

The Experimental Study on the Injury Model of Motorcycle-Pedestrian Impact Injury

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Abstract –To investigate the injury model of motorcycle-pedestrian impact injury. A total of 12 dogs were used. An animal was installed in the upper of our simple pedestrian dummy physical model and chosen to develop a pedestrian dummy animal model. The head-neck of the animal was erectly exposed in the upper of pedestrian dummy physical model and the rest of the animal was fixed in the thorax of pedestrian dummy physical model. Firstly, the motorcycle was straightly accelerated by our self-made motorcycle crash test system and impacted an erect pedestrian dummy animal model when the motorcycle speed reached the preconcerted velocity value ($v = 30, 50 \text{ km/h}$) at the preconcerted position point. Secondly, the pathological and dynamics analysis were conducted with the high-speed photograph, acceleration/velocity signal test, gross observation and light microscope examination as well as AIS-ISS grade.

The self-designed injury model could well simulate the course of pedestrian impacted by a motorcycle and the velocity precision of 12 cases animal experiments was in control of $\pm 2\%$. High-speed photograph showed that after impacted by front-wheel of motorcycle, the movements of pedestrian dummy animal model were as follows: First, the model circumgyrated surrounding the front-wheel of motorcycle and the motorcycle decelerated suddenly because of braking ; after aerial circumrotation, the head of model first bumped the floor or the limbs first bumped the floor. Gross observation and light microscope examination showed that main injured regions of dogs were head, thorax and abdomen. AIS-ISS grade showed that ISS of dogs was 22.3 ± 3.7 for 30km/h while ISS was 33.3 ± 1.9 for 50km/h.

The injury model of the motorcycle-pedestrian impact injuries was stable and well-repeated. Further more, the injury severity of animals impacted by 50km/h was more than that of the animals impacted by 30km/h when bumping parts were alike.

Keywords: Motorcycle, Pedestrian, Impact injury, Animal model

1 Introduction

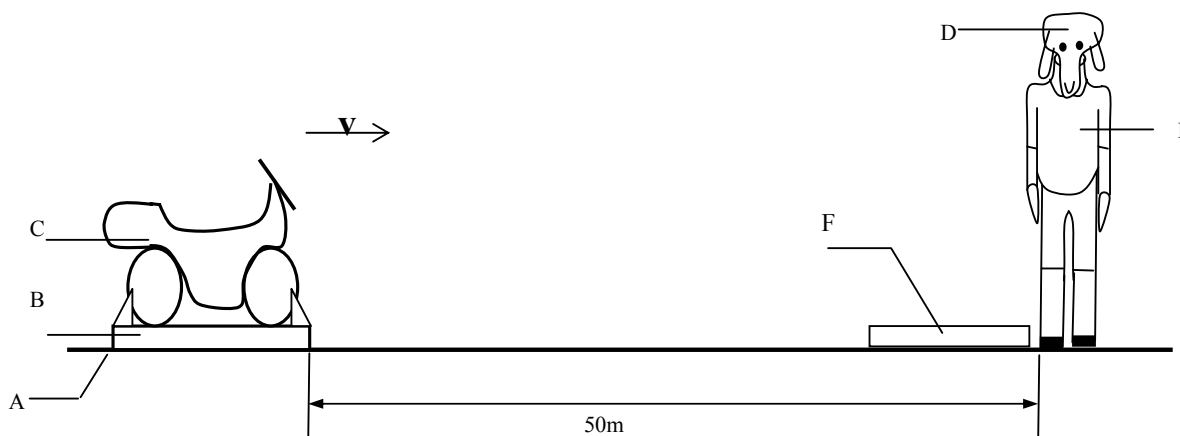
Nowadays, the focus of research on motorcycle accidents is about analysis of injury types, injury traits, the computer simulation of injury system, as well as safety protection of motorcycle impact. To investigate the injury of motorcycle accidents, we need develop a real motorcycle impact experiment and set up a stable injury model of motorcycle accidents injury based on animals, bodies, and dummies. So, there have been no related reports so far. This research is based on the common type of motorcycle injury .With the help of space facilities and measure equipment in the newly-built of key project in our country of our school, we succeeded in developing motorcycle impact experiment system, the pedestrian dummy animal model and related experimental installments. Further more, we had set up the animal model of typical motorcycle injury, upon which we carried out the study of motorcycle-pedestrian impact injury.

2 Material and methods

2.1 The injury installation of motorcycle-pedestrian impact injury(as picture 1)

It is mainly consists of a tractive track, a tractor, a motorcycle and a buffer equipment. First, a motorcycle of JiaLing YD-48 was installed on the self-designed tractor B, and then the

motorcycle moved a certain distance (about 50 metres) along the track by electric system. The front wheel of the motorcycle decelerated quickly by the buffer equipment F. The pedestrian dummy physical model which was installed with experimental animals was thrown away and dropped on the ground.



