BILATERAL STUDY
100 INJURED PEDESTRIANS
CONNECTION WITH THE VEHICLE

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This is a study of traffic accidents involving pedestrians. With the aim of being able to possibly achieve also a study of the cinematics of the injured pedestrian, we have selected accidents in which both the pedestrian was injured and the vehicle was damaged. We limited the study to accidents between a pedestrian and a four-wheel vehicle.

STUDY OF THE PEDESTRIAN

Importance of the lesions

This study deals with 100 pedestrians injured in 94 accidents of various degrees of seriousness. (Some vehicles ran over several pedestrians at a time and in 2 cases only 1 single pedestrian was involved in an accident with 2 cars).

AIS = 0 ...... 1 pedestrian
AIS = 1 ...... 21 "
AIS = 2 ...... 30 "
AIS = 3 ...... 24 "
AIS = 4 ...... 4 "
AIS = 5 ...... 3 "
AIS = 6 ...... 1 "
AIS = 7 ...... 8 "
AIS = 8 ...... 8 "

None of these injured pedestrians showed an AIS 9, which corresponds to 3 lesions, each being fatal The average severity index for these pedestrians is :

AIS av. = 3.1

This index does not reflect the fact that the pedestrian was hospitalized or not.

Non hospitalized : 31 .... AIS av. = 1.3
Total injured : 81 .... " = 2.1
Hospitalized, non fatal : 50 .... " = 2.7
Total hospitalized : 57 .... " = 3.1
Fatalities : 19 - 12 died on the spot.
- 7 after being admitted to hospital AIS av. = 7.4

Age and Sex

The study concerns 60 males and 40 females. We have thus a slight male preponderance compared with the national figures for 1974 (X) :
Male = 54.4 % Female = 45.6 %

For the males :	....	AIS av. = 3.0
For the females :	....	AIS av. = 3.1

So, the accidents are equally serious whatever the sex.

The ages range from 2 to 90, the average being 351/2. The frequency and importance of the lesions according to the age are as follows :

From age	0 to 9	:	10 pedestrians	- AIS av.	= 2.7
"	10 to 19	:	27 "	- "	= 2.2
"	20 to 29	:	15 "	- "	= 3.9
"	30 to 39	:	8 "	- "	= 2.9
"	40 to 49	:	8 "	- "	= 3.0
"	50 to 59	:	8 "	- "	= 2.9
"	60 to 69	:	7 "	- "	= 4.0
"	70 to 79	:	14 "	- "	= 4.4
"	80 on	:	3 "	- "	= 1.7

Our population range compares with that of injured pedestrians in the whole of France (1) ; in our case however, there is a "peak" mainly between ages 10 and 20. We also notice the small number of middle aged adults who are involved in accidents, and the relative slightness of their lesions compared to those of young adults (aged 20 to 30) and of people of retirement age (over 60). As for the 3 pedestrians in our study who are over 80, their lesions seem to be very slight, but we must say that these persons are systematically taken to hospital on account of their old age, and that on the corresponding vehicles the damage was negligible, such a few scratches on the bodywork.

If we divide our population into almost equal parts corresponding to typical age groups, we note an increase in gravity of the injuries proportionate to the age :

From age	0 to 14	:	28 pedestrians	- AIS av.	= 2.5
"	15 to 29	:	24 "	- "	= 3.1
"	30 to 59	:	24 "	- "	= 2.9
Over 60		:	24 "	- "	= 3.9

This progressive increase is better seen on a graph.

Nationality

In our injured pedestrian population situation, we have found a higher proportion of foreign subjects than in the overall population of the region :

82 pedestrians of French origin	....	AIS av. 3.1
18 pedestrians of foreign origin	....	AIS av. 3.1

So, there are 18 % foreigners in our study, whereas their proportion on a regional scale is only 9.5 % in the Rhone-Alps region (2).

