidewalls, and its seat belt fastened, was believed to have the potential of reducing head injury.

Dr. Miyamoto carried out a survey and reported that more than 30% of accidents occurred when a bicycle stood still including the time when a child was put on or off the bicycle. Considering this fact and the results of our testing, it is evident that the use of a helmet can reduce significantly the collision impact on the head irrespective of kinds of a bicycle-mounted child seat when a bicycle tips over practically. In conclusion, we believe that it is imperative for parents to have their children wear a helmet when using a bicycle-mounted child seat.