DEVELOPMENT OF ELDERLY PEDESTRIAN ACCIDENT SIMULATION MODEL AND EVALUATION OF INJURY RISK

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ABSTRACT

In these days, approximately 40% of traffic accidents are pedestrians. The numbers of elderly pedestrian death and injury are increasing. It is important to discuss the injury prevention for elderly pedestrian from the viewpoint of reduction of the social cost for medical care. The stiffness of car front structures, the bonnet hood and bumper, are regulated to prevent pedestrian injuries but those regulations do not considered elderly. On the basis of these backgrounds, we developed male and female pedestrian multibody models, and evaluated injury severity of head and femur. Head injury is often fatal and proximal femur fracture, so called hip fracture, can be a cause of bedridden. Therefore we reproduced the accident conditions of real accidents for multibody simulation. Then, we conducted pedestrian accident simulations with male and female elderly pedestrian models and two types of car models. We evaluated HIC (Head Injury Criterion), and found the behavior of the shock that a head requires. In the simulation results with high impact velocity conditions head impact to the bonnet hood were observed, on the other hand the head impacts not to the hood but to the ground in low impact velocity conditions

1. INTRODUCTION

In 2014, the traffic accident death of the pedestrian and the bicycle crew becomes approximately 60% in Figure 1. In addition, the number of elderly pedestrian death and injury are increasing[1]. To reduce the fatalities of pedestrian, Japan New Car Assessment Program (JNCAP) has started the pedestrian head and lower extremity protection performance tests. But these performance tests aim only to the adult (head and lower extremity) and child (head). Thus it is necessary to evaluate the protection performance for elderlies to reduce the number of death in traffic accident.

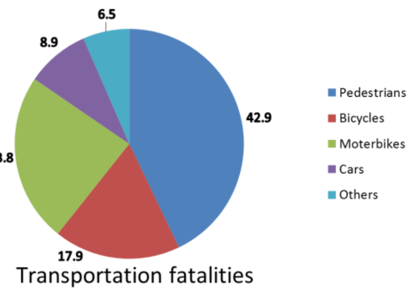


Fig.1 Fatalities in traffic accident in Japan (2014)[1]

2. PURPOSE

In consideration of these backgrounds, the purpose of this research is to investigate the effectiveness of protection for elderly pedestrian in car-to-pedestrian accidents. Therefore it is necessary to reproduce the situation of a typical accident by simulation.

We developed a model of typical traffic accidents between pedestrians and cars so as to assess the injury of the pedestrian.

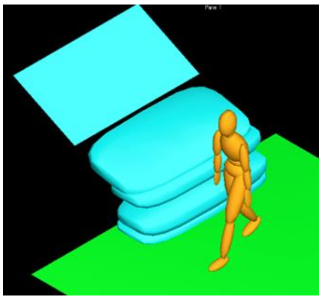


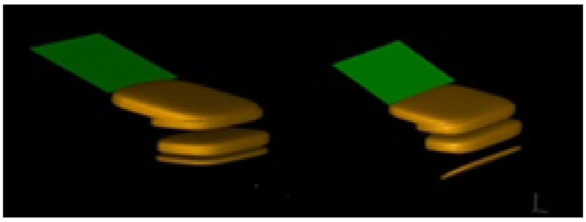
Fig.2 Example of side collision of pedestrian

3. METHOD

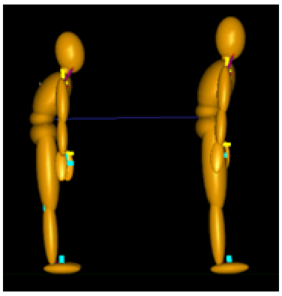
Using MADYMO (TASS International), we conducted pedestrian accident simulations with male and female elderly pedestrian models and two types of car models as shown in Figure 3. Car models were developed and validated in the previous study [2]. The simulation conditions are shown in Table 1. We considered the effects of car speed, shape of the car, braking of car, pedestrian's gender and attitude of lower extremities.

The severity of the head injury was evaluated by HIC15(Head Injury Criterion 15) shown in Equation (1).

$$HIC_{15} = Max\left\{ 1/(t_2 - t_1) \int_{t_1}^{t_2} \left[a(t)\right]^{2.5} dt \right\} (t_2 - t_1) \qquad (1)$$



(a) SUV and sedan model (left: sedan, right: SUV)



(b) Pedestrian model

Fig. 3 Simulation models

Table1 Simulation Condition

Condition	Content
Collision direction	Side from Pedestrian
Car speed	10, 20, 30, 40 km/h
Car model	Sedan, SUV type
Braking	With / Without
Pedestrian gender	Male, Female
Pedestrian attitude	Right or Left Leg Front

4. RESULTS

Figure 4 shows HIC values in each car speed condition against male pedestrian without car braking. The maximum HIC was observed at 30 km/h. As the HIC value depends on the head impact point on the car, HIC did not increase with the car speed. To evaluate the effects of car deceleration by breaking, we also analyzed HIC for Car-to-Male pedestrian collision with car breaking in Figure 5. Comparing with the results in Figure 4, the behavior of the pedestrian head changed. Car model with braking shown in Figure 5 showed lower HIC values but the dependency on car velocity is qualitatively similar. The head injury severity was depended on the head impact point on car structure rather than car velocity. The body motion and initial posture can effect on the head impact point. Thus we need more discussion on the relation between impact condition and injury severity control.

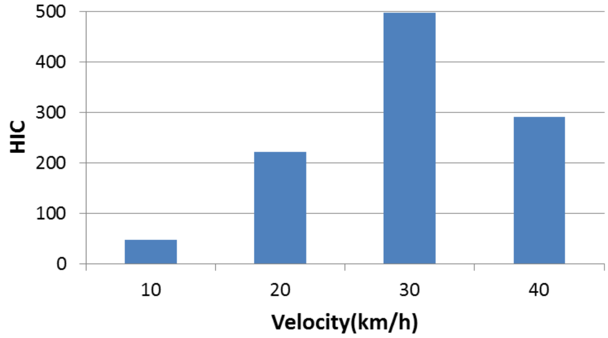


Fig.4 HIC in Sedan-to-Male pedestrian (without braking, left leg-forwad model)

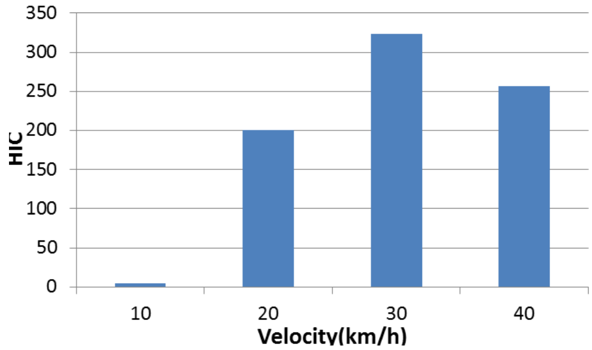


Fig.5 HIC in Sedan-to-Male pedestrian (with braking, left leg-forwad model)

5. CONCLUSION

Head injury severity of elderly pedestrian in traffic accident was discussed. The head injury severity was depended on the head impact point on car structure rather than car velocity. We need more discussion on the relation between impact condition and injury severity control.

REFERENCES

[1] Statistics of Traffic Accident in 2014, Department of Traffic, National Police Agency, Japan (in Japanese)

[2] Yamamoto, S. et al., Behavior and Injury Evaluation of Cyclist in Car-to-Bicycle Collisions using Multibody Analysis, 2015 JSAE Annual Congress (Spring) Proceedings (2015), S377 (in Japanese)

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