FREQUENCY AND SEVERITY OF HEAD AND NECK INJURIES AS A FUNCTION OF TYPES OF TRAFFIC USERS

G. Vallet - M. Ramet
Organisme National de Sécurité Routière
Laboratoire des Chocs et de Biomécanique

1 - INTRODUCTION

A lesional typology investigation concerning the road traffic accidents were realised in order to have "the picture" of the injured during a given period of time.

This study was in progress for two years and we collected 5459 files. Several hospitals, in particular from Nîmes, Lyon, Salon-de-Provence and Annecy, provided these files for our collection.

1.1 - Aim of Study

This study allowed to obtain, during a short time, injury an typology of traffic accident victims. This study indicated the trends at the medical level, what suffered the traffic users during a definite time. The aim is to repeat this study, with intervals which be precised in order to observe the eventual lesional modifications of the injury due distribution to different arrangements of vehicles.

1.2 - Methodology

In first, we have to precise the way we execute this information collection. This collection being essentially of medical nature, we contacted the emergency care mobile units (SAMU, SMUR...) of several hospitals in order to fill up an information docket for all traffic injured (pedestrians, two-wheeler users, motorists...) as well uninjured as dead. So, we collected 5459 files concerning all types of injured people from 0 to 94 years old. The quality of these files allowed to obtain very precise informations as well in medical nature as obstacle type, road type, accident place. Concerning safety equipments (safety belts, helmets), the informations are less sure. We have to point out that we have no information on vehicle deformations.

1.3 - Sample characteristics

Table 1 give the distribution of 5459 files by type of users.

Type of users	Numbers
car occupants	3.066
light van occupants	92
truck occupants	72
bicycle users	315
two-wheelers users (< 125 cc)	920
two-wheelers users (> 125 cc)	512
pedestrians	492

Table 1 : Injured people distribution

If we consider the sex distribution as it is indicated in table 2, we can see an equal risk for male or female pedestrians. But, for the other users, males are more often injured than females, this is especially clear for powered two-wheels users.

The males are twice more involved in traffic accidents than females and our data are similar to those of French National Statistics (1). We notice that pregnant women are involved in 4,5 % of cases.

Type of users	Nb of males	%	Nb of females	%
car occupants	1.803	58,8	1209 + 54*	41,2
light van occupants	72	78,3	20	21,7
truck occupants	64	88,9	8	11,1
bicycle users	220	69,8	83 + 12*	30,2
two-wheelers users (< 125 cc)	680	74,9	223 + 8*	25,1
two-wheelers users (> 125 cc)	426	83,2	82 + 4*	16,8
pedestrians	262	54,5	212 + 8*	45,8
Total	3.536	64,8	1837 + 86*	35,2

* pregnant women

Table 2 : Sex distribution

Age distribution is illustrated by figure 1. It appears that the age classes of 15 to 20 years old and 20 to 25 years old injured people are the most represented, respectively 19,9 % and 19,6 % of the complete data whereas these age ranges represent respectively 8,0 % and 7,8 % of the french population (2). At the opposite side, the age class of 25 to 50 years old injured people represent the third of the total data and are also the third of all the population in this class. In consequence the people of 15 to 25 years old represent a high risk population.

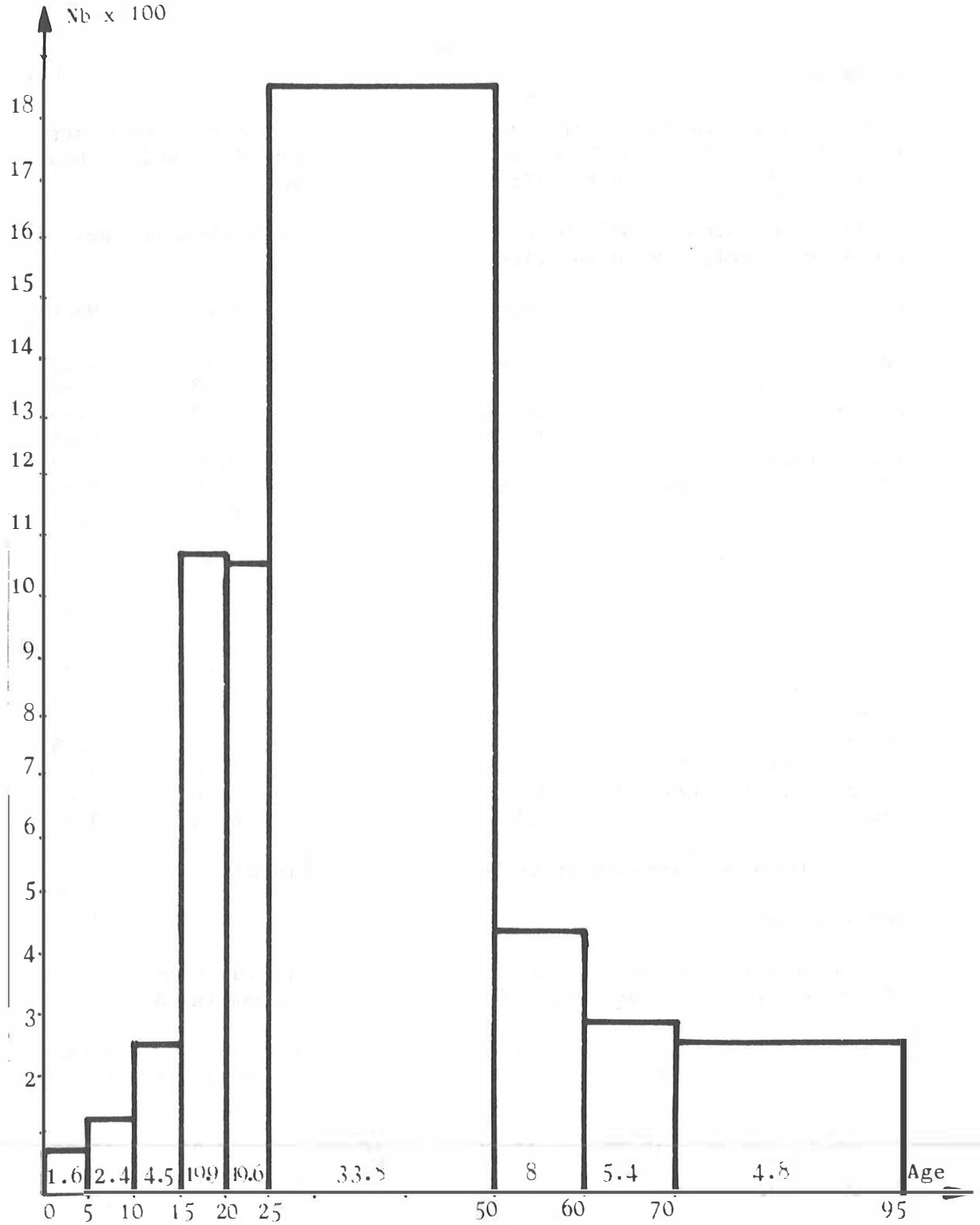

Figure 1 : Age distribution of victims in all accident types

2 - CEPHALIC AND CERVICAL LESIONS

We have defined four parts : the head (skull and brain), the face, the eyes and the neck.