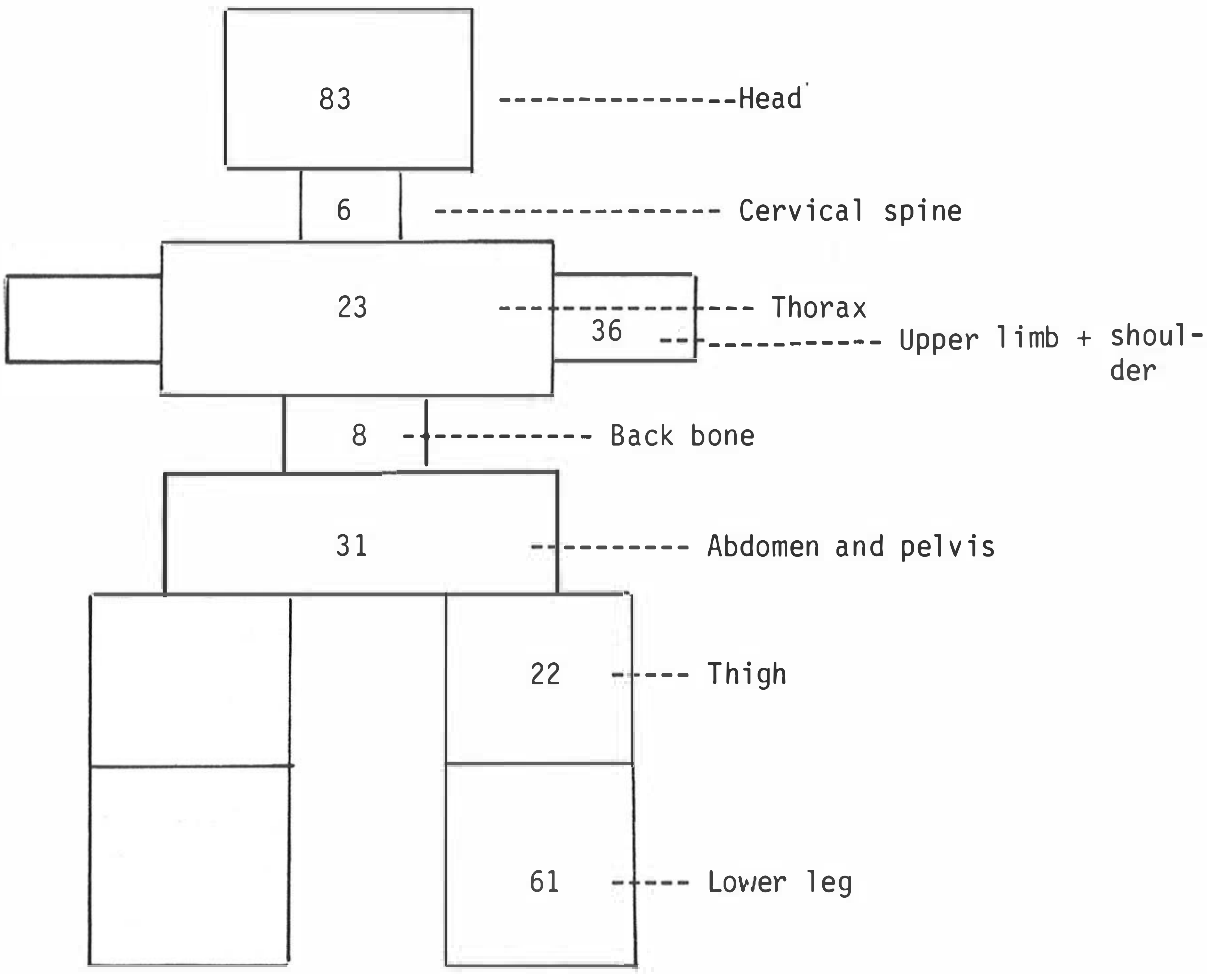
Origin : 10 from Maghreb (North Africa)
5 from Southern Europe (2 from Spain, 2 from Italy, 1 from Yugoslavia)
2 from the Middle East (1 from Turkey, 1 from Israel)
1 from Great Britain

There were 15 males and 3 females.

On the other hand, the gravity itself is not influenced by the national origin of the pedestrian.

Distribution of lesions by anatomical areas

It is classically customary to note that the pedestrian casualty has bipolary injuries : the head and the lower limbs, lesions at the extremities of the body which are easily explained by an overturning motion, followed by projection, the first impact with the vehicle in the lower limbs, followed by a secondary cephalic impact.



In numerical order, the first part affected is the head therefore, the second is represented by the distal part of the lower members, foot, leg and knees.