Picture1-----The injury installation of motorcycle-pedestrian impact injury

A---tractive track. B---tractor C---motorcycle D---experimental animals E---pedestrian dummy physical model F---buffer equipment

2.2 The pedestrian dummy animal model

Equipped with joints ,a artificial skeleton was set up with artificial materials .Then, an animal was installed in the upper of the skeleton, which was the pedestrian dummy animal model.The head-neck of the animal was erectly exposed in the upper of pedestrian dummy physical model and the rest of the animals was respectively fixed according to the Hybrid III dummy physical.

2.3 Experimental animals

A total of 12 dogs were used, male or female was not limited ,weighed at 12 ± 2 kg, these animals were in good condition before being injected with 1.5% Sodium Pdotobarbital. Based on different impact velocity, those animals were divided into slight injured group and seriously injured one.With six dogs each group,the preconcerted velocity is 30km/h and 50km/h respectively.

2.4 Main reagent and equipment

1.5%Sodium Peotobarbital, Motionpro 2000c high speed photograph (made in Relake),cs-1light microsope examination and WaveBook/512 data collect system, et al.

2.5 Gross observation

Dissect as soon as the animal died .The survived ones wrer caused to die after 6hours through femoral artery bleeding while anaesthesiaed.Observations mainly include whether the cranium of injured animals have haematoma,bleeding,or some common focus;whether neck has subcutaneous bleeding;whether the neck musle,soft tissue and the neck vertebra have cardinal injury; whether lung has pulmonary bleeding or pulmonary oedema;whether the seriously injured one has deeper pulmonary bleeding;whether the heart has cardiac bleeding,chambers of the heart lancinate.At last,record all the focus' definite place ,size(bulk:length*width*thickness)and the shape.

2.6 Light microscope examination (Hematoxylin and Eosin dyeing)

Picking up the tissue sample from the brink regions of cranium, spinal cord, heart, lungs, liver of the animal. These samples were saturated and fixed in the neutral formalin, paraffin sliced, HE dyeing, and then could be examined through light microscope. Through observation, we could ensure all the tissues morphology and microscopic abnormal changes.

2.7 AIS-ISS grade

According to the results of gross observation, AIS-ISS grade could make a comprehensive evaluation to the injury severity of animals. Using the SPSS11.0 software to statistical analyse, the calculated datas were expressed with "equal value $\pm$ standard disparity" ($\bar{x} \pm s$).

3. Results

3.1 The injury installation of motorcycle-pedestrian impact injury

After repeated impact, the motorcycle had not been destroyed obviously except some deformation of lights and treadle of the motorcycle. After crashing on the pedestrian dummy physical model, the injury installation could decelerate suddenly because of braking. The motorcycle crash test system could well simulate the course of motorcycle-pedestrian impact injury and the velocity precision of 12 cases animal experiments was in control of $\pm 2\%$.

3.2 Pedestrian dummy animal model

The model weighed 68kg, 170cm long, the arrangement of all the sections were approached to the Hybrid III dummy physical. Animals could be easily installed and picked out. The self-designed joints of the model were flexible. The pedestrian dummy animal model could achieve the desired results.

3.3 The course of the motorcycle-pedestrian impact injury

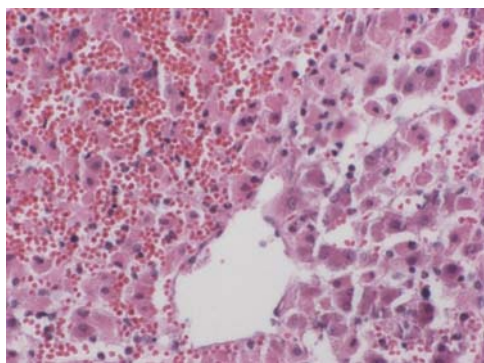
High-speed photograph showed that after impacted by front-wheel of motorcycle, the movements of pedestrian dummy animal model were as follows: First, the model circumgyrated surrounding the front-wheel of motorcycle and the motorcycle decelerated suddenly because of braking; after aerial circumrotation, the head of model first bumped the floor or the limbs first bumped the floor.

3.4 Gross observation

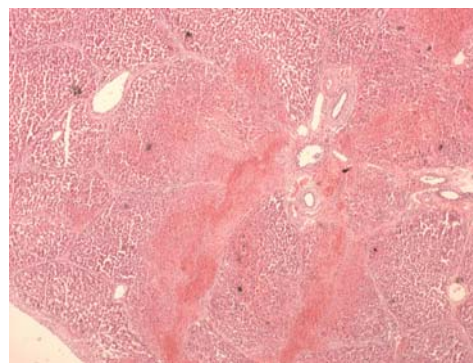
Gross observation showed that impacting with different speed caused different degree of injury on animals. In group A1, subcutaneous bleeding on the brow, there were areas of clots in the upper rightside of the brow. Bleeding in the frame of the brow (mainly at leftside), spotted bleeding scattered on the membrane. Both leftside and rightside of the chambers were bleeding. With equal injurious circumstance, the injury severity of animals impacted by 50km/h was more than that of the animals impacted by 30km/h.