Tables 3 and 4 indicate the average number of lesions for each body segment defined before. These results are draw out in appendix A which shows the lesional typology for each traffic injured user type.

Table 3 takes into account all lesions (AIS 1 to 6) (3) whereas table 4 takes into account only severe injuries (AIS $\geqslant$ 3).

Type of users	Head	Face	Eye	Neck
car occupants	16.01	18.82	1.17	6.99
light van occupants	18.71	15.2	0.58	4.68
truck occupants	14.06	16.41	0	7.03
bicycle users	15.74	13.06	0	2.68
two-wheelers users ($<$ 125 cc)	10.86	13.92	0.36	2.62
two-wheelers users ($>$ 125 cc)	7.81	8.02	0.52	2.29
pedestrians	18.35	14.12	0.98	2.06

Table 3 : lesions distribution all severities (in %)

Type of users	Head	Face	Eye	Neck
car occupants	13.46	4.39	0.5	6.48
light van occupants	10.87	2.17	0	2.17
truck occupants	15.15	0	0	9.09
bicycle users	24.74	3.09	0	2.06
two-wheelers users ($<$ 125 cc)	13.33	3.56	0	3.11
two-wheelers users ($>$ 125 cc)	13.37	4.46	0	2.48
pedestrians	19.5	1.24	0.83	3.73

Table 4 : lesions distribution AIS $\geqslant$ 3 (in %)

2.1 - Head injuries

The table 5 indicates the percentage of head injuries in function of total number of lesions for each user type, for all severities and for AIS $\geqslant$ 3.

	car occup.	light van occup.	truck occup.	bicyclists users	two-wheelers users	two-wheelers users	pedestrians
all severity	16.1	18.71	14.06	15.74	10.86	7.81	18.35
AIS $\geqslant$ 3	13.46	10.87	15.15	24.74	13.33	13.37	19.15

Table 5 : Percentage of head injuries as a function of total number of lesions for each type user (all severities and AIS $\geqslant$ 3).

Considering all severities, we note that the user types the more injured to the head are the car users, the light van users and the pedestrians. But at the head level, the AIS 1 and 2 injuries represent very slight lesions (wounds, trauma with slight inconsciousness less 15 mn) or minor fractures. These injuries are exceptional in one sample. It it more right to consider the AIS 3 injuries in order to evaluate the sustained damages by the different user types. So, we note that for the car and light van users, the head lesion percentage decreases if we consider AIS $\geqslant$ 3 lésions instead of all severity lesions. This situation is reversed in all the other cases, particularly concerning the bicyclists because of helmet absence. This situation is also clear concerning two wheeler motorised users and we remark that the difference is more important for big engine displacement two-wheeler users though the helmet wearing is more important ($>$ 90 %) and these users sustain very violent impacts. The table 6 gives the distribution of different skull and brain lesions in fonction of user types.

	Lacer.	base fract.	temp. fract.	front. fract.	pariet. fract.	occip. fract.	crush brain injury	cereb. hemorr.
car occ.	657	6	19	20	11	13	76	12
light van occ.	26	0	1	0	0	0	4	0
truck occ.	12	1	0	0	0	0	4	0
bicycle users	58	0	9	2	3	4	7	3
2 wheeler users ($<$ 125 cc)	139	0	10	4	2	3	18	1
2 wheeler users ($>$ 125 cc)	40	1	7	1	2	2	16	3
pedestrians	104	1	6	6	9	6	30	4

Table 6 : Numbers of skull and brain lesions

2.1.1 - The car occupants

The table 5 (above) shows that the car occupants are less frequently injured at level of skull than the light van occupants but they are injured more severely. In fact, the table 6 shows there are many head injuries with cerebral dilaceration as they represent 9 % of all severity lesions or 56 % of AIS $\geqslant$ 3 lesions.

We remark also many temporal and frontal fractures. They represent 62 % of head fractures without cerebral dilaceration.
Most of these fractures result from head impact against windshield or dashboard but also against windshield pillar. The head wounds are frequent (1/5 of car occupants). They result from impact against windshield and frequently because of the absence seat belt wearing.

2.1.2 - Light van and truck occupants

Our sample being poor for this user type, we studied some particular cases. We noted a similar behaviour of these two types of vehicles with severity notion of "all or nothing". We noted slight wounds and crush brain (table 6). These crushes result from head impact against the pillars or against the elements penetrating into the compartment (crushing of cab) and also during ejections. The ejections are numerous and due to large glasses and doors. We remind that seat belt is non-existent in trucks and in the light vans when the seat-belt is present, it is no frequently used.

2.1.3 - Two-wheeler users

Concerning the bicyclists, we remark that head lesions represent about 1/4 of severe injuries. Among these lesions we note many temporal fractures and crushes. These injuries are due to fall on ground. The head wounds are often slight.

Considering the two wheeler motorised users, it appears that the head wounds are more numerous for the little cubic capacity two-wheeler users, respectively 76 % and 53 % of head wounds. This is explained essentially by the percentage difference of all severity lesions (table 6).

The severe lesions percentage is identical in the two groups (table 5) and even in the lesion distribution (table 6) particularly for temporal fractures and the crushes. The difference at level of wounds is explained by the helmet wearing rate difference, which is less important for the little cubic capacity two wheeler users. This difference is reduced by the impact speeds more important for the big cubic capacity two wheeler, explaining the likeness of crushes number and head fractures. These remarks corroborate the Dedoyan's report (4) concerning the impact location (temporal particularly) and the efficiency or the reliability limits of helmet during very severe impacts.