Certain pedestrians are shorter than others, and, what is more, the car bumpers are not all at the same level, with the result that sometimes the pedestrian is first struck in the thigh. It is curious to note that we find as many lesional impacts in the cephalic extremity as we do in the total lower limb impacts (83/61+22).

In detail, and concerning the parts of the body that have been categorized, here are the injuries :

83 head lesions represent in fact 80 skull injuries,
37 facial lesions,
that is 3 isolated facial injuries

31 injuries to the abdomen and the pelvis are divided in fact into :
20 pelvic lesions
12 abdomen injuries

36 injuries to the upper limbs and shoulders :
25 of an upper limb
13 of the shoulder

Importance of multiple shock

Pedestrian casualties often reveal several lesional impacts :

0 lesional impact	:	1 pedestrian	-	AIS av	= 0
1 "	:	14 "		"	= 2.3
2 "	:	36 "	-	"	= 2.3
3 "	:	29 "	-	"	= 2.8
4 "	:	9 "	-	"	= 5.1
5 "	:	7 "	-	"	= 6.0
6 "	:	4 "	-	"	= 6.5

It will be noted, in all logic, that the gravity of the lesions increases with the number of lesional impacts. It is relatively stable for 1, 2 or 3 impacts and becomes very important beyond 4. However, it must be pointed out that one of the subjects with 6 lesional impacts survived, in spite of extremely serious lesions : skull and facial disjunction, fracture of both bones in one leg, of the shin of the other, of a femur, of a humerus, 3 ribs, and abdominal contusion with a wound of the right hepatic lobe.

It is noteworthy that 52 pedestrians are injured in the typical bipolar fashion, in the head and in the distal lower limb, and that 16 of them were only injured in those two isolated places.

Importance of cephalic injuries

We observe that only 17 pedestrians have no lesions in the cephalic extremity. There is only one death among these victims : a little girl of two, run over on the thorax by a car.

The detailed study of these lesions shows that the pedestrians were often able to protect their cephalic extremity with their upper limbs.

Moreover, the average age of these 17 victims is under that of the others : 25 years old.

Among the 83 victims with head injuries, we can distinguish :

— 80 cerebral injuries :
  - 29 without unconsciousness, one with a fracture of the interior part
  - 23 S.T. with loss of consciousness under 15 minutes
  - 12 S.T. with loss of consciousness over 15 minutes, 2 with fracture
  - 16 S.T. with one fracture, followed by death

— 37 facial lesions
  - 12 fractures, 5 of the nose, 4 of the jaw, 2 of the malar, 1 dislocation
  - The 25 other cases revealed simple or multiple wounds, generally associated with cerebral injuries.

There was a total of 22 fractures of the cephalic extremity, 16 of which were followed by death. On the other hand, none of the facial fractures resulted in death.

So 16 deaths out of 19, that is 84 % were due to skull injuries, isolated in 2 cases. Apart from these 2 cases, and the child mentioned above, all deaths had bipolarity in their lesions.

Anatomo-clinical features

- The bipolarity of the lesions : Head and "distal" lower limb, but sometimes : thigh + head or pelvis + head
or, when the second impact is not cephalic : leg + shoulder or knee + spine

- Almost 1 victim out of 4 has a thoracic lesion : it is generally quite serious : 12 out of 19 died. Especially when the pedestrian is run over by the vehicle : 10 of the pedestrians in our study, with an AIS av. of 6.2.

- The small number of injuries to the cervical column, especially if one makes the comparison with other road injuries, car drivers and car passengers, these lesions of the cervical column are always related to serious skull injuries, generally fractures.

- Fractures of the lower limbs, and especially of the shin are of the linear type, transversal, for they occur due to a direct mechanism.

- Importance and gravity of lesions of the soft parts of the body.

STUDY OF THE VEHICLE

These 100 pedestrian casualties with 96 vehicles during 94 accidents :

- In 2 cases, 3 casualties for 1 single accident
- In 2 cases, 2 casualties for 1 single accident
- In 2 cases, 1 single pedestrian, hit by 1 vehicle, and run over by a second one.

We are not taking into account the fact whether the driver of the vehicle was injured or not during the accident. We consider that, for each casualty, we are dealing with a couple - pedestrian/vehicle : thus the AIS av will refer to the number of injured pedestrians, and not to the number of damaged vehicles. Nevertheless, when a vehicle is involved with several pedestrians, its damages are only registered once. Since there is a specific impact on the bodywork for each pedestrian.