3.5 Light microscope examination

The result of HE dyeing (as picture 2). After examination of group A1, injured liver tissue was bleeding under the membrane, some erythrocyte spilled from lobule collected area, however, it was still near to the normal liver lobule; With large areas of bleeding of liver cells, liver plate was arranged in disorder arounded with a lot of erythrocyte, and large quantity of liver cells were necroses.



(a)slight injured group×400



(b)seriously injured group×40

Picture.2 Pathological changes of liver with HE dyeing light microscope examination

3.6 AIS-ISS grade

Since the result of experiment had showed that injured regions were head, neck , thorax. abdomen and pelvic cavity, we had only considered these four regions, and only chosen the most seriously AIS grade from each region. We got ISS from the sum of squares of the peak AIS value from in seriously injured area .We got the AIS-ISS score chart as Chart1.

3.7 Biomechanics parameter

Measured from experiment, biomechanics parameter was analysed statistically by the SPSS11.0 software. The calculated datas were expressed with “equal value $\pm$ standard diaparity” ($\bar{x} \pm s$) as chart 2.

4 Discussion

Motorcycle accident is universal and increasing rapidly every year .The common way to study accidents injury both here and abroad is computer simulant analysis. In our study ,taking real motorcycle as injurious tool, taking animals or dummy persons as objection , the experiment well simulated the motorcycle-pedestrian impact .Since the expense for special laboratory is expensive , there is few research in this field .The newly-built biological impact laboratory by research institute of surgery in Daping hospital of Third military medical university provides good space facility and measure equipment for the development of injury model.

The result showed that the injury model of the motorcycle-pedestrian impact injuries was stable, well-repeated and well-controlled, and 12 cases animal experiments were in control of $\pm 2\%$.Without any related document records in the world, the self-designed tractor,the single track driving system and such injurious model would provide reference developing motorcycle injury model experiment in some way.

The pedestrian dummy animal model proved to have some merits:1. height, weight, and main joints of the model were closed to HypridIII type dummy physical.2. the experimental animals could be easily installed and also picked out.3. the model was low cost and impact-durable. So, to study such accidents injury and develop dummy animal experiment, this model could be regarded as reference to some degree.

Gross observation, microscope examination and the AIS-ISS score results indicated :1.main injured regions of animals were head, thorax and abdomen. 2.different impact velocity caused different injury severity; the injury severity of animals impacted by 50km/h was more than that of the animals impacted by 30km/h when other circumstance were alike.

Traits of this injury model:1.the injury of experimental animals was similar to the injury mechanism of clinical motorcycle-pedestrian impact injury.2.It was instrumental in studying

Table 1 ASS-ISS score of motorcycle-pedestrian impact injury

Animal number	AIS grade				ISS grade
	head	neck	thorax	abdomen and pelvic cavity	
1-D30	1	—	4	—	17
2-D30	4	—	3	1	26
3-D30	3	2	3	—	22
4-D30	4	—	2	2	24
5-D30	3	—	3	1	19
6-D30	4	—	3	1	26
		$\bar{x} \pm s$ (n=6)			22.3±3.7
7-D50	4	2	3	2	33
8-D50	3	1	4	2	30
9-D50	4	—	4	1	33
10-D50	4	—	4	2	36
11-D50	4	—	3	3	34
12- D50	4	—	3	3	34
		$\bar{x} \pm s$ (n=6)			33.3±1.9

Notes: 1. animal codes: experimental animals order-[dog](preconcerted impact velocity)

2. AIS score only choose the number after the point, which is AIS grade

Table 2 Biomechanics parameter of the motorcycle-pedestrian impact experiment

Animal group	impact velocity (km/h)		pulling acceleration (g)	
	preconcerted	real	max	mean
GroupA1	30	29.84±0.11	0.44±0.01	0.14±0.02
GroupA2	50	49.89±0.16	0.46±0.01	0.19±0.03

how to ease or prevent such kind of motorcycle injury.3. the impact spot unanimous, the point of action constant, the impact velocity could be quantized , so the experiment was well-controlled and well-repeated.4.the definite relation between the injury severity of animals and the impact velocity offered a good research model to study different mechanism of pathological and physical changes after the animals being impacted.5.the injury installation of motorcycle-pedestrian and the pedestrian dummy animal model are handy but useful ,which would offer a preliminary technique platform for the research on the occurring mechanism and protective measure of the motorcycle injury.

5 Reference

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