2.1.4 - Pedestrians

The pedestrians are frequently injured at head level. They take place just after the bicyclists concerning the severe lesions (20 %). The table 6 shows that the crushes represent 64 % of these severe injuries. These lesions are due to impact against the stiff parts of car : windshield frame, upper part of bonnet, and so on... some fractures, particularly occipital, and also numerous wounds are due to secondary fall on ground.

2.2 - Face lesions

The table 7 indicates the pourcentage of face injuries in fonction of total number of lesions for each user type, for all severity and for AIS $\geqslant$ 3.

	car occup.	light van occup.	truck occup.	bicyclists users	two-wheelers users	two-wheelers users	pedestrians
all severity	18.83	15.2	16.41	13.06	13.92	8.02	14.12
AIS $\geq$ 3	4.39	2.17	0	3.09	3.56	4.46	1.24

Table 7 : percentage of face injuries in function of total number of lesions for each user type

The facial lesions are frequent in all type users, except among the big cubic capactity two wheeler users because helmet wearing. Generally these lesions are not very severe. Their distribution is given in table 8.

	Lacer.	Nose fract.	Mandib. fract.	Facial massif fract.	Pyramidal fract.
car occ.	777	99	38	48	8
light van occ.	23	2	0	1	0
truck occ.	15	5	0	0	0
bicycle users	60	5	1	5	1
2 wheeler users ($<$ 125 cc)	175	25	11	17	2
2 wheeler users ($>$ 125 cc)	50	10	4	8	4
pedestrians	97	16	1	12	1

Table 8 : Number of facial lesions

2.2.1 - The car occupants

The car occupants are frequently injured at level of the face : generally these lesions are wounds (80 % of lesions). These wounds are due to windshield impacts. This is corroborated by a previous study which explains the high frequency of skull face lesions among the motorists by the seatbelt wearing decrease (5). The table 7 indicates also that the car occupants are the most severely injured at face among the road users. Effectively we note 4,4 % of AIS $\geq$ 3 lesions. These lesions correspond essentially to facial massif fractures and pyramidal fractures due to center of steering wheel and the top of dashboard impacts but also due to impacts on external obstacles penetrating in compartment of vehicle (rigid fixed obstacles, truck rears).

We find again an important number of nose fractures (10 %). These lesion types are noted also among restrained occupants. This is explained by a steering column movement too important on some vehicles or by an incorrect seat-belt wearing (for instance lap-belt not enough tightened) and, during a violent impact by the cephalic segment rotation around of shoulder belt.

2.2.2 - Light vans and trucks users

Our sample collected only slight lesions except one facial massif fracture.

2.2.3 - Two wheeler users

For the bicyclists, face lesions are frequent but not severe. The wounds are due generally to fall on ground. On the other hand the severe lesions (facial massif fracture, pyramidal fracture) are due often to impact against obstacle, generally antagonist vehicles, and sometimes fixed rigid obstacles (different types of pole, curb of pavement).

Table 8 shows that the $<$ 125 cc two wheeler users suffer injuries like those of bicyclists with increase of severity due to a generally greater speed. The helmet is a generally an open face helmet which does not protect the face.

In addition, we remark that in this user type, the helmet is not always worn (60 %) (state police force statistics).

The $>$ 125 cc two wheeler users suffer scarcely face lesions but they are severe. The pyramidal fractures represent the half of those and this lesion type is induced by an important energy. These injuries proceed from impact speed in spite of more important helmet wearing rate (90 %).

2.2.4 - Pedestrians

The injuries concerning pedestrians are slight and are localised at face.

All face lesions represent 14 % of all body lesions, but severe face lesions represent only 1,24 % of severe body lesions (table 7). Among these severe lesions we note particularly nose fractures and facial massif fractures. These injuries are due, in the most of cases, to falling on ground. Concerning some lacerations, the falling ground is also the cause of these injuries.

Effectively, the vehicle is not responsible of this type of lesions, because the pedestrian impact happened laterally or by back.

2.3 - Eye lesions

These injuries are very exceptional and due to windscreen shock but there are only 7 eyeball wounds (AIS $\geqslant$ 3). Five of these wounds were in car occupants and two on pedestrians, this corresponding to 0,1 % of severe injuries almost the traffic victims in our investigation.

2.4 - Neck injuries

Table 9 gives the "percentage of neck injuries in fonction of total number of lesions for each user type for all severities and for AIS $\geqslant$ 3 .

	car occup.	light van occup.	truck occup.	bicyclists users	two-wheelers users	two-wheelers users	pedes-trians
all severity	6.99	4.58	7.03	2.68	2.62	2.29	2.06
AIS $\geqslant$ 3	6.48	2.17	9.09	2.06	3.11	2.48	3.73

Table 9 : Percentage of neck injuries in fonction of total number of lesions for each user type for all severities and for AIS $\geqslant$ 3.

The neck is a body segment injured particularly among car and lorries occupants. The severe neck injury are not very frequent but the disability risks are important. Table 10 shows the lesion distribution.

	Lacer.	disloc. (*)	disloc. (**)	fract. (*)	fract. (**)	vascul. and/or nerve root avuls
car occ.	70	187	7	62	15	8
light van occ.	2	2	0	0	1	0
truck occ.	1	3	1	1	3	0
bicycle users	3	7	1	4	0	1
2 wheeler users ($<$ 125 cc)	10	25	0	7	2	2
2 wheeler users ($>$ 125 cc)	5	9	0	5	1	2
pedestrians	0	10	1	6	5	0

Table 10 : Number of neck injuries

(*) : without neurological trouble
(**) : with neurological troubles

2.4.1 - Car occupants

The car occupants are among the injured the more wounded but that no very often. This neck lesions represent 7 % of lesion entirety, and are very severe. If we consider the table 10, we note 77 fractures which represent 20 % of neck injuries whom 1/5 with associated neurological troubles. The neck dislocations are rarely aggravated by neurological troubles (2 % of cases).

These injuries are due to hyperflexion round seat belt or hyperextension motion when the head strikes the windscreen, or the association of both (whiplash). The rear impact is rarely the cause of these injuries.

Some neck small abrasions are due to seat-belt rubbing when it is not adjusted to the occupant height. Some cases of vascular and nerve root avulsions (2 %) appear in complex and very violent impacts.

2.4.2 - Light van occupants

The light van occupants are rarely injured at this level, contrary to truck occupants who suffer severe injuries (fractures with neurological troubles) which are due to rollover and to the frequent ejection for this type of user (6).