Category of the vehicles

92 light cars	95 casualties	AIS av. = 2.9
2 buses	3 casualties	AIS av. = 5.3
2 trucks	2 casualties	AIS av. = 6.5

The difference in gravity is important, but the number of vehicles of each category is not comparable enough to draw significant conclusions.

Official registered power of the vehicles

We are drawing a comparison between light cars basically.

2CV	= 6 cars	6 pedestrians	including 1 dead	- AIS av.	= 2.7
3CV	= 3 cars	3 "	....	- "	= 2.3
4CV	= 11 cars	11 "	including 3 dead	- "	= 3.3
5CV	= 10 cars	11 "	....	- "	= 2.3
6CV	= 21 cars	21 "	including 2 dead	- "	= 2.8
7CV	= 17 cars	19 "	" 4 "	- "	= 3.2
8CV	= 1 car	1 "	....	- "	= 2.0
9CV	= 10 cars	10 "	including 1 dead	- "	= 2.2
10CV	= 1 car	1 "	who died	- "	= 8.0
11CV	= 7 cars	7 "	including 3 dead	- "	= 4.4
12CV	= 4 cars	4 "	" 1 "	- "	= 3.5
14CV	= 1 car	1 "	....	- "	= 3.0

This table seems to indicate that the gravity increases with the power of the involved vehicles ; in order to better observe this factor we have grouped together different vehicles in series roughly homogeneous to cars that are in competition on the market :

2 - 5 CV	30 cars	31 pedestrians, 4 dead	AIS av=2.7
6 - 8 CV	39 cars	41 pedestrians, 6 dead	AIS av=3.0
Over 8 CV	23 cars	23 pedestrians, 6 dead	AIS av=3.4

Admittedly the difference in gravity between each series is of little importance, but it existe just the same. In fact, it is not so much the real official registered power that is studied here, but the speed of the vehicle which, without being proportionate to it, increases parallel to this power in spite of traffic control in an urban environment.

Origin of the vehicles

Trucks and buses are all of French origin. There are 73 % of the cars of French origin and 19 % of foreign origin.

French origin : AIS av. = 3.0
Foreign origin : AIS av. = 3.6

But it must be noted just the same with the following difference, that foreign made cars have on the average a larger number of cylinders than French made cars. So, in fact this difference in gravity does not seem significant in our opinion. The study of the "power" factor is more significant.

Distribution of damages noted on the vehicles

1) Localisation and types of damage

In order of numerical importance, we have noted :

44 corners of the hood
41 bumpers
39 right front fenders
29 dented hoods
29 broken windshields
23 grills
23 bent tops
21 left front fenders
18 right headlights
10 left headlights
10 right front doors
3 outside rear-view mirors
2 left front doors
2 rear doors
1 exhaust pipe

Several types of damage can only have been caused by one single pedestrian impact ; for example, bumpers and grill, or fender and headlight on the same side. Thus, the 41 bumpers and the 23 grills only represent in fact 44 impacts centered at this level.

In all, out of the 96 vehicles, we have registered 247 impacts. If one takes into account the fact that 25 of our accidents were due to lateral impact, that is to say one single pedestrian impact on one of the sides of the vehicle, there remain 222 impacts corresponding to the 71 vehicles which received a frontal impact, giving an average of 3 impacts per vehicle.

The damaged exhaust pipe belongs to a car which ran over a pedestrian who had been hit by another car : this was the only type of damage noted on this vehicle. Remember that there were 9 cases of being run over, involving 10 pedestrians, 7 of whom were killed.

Types of damage :

a) Dents :

On the parts of bodywork located on a frontal or horizontal plane ;
frontal : front of the vehicle, or sides ;
horizontal : hood or top.
These dents measured between 1/2 cm and 33 cm. The deepest were noted on the hood and correspond most frequently to heavy impacts during which the pedestrian, after being thrown by the first impact against the front of the vehicle, fell heavily on the hood from which he could possibly rebound on to the windshield or fall directly on the ground.