2.4.3 - Two-wheeler users

Considering the table 10, we note an evident likeness between the lesion distribution of the three two wheeler user types. Effectively, we remark a high frequency of cervical spine dislocation which represent about 50 % of neck lesions. We notice also some vascular and nerve root avulsions among the user types. This is due to falling in ground mechanism : first shoulder impacts the ground, secondary the head strikes in forced lateral extension movement (7).

2.4.4 - Pedestrians

The pedestrians an not frequently but severly injured at this level. We note as many cervical fractures as cervical dislocations. Theses dislocations are rarely associated with neurological troubles, contrary with the cervical fractures of which the half is associated with neurological troubles. These injuries are due to falling in ground.

3 - CONCLUSION

The cephalic extremity lesions (head + neck) of AIS $\geqslant 3$ are frequent for all road traffic users (appendix B). Effectively, they represent from 15 % of light van user lesions to 30 % for the bicycle users.

On the other hand, we note that contrary to "bicycle users" who are vulnerable, the other motor two wheels users are less frequently injured, this is due to helmet wearing.

The likeness of severity for the two motor two-wheeler user categories is explainable because the big cubic capacity two-wheeler users drive very fastly, the drivers and passengers wear often an helmet, generally of good quality, providing a real and efficient head protection.

We note that cephalic lesion is frequent to the pedestrians (head-leg binomial) which is explained as well by the impact on struck vehicle as by secondary falls on ground.

On the other hand, we note a light difference between car occupants an light van occupants. We can deduce that cars and vans have not the same behaviour and this difference is more clear because the seat belt wearing is non-existent in the light vans.

We remark that the frequency and severity of head-neck lesions is important on road traffic users in spite of protection devices such as helmet or seat-belt.

ACKNOWLEGEMENT

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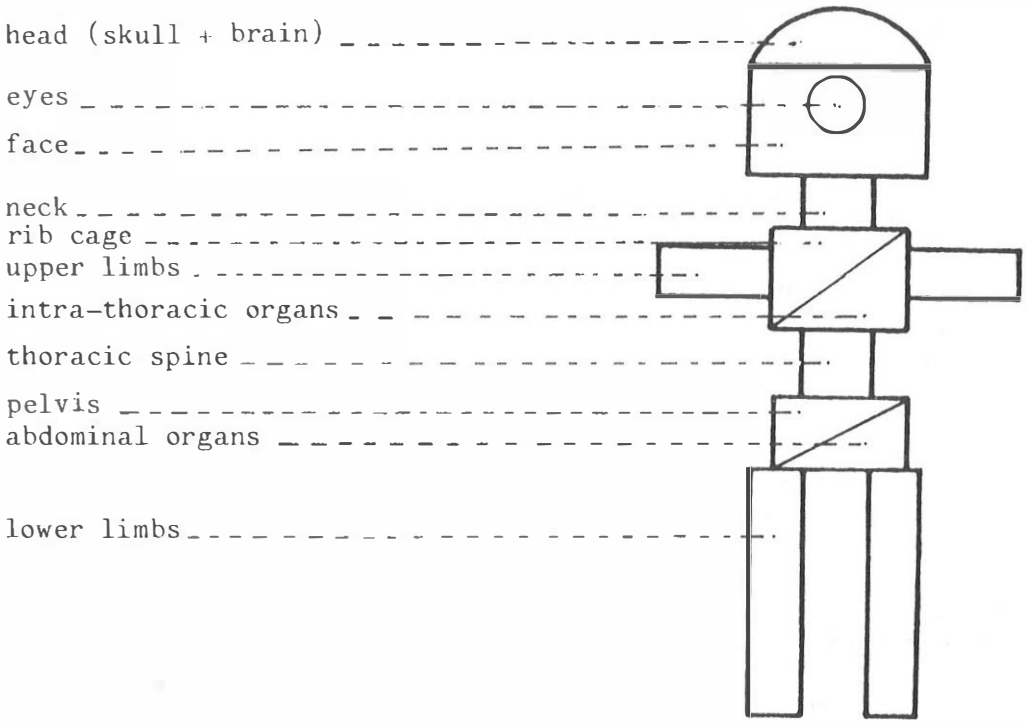
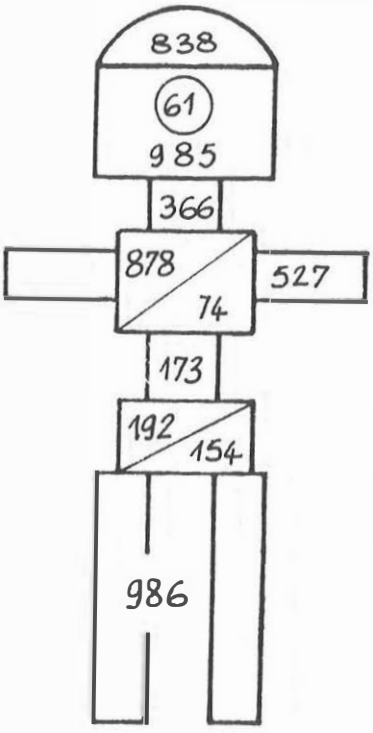
APPENDIX A



Considered different body segments



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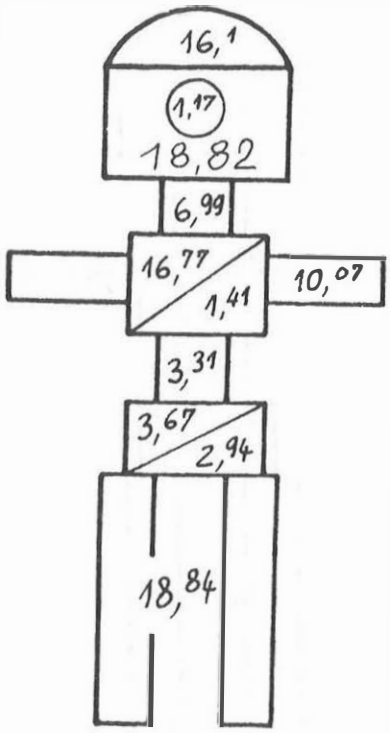
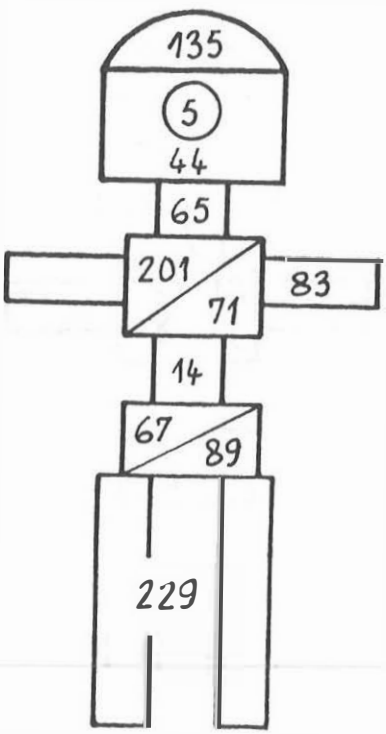
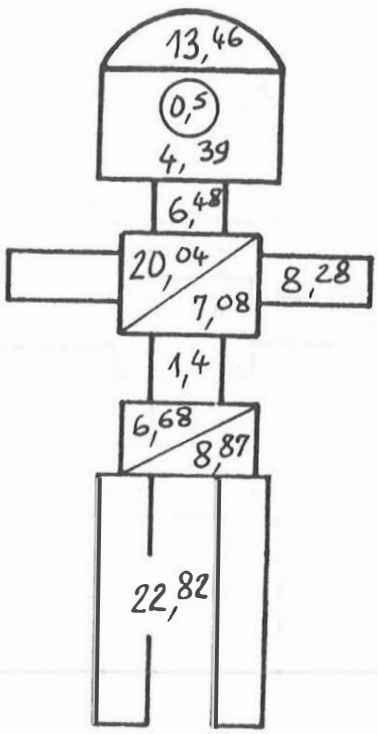