Accidents in which the hood was dented : AIS av. = 3.8
Other accidents : .... : AIS av. = 2.9

b) Scratches :

Especially in cases of impact with one of the sides of the vehicle. All on a sagittal plane, on the fenders and doors.

c) Broken glass :

- Windshields
- Headlights and direction signals : there were 28 cases of broken headlights ; 25 of the pedestrians involved in these accidents revealed wounds in the lower limbs : 20 knee wounds, more or less deep, 5 cases of thigh wounds.
- Outside rear view mirrors : in 3 cases in our study. In general during a side impact. They produce lesions in the form of very localized contusions in the back and upper limb, easily detected during questioning and the clinical examination of the pedestrian casualty.

2) Importance of frontal impact

It is logical to observe that it is the front of the vehicle that is most often damaged ; and more frequently the right side than the left side :

39 right front fenders	18 R. headlights	10 R.F. doors
21 L.F. fenders	10 L. headlights	2 L.F. doors

From detailed observation, we note that among the 44 corners of the hood damaged, 18 are damaged without any damages to the bumpers or grill. So, the first contact with the pedestrian occurred at this particular corner of the hood.

In fact, we have 62 impacts centered on the front of the vehicle :
41 twisted bumpers, 30 of which with the grill intact.
23 grills damaged, 14 with the bumper intact.
44 twisted corners of the hood, 18 of which with the bumper and grill undamaged.
During certain very violent impacts, the three parts were affected. This was true for 14 damaged vehicles ; the AIS av. for the pedestrians involved in these cases was 3.7.

3) The windshield

The impact against the front of the car is only the beginning of a trajectory which, in fifty per cent of the cases, will end up against the windshield.

71 impacts centered on the front of the vehicles :

- 32 cases in which no damage to the windshield, the top or the roof,
- 26 windshields broken,
- 13 cases in which the windshield was undamaged, but the top or the roof was twisted,

with a total of 39 pedestrians thrown against the windshield.

In all, there were 29 windshields broken, 28 by the pedestrian and 1 by the driver of the vehicle. Among the 28 windshields, 2 were broken in lateral impact, and, as we have already mentioned, the other 26 in frontal impact. There were 22 made of tempered glass, and 7 of laminated glass.

- Laminated : 7 accidents .... 8 pedestrians, 3 killed, AIS av. = 4.4
- Tempered : 22 accidents .... 22 pedestrians, 8 killed, AIS av. = 4.5

So, no difference, and in both cases, just over one third of the casualties died. In general, therefore, they are very serious accidents.

4) The shape of the vehicle

Our aim was to verify the assertions made in certain studies carried out in the laboratory with dummies (3,4) according to which the height of the front of the vehicle and the length of the hood had an influence on the gravity of the accident, in view of the facilitation of the pedestrian's course.

We looked for those relations in light of the windshields that were broken, damage to the corner of the hood, the dents in the hood, and damages noted on the top and the roof : but to no avail. In all the types of vehicles, we found both that vehicles had very different morphological features and generally speaking, the difference between the gravity of the lesions of the pedestrians involved was in the order of 0.2, that is to say not significant for a small number of cars.

Moreover, we frequently lacked information on the height of the pedestrians, and consequently had no knowledge of the height of the lesions observed in relation to the ground, in order to be able to compare with the damages noted on the cars.

STUDY OF THE CIRCUMSTANCES OF THE ACCIDENT

Time-frame

We have calculated the number of pedestrian casualties by periods of two hours, and the seriousness of their lesions.

from 6:00 to 8:00	....	10 pedestrians - AIS av.	= 2.9
from 8:00 to 10:00	....	7 - "	= 1.6
from 10:00 to 12:00	....	8 " - "	= 2.8
from 12:00 to 14:00	....	12 " - "	= 3.3
from 14:00 to 16:00	....	14 " - "	= 2.1
from 16:00 to 18:00	....	11 " - "	= 2.6
from 18:00 to 20:00	....	21 " - "	= 3.3
from 20:00 to 22:00	....	11 " - "	= 4.5
from 22:00 to 6:00	....	6 " - "	= 5.7

So accidents are most numerous in the evening at the close of business in offices and factories ; they were most serious at night and in rush hour for pedestrian traffic, in the morning between 6 a.m and 8 a.m, at noon, between 12 an 2 p.m and in the evening. Moreover, in the winter, it is dark at the close of work, which explains why we attempted to differentiate these accidents based on daylight.