Nb of lesions

% of lesions



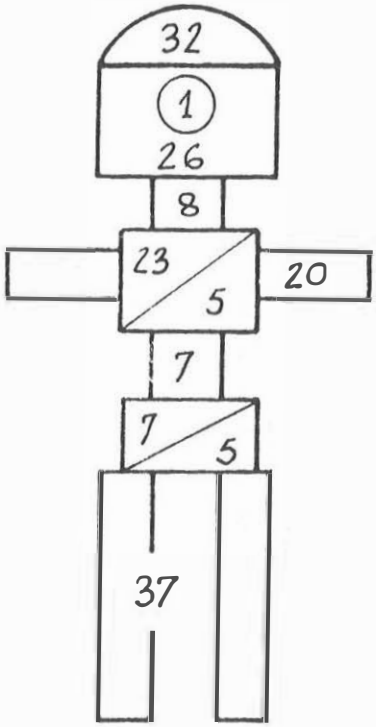
AIS ⩾ 3



Nb of lesions

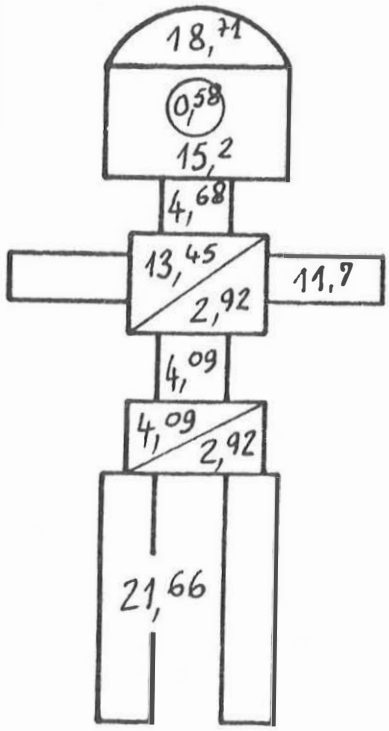
CAR OCCUPANTS

% of lesions

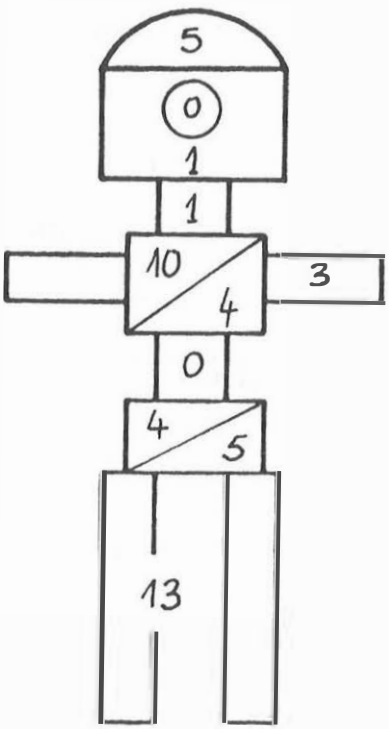


Nb of lesions

ALL SEVERITIES

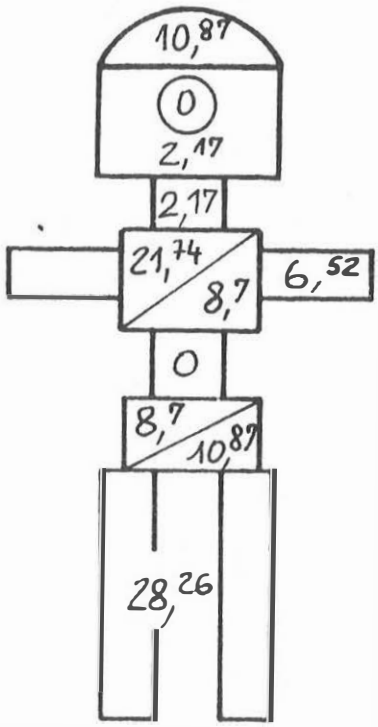


% of lesions



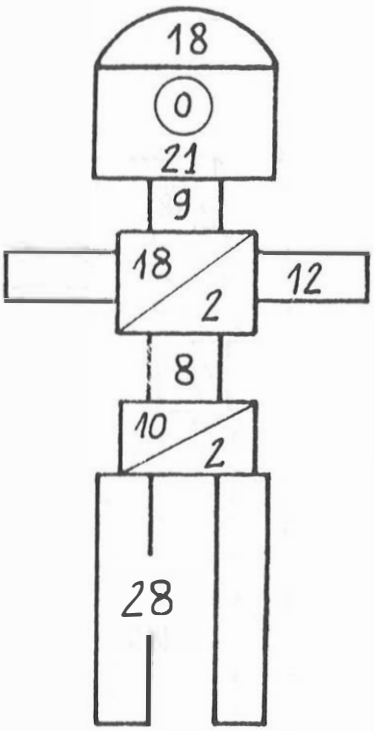
Nb of lesions

AIS $\geqslant$ 3



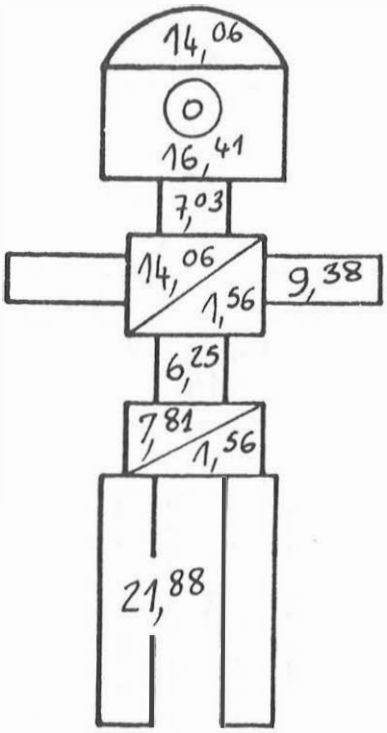
% of lesions

LIGHT VAN OCCUPANTS

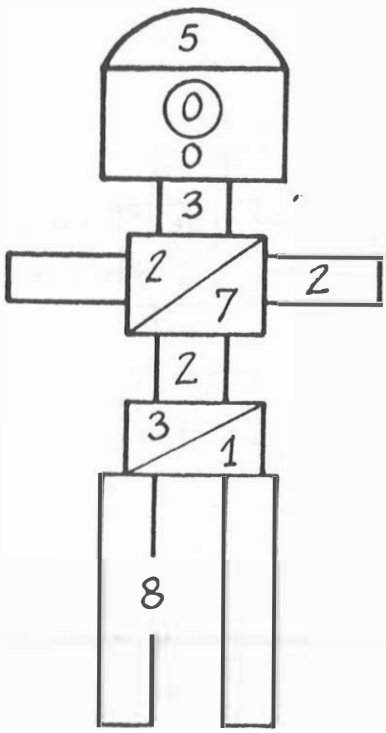


Nb of lesions

ALL SEVERITIES



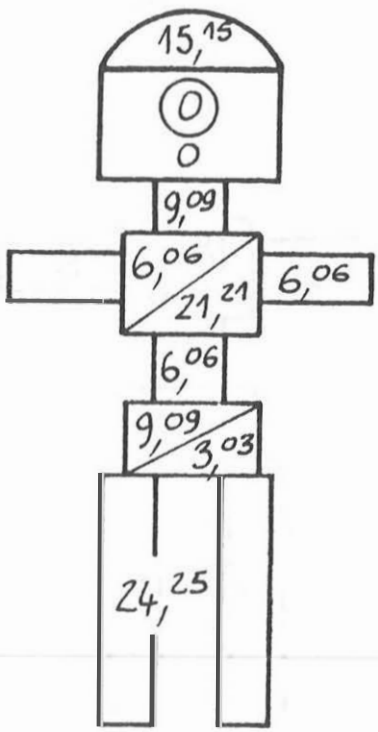
% of lesions



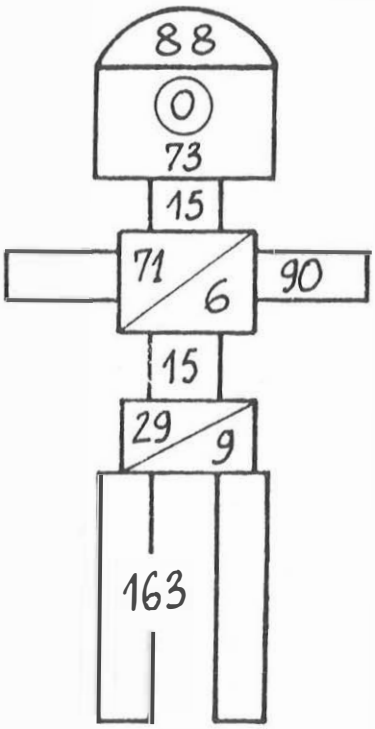
Nb of lesions

AIS ⩾ 3

TRUCK OCCUPANTS

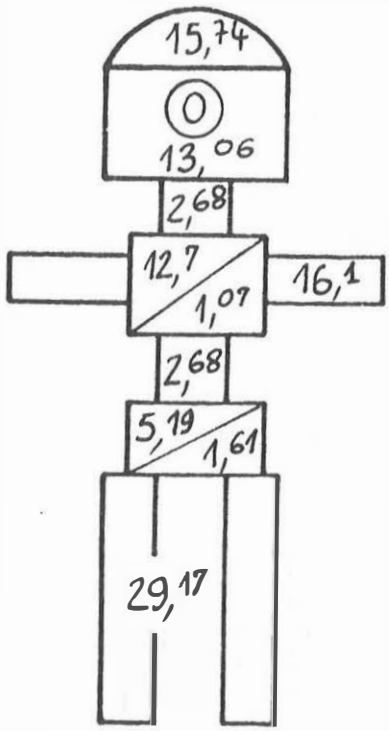


% of lesions

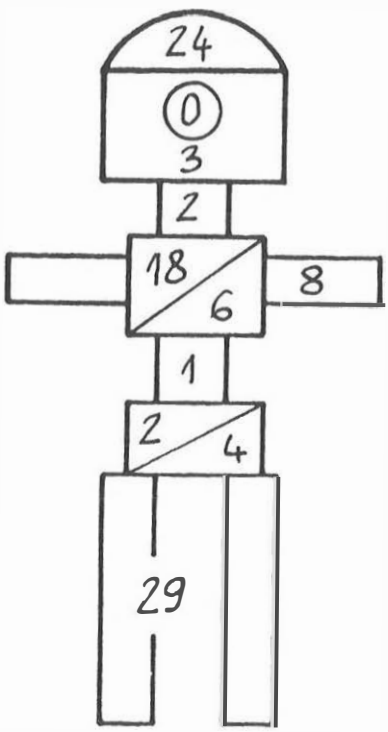


Nb of lesions

ALL SEVERITIES



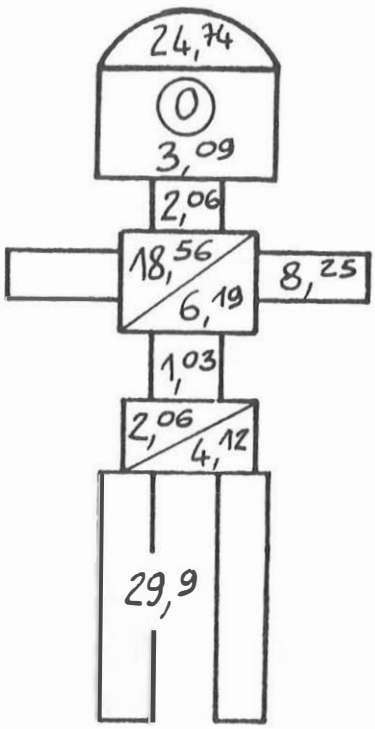
% of lesions



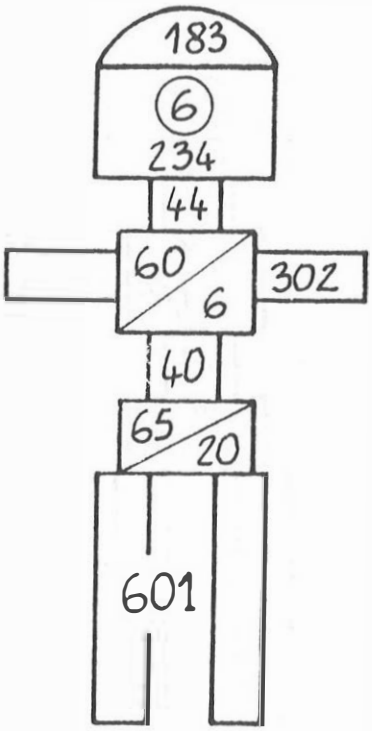
Nb of lesions

AIS ⩾ 3

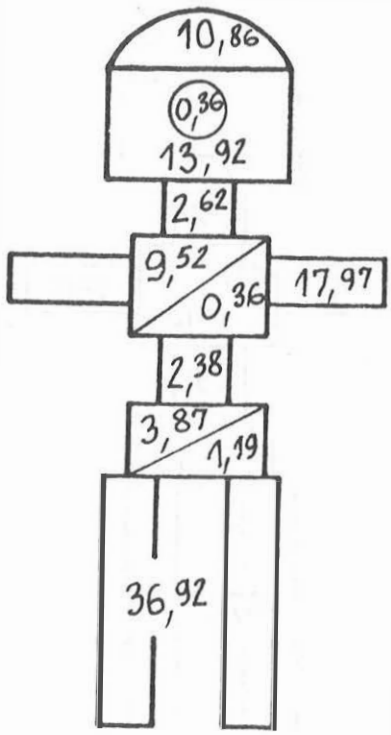
BICYCLE USERS



% of lesions

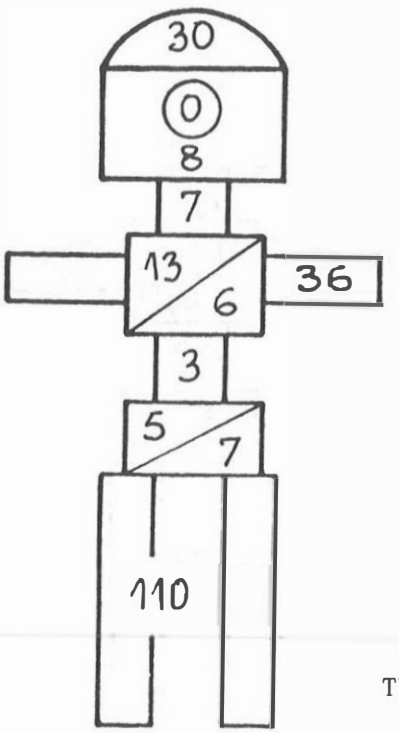


ALL SEVERITIES

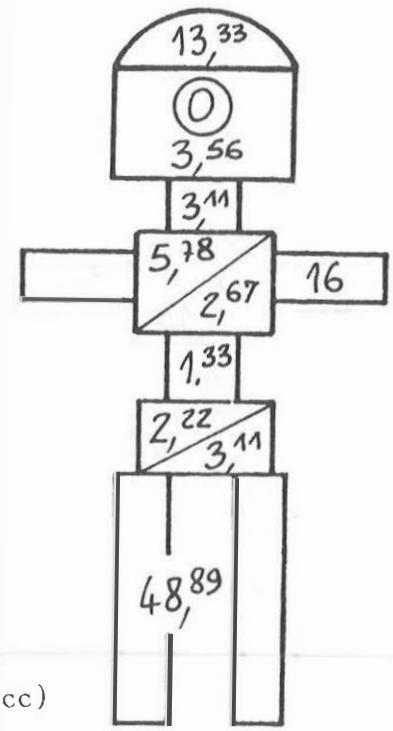


Nb of lesions

% of lesions



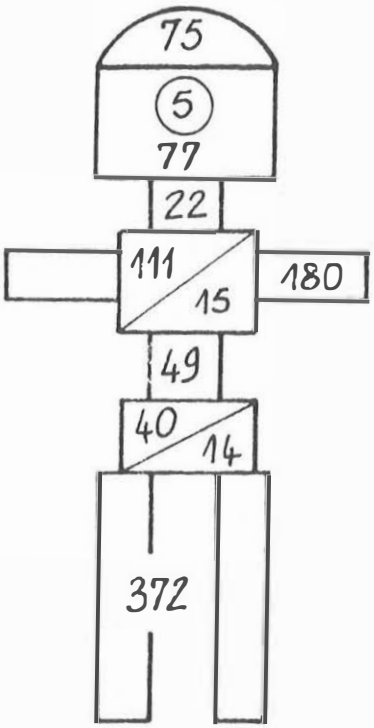
AIS $\geqslant$ 3



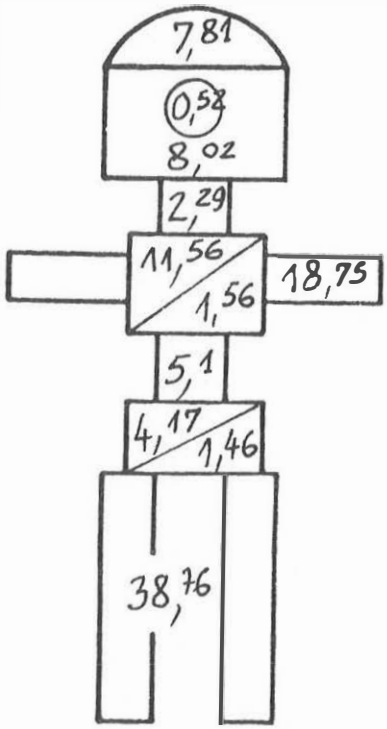
TWO-WHEELS USERS ($<$ 125 cc)