58 pedestrians injured in daylight .... AIS av. = 2.6
42 " " at night .... " = 4.0

So, the difference is very significant. And we also noted :

In daylight hours, 5 killed for a total of 58 casualties, = 8.6 %
At night-time, 14 " " 42 " , = 33.3 %

There is 1 fatality for 12 pedestrians injured during the day,
There is 1 fatality for 3 pedestrians injured at night.

Road conditions

19 accidents on dry roads .... AIS av. = 2.9
75 accidents on wet roads .... AIS av. = 4.1

In addition we can combine this factor with the preceding one :

Day-time, dry road :
49 accidents, 55 pedestrians involved (5 killed) ... AIS av. = 2.5

Day-time, wet road :
3 accidents, 3 pedestrians involved (0 killed) .... AIS av. = 2.3

Night-time, dry road :
26 accidents, 26 pedestrians involved (7 killed) ... AIS av. = 3.7

Night-time, wet road :
16 accidents, 16 pedestrians involved (7 killed) ... AIS av. = 4.4

We may say then that, overall, the accidents are more serious at night than in daylight, and all the more,so if the road surface is wet, in other words slippery. It may be noted in passing, that all accidents involving several pedestrians with one single vehicle occurred on a dry road in daylight.

Existence of pedestrian crossings, traffic lights

Only 23 pedestrians in our study were injured on a pedestrian crossing which in 12 cases was located near an intersection equipped with traffic lights: only once did the pedestrian cross when the light was green for oncoming traffic.

If these accidents on pedestrian crossings are as serious as the other accidents as far as the gravity of the casualties' lesions are concerned, they are on the other hand far less fatal, by one half :

12 % killed on pedestrian crossings
25 % on the highway.

It must be pointed out here that 8 of our pedestrian casualties were injured on a sidewalk.

Location of the accident

1) Classification

Main thoroughfares (urban) :	38 accidents,	41 pedestrians,	8 killed,	AIS av. 3.1
Medium to secondary streets :	29 "	, 30 "	, 3 "	, AIS av. 2.8
Intersections :	20 "	, 22 "	, 1 "	, AIS av. 2.1
Outside urban areas :	7 "	, 7 "	, 7 "	, AIS av. 7.6

In accidents classified as "outside urban area", we have placed those occuring on suburban highways, on which the speed limit is no longer 60 kph (36 mph), but more often 80 kph (50 mph) and on which cars tend to travel in excess of the speed limit.

Accidents seem to be less serious at intersections ; the speed of traffic is in fact the lowest in such cases. On main thoroughfares, where the speed is frequently in excess of the authorized 60 kph (36 mph) speed limit, accidents are more serious. As for suburban highways, there is no point in making any comment.

2) One-way streets

Main thoroughfares :				
- two-way traffic :	21 accidents,	21 pedestrians,	2 killed,	AIS av. = 2.8
- one-way traffic :	10 "	12 "	, 3 "	, AIS av. = 3.4
- with priority lane :	7 "	8 "	, 2 "	, AIS av. = 3.4
Medium-secondary roads				
- two-way traffic :	25 "	26 "	, 2 "	, AIS av. = 2.7
- one-way traffic :	4 "	4 "	2 "	, AIS av. = 4.0
Intersections :				
- two way traffic :	17 "	19 "	1 "	, AIS av. = 2.1
- two-lane one-way :	3 "	3 "	0 "	, AIS av. = 2.0

In the case of highways outside the urban area, they are generally very wide with a solid white line down the middle, so that we may consider them as one-way roads as well.

Total :	Two-way traffic :	66 accidents	
		69 casualties	AIS av. = 2.5
		5 dead	
	One-way traffic :	28 accidents	
		31 casualties	AIS av. = 4.4
		12 dead	

The gravity of accidents involving pedestrians is thus definitely higher in one-way streets. The speed of traffic increases considerably also as soon as there is one way traffic. We may add that the speed of automobile traffic is a very important factor in pedestrian accidents.
We may observe that the creation of priority traffic lanes for public transportation on main roads does not seem to increase the seriousness of accidents. However, 2 of those killed were knocked down by a bus in one of these priority lanes.

Movements of pedestrians at moment of impact

5 were stationary	; 3 killed	....	AIS av. = 5.2
54 were walking	; 11 killed	....	AIS av. = 3.1
39 were running	; 4 killed	....	AIS av. = 2.7

It is also noteworthy that the average age of those running is 27, whereas that of those walking is close to 40. Age does not affect the desire to run, but it permits greater suppleness at the moment of impact, and it is undoubtedly far more the phenomenon of dodging the vehicle that counts, than the age or type of movement.

One of the pedestrians injured while stationary was seated right in the middle of a badly lit suburban road, with the purpose of committing suicide.

Direction of travel of the pedestrian in relation to the vehicle

L. to R. : 29 pedestrians - AIS av. = 3.1
R. to L. : 58 pedestrians - AIS av. = 2.7
In addition, 5 pedestrians were proceeding in the same direction as the vehicle, (2 killed).
1 was going in the opposite direction (killed)
1 was sitting in the middle of the road, as we have already mentioned.
In 6 cases, the direction of the pedestrian could not be determined.

Position of pedestrian at time of impact

On left side :	51 pedestrians,	7 killed,	....	AIS av. = 2.7
On right side :	30 pedestrians,	4 killed,	....	AIS av. = 2.9
From behind :	10 pedestrians,	4 killed,	....	AIS av. = 4.7
From front :	7 pedestrians,	3 killed,	....	AIS av. = 4.1

So, there is no difference in seriousness of injury from one side or another. On the other hand, when the pedestrian is hit from behind or in front, he is taken by surprise and is possibly more off balance : it is in such cases that there is the largest variety of damages to the vehicle, and the greatest number of lesional impacts on the pedestrian casualty.

Pedestrian carrying an object

There were 18 pedestrians carrying an object in their hands at the time of the accident. 50 were not carrying anything, and in 32 cases this point is not mentioned.

AIS av. of people carrying objects : 2.7

In other words, this factor is not very significant in relation to the rest of the pedestrians. It must be pointed out that, in one case, the bicycle being pushed by a child caused more damage to the vehicle than the pedestrian did.

Vehicle attempts to avoid collision : braking

Attempts to avoid were noted in 5 % of the cases ; there were skid marks in 31 accidents, while 37 drivers claimed they had applied their brakes.

The 37 accidents involved, 41 pedestrians with AIS av. of 3.2, that is comparable to the total population under consideration.

The length of the skid marks varies from 2 to 35 metres, and in 2 cases there is a difference in length for each side.

In 2 cases, the pedestrian was dragged by the car : one of these 2 pedestrians was a child of 7, who, after the first impact, slipped under the car ; when the vehicle stopped, 7.5 metres further on, the child was at the level of the rear wheels, without being run over.

STUDY OF THE RELATION PEDESTRIAN/VEHICLE

Our purpose is to study how an accident occurs per se, in the light of the statements of the injured pedestrian and of the driver of the vehicle involved.

Thus we have been able to define roughly two kinds of impact between pedestrian and vehicle : frontal impact and lateral impact.

In our study there were :
75 cases of frontal impact : 18 killed - AIS av. = 3.4
25 cases of lateral impact : 1 killed - AIS av. = 2.2

We immediately note the distinct difference of gravity between the two types of accident, from the point of view of gravity of lesions.

The death we registered from lateral impact was due to a truck which, after hitting the pedestrian on its L.F. door, ran over him with its rear wheels. It should be pointed out in this respect that the truck-driver was under the influence of alcohol.

Mechanics

In the most typical case, the pedestrian is struck in the leg by the front bumper of the car. He loses his balance and strikes the edge of the hood. This second impact thus becomes a sort of fulcrum for a swinging motion followed by projection.

The course thus set forces the pedestrian either on to the hood (dented) or against the top (twisted) or the windshield, which tends to break if the impact is too heavy.

The pedestrian may, then, after contact of his head with the windshield, either fall on the ground, or rebound towards the top, or back on to the hood.

Physio-pathology of lesions

During this course, the pedestrian can sustain several lesions, while there is damage to the vehicle. The leg is the first part to be affected upon impact with the front of the car. There is a correlation between the 61 cases involving the "distal" part of the lower limbs and the 23 grills and the 41 bumpers damaged.