Nb of lesions

% of lesions

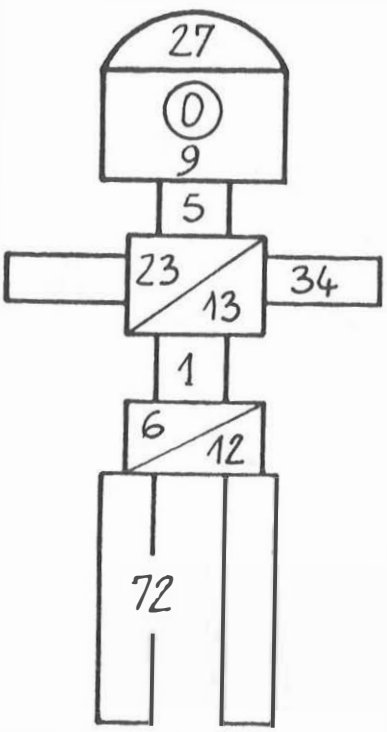


ALL SEVERITIES

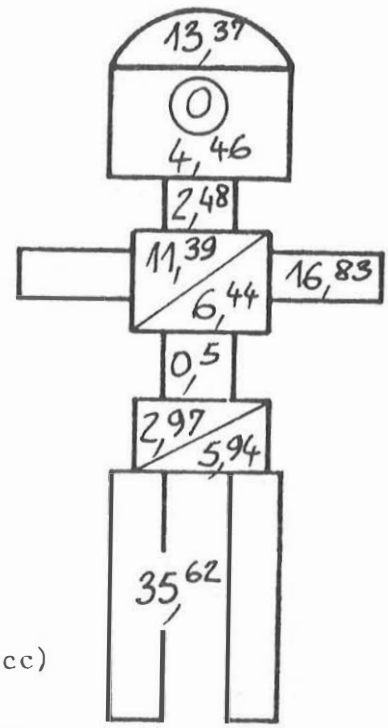


Nb of lesions

% of lesions



AIS ⩾ 3

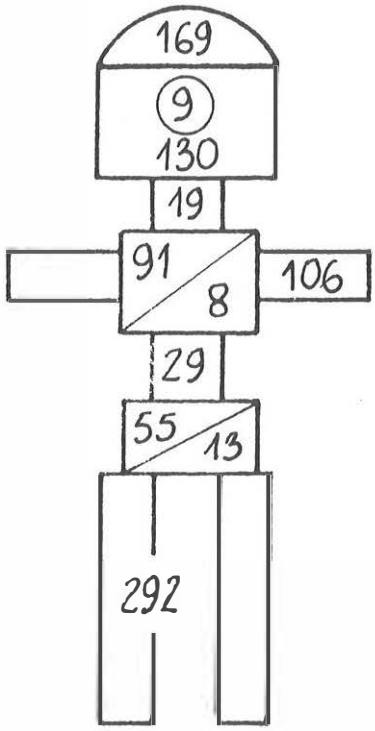


TWO WHEELS USERS (> 125 cc)

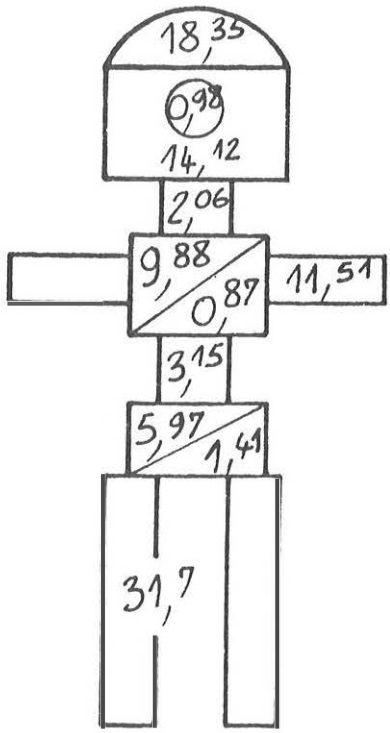
Nb of lesions

% of lesions

ALL SEVERITIES

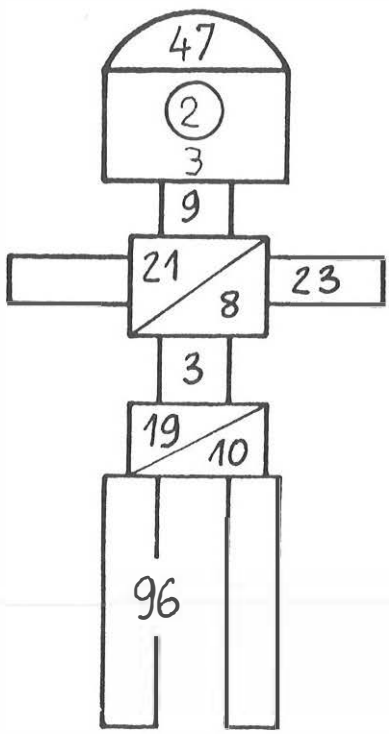


Nb of lesions

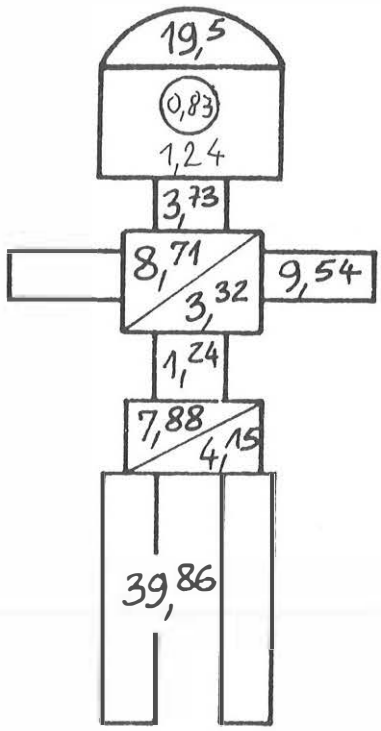


% of lesions

AIS ⩾ 3



Nb of lesions



PEDESTRIANS