The next parts of the body liable to sustain lesions are the thigh and the pelvis, against the edge of the hood. We find 22 pedestrian thigh injuries and 20 lesions of the pelvis, compared with 44 twisted hood edges.

The shoulder, the upper limb, the back or the head may be subject to lesions in impacts with the hood, the roof or top, after projection. Thus we find on the one hand, 13 injuries to the shoulder-bone and 8 to the dorso-lumber column, and on the other hand, 23 cases of damage to the roof or top of the vehicles.

The head is exposed to injuries at any time, in impact with the hood, the top, the windshield, and the ground in the case of a fall. So it is not possible for this part of the body to be used in comparative figures concerning pedestrian lesions and vehicle damage.

On the other hand, one can correlate the 26 broken windshields with the 24 pedestrians involved in these accidents suffering typical windshield injuries due to glass particles.

Study of typical impacts in our inquiry

Let us begin with the 41 vehicles with bumper damage ; among the pedestrians involved in these vehicles, there are 38 with injuries to the distal part of the lower limb. In the same 41 vehicles, we find 26 with the hood edge damaged, corresponding to 23 lesions of the pelvis or thigh to the pedestrians involved.

Among these 26 vehicles, 17 had a broken windshield ; as for the preceding, 23 pedestrians, 20 of them also had concussion, 16 loss of consciousness, 8 were injured in the shoulder-bone or an upper limb.

So we observe that out of 41 pedestrians in our study who were hit in the leg or knee by the bumper, 20, that is one half, followed the course described above.

Lateral impact

We have seen that these impacts are far less serious than the others. Generally, one finds only one impact due to the pedestrian, who then falls on the ground.

Role played by environment

Whether the accident involves frontal or lateral impact, the fall on the highway plays an essential role in the seriousness of the lesions.

Out of the 100 pedestrians in our study :

- 1 was uninjured, whereas the vehicle showed a slight dent in the door (Buttocks)
- 9 had lesions due solely to a fall (AIS av. = 2.1)
- 27 had lesions due solely to contact with the vehicle (AIS av.=2.8)
- 63 had lesions due to both the vehicle and the environment (AIS av. = 3.4).

Those who have lesions only due to their falling to the ground are no more hurt than if they fell over. There is not a single death among these 9 pedestrians.

Pedestrians with lesions due solely to the vehicle are more seriously injured, but when both factors coincide, the pedestrian being thrown to the ground after sustaining lesions from the first contact with the vehicle, the Abbreviated Injury Scale average is much higher.

Behaviour of the pedestrian

Right at the outset, it must be pointed out that some individuals choose this kind of accident to commit suicide : such was the case for 2 pedestrians in our study. An elderly woman, already mentioned previously, and a young man of 27, who was incidentally under treatment in a psychiatric center, and was merely injured.

We have seen that for the others, only 23 % were on a pedestrian crossing. This is a typical French phenomenon, and in the Federal Republic of Germany, for instance, this does not hold true ; and yet the highway code is not very different from ours , but presumably it is much better respected (5).

The pedestrian refuses more or less to obey a code which he considers exclusively applicable to automobiles. Moreover, when he happens to use one of the pedestrian crossings, he tends to believe that they give him a priority that is inviolable. But when perchance the same pedestrian gets into his car, he adopts a completely different attitude !

REFERENCES

(1) - SETRA (Ministère de l'Equipement) : Accidents corporels de la circulation routière en 1974

(2) - INSEE : Les dossiers de l'INSEE Rhône-Alpes : Santé, Sept 1975

(3) - A. KHUNEL : Vehicles-pedestrian Collision Experiment with the use of moving dummy. (Institute of Automotive Engineering, Berlin) Proceeding of the 18th annual meeting A.A.A.M. Sept. 1975

(4) - TANEDA K. and Al. : Experiments on Passenger Car and Pedestrian Dummy collision. Comité sur les Défis de la Société Moderne. Rapport N° 27 du C.D.S.M. Sept 1972

(5) - HARTEMANN F., TARRIERE C. : Synthèse des données statistiques sur les accidents du trafic en France, Allemagne Fédérale, Italie et Grande-Bretagne. Communication à la 5e conférence internationale sur les véhicules expérimentaux de sécurité, E.S.V. Londres, Juin 1974.