

STUDY OF LETHAL CRANIAL LESIONS
OBSERVED ON "TWO-WHEEL" USERS

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Statistics on cranial and intra-cranial lesions observed on drivers of two-wheeled vehicles which have undergone accidents are quite numerous in the medical literature. Researches into the circumstances of the accidents in which such vehicles are involved have also developed for a number of years. On the other hand, studies specifying the lesions observed as a function of the circumstances of the accident are practically inexistant and the distribution of the impacts in the skull is understood only little.

These concepts however are indispensable to specify the conditions of effectiveness of helmets. Knowledge of the frequency of the various points of impact is not usable without knowing the seriousness of the lesions provoked.

We have therefore striven to compare the lesions observed in two homogenous series of lethal accidents where the circumstances of the accident were known.

One series considers all lethal accidents in a suburban zone, whether death has ensued immediately or as a result of secondary causes.

The other concerns users whose condition justified transfer to a neuro-surgical environment, where death followed for secondary reasons.

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OVERALL STUDY OF THE TWO SERIES OBSERVED

1° - Breakdown by type of vehicle

The 35 users of two-wheeled vehicles studied had suffered a cranio-encephalic lesion either isolated or in conjunction with other injuries, in which case it appeared as the main cause of death. Their breakdown by type of two-wheeled vehicle used differs slightly from those of deaths in 1974 at national level.

35 cases studied		France complete (3614 deaths)	
11.5 % (4)		Cycles	16 %
54 % (19)		Mopeds	64 %
34.5 %	8.5 % (3)	50/125 cc motorcycles	6 %
	26 % (9)	125 cc motorcycles	14 %
		20%	

The difference is significant for users of motorcycles. Since the lesions responsible for death are not known on national scale, one cannot assert whether the difference observed is caused by a higher frequency of deaths of cranial origin in drivers of motorcycles or whether it can be explained by the lack of representativity of our sample.

2° - Configuration of accidents involving a second vehicle other than the two-wheeled vehicle

24 accidents fall into this category. We have attempted to specify whether the lesions observed were provoked by the vehicle (13 cases), falling onto the ground (9), or against a rigid fixed obstacle and then onto the ground (2) depending on the type of collision.

In this type of accident, the ground is responsible for cranial traumas in 46% of all cases, and this proportion increases to 100% when one considers side-swipe conditions. On the other hand, it falls to 23% if the collision is frontal for the two-wheeled vehicle and the proportion is only slightly

different when one considers frontal collisions for the vehicle impacting the two-wheeled vehicle (25%).

		Two-wheeled vehicle			
		Frontal		Lateral	
Other vehicles	Frontal	7	/6	5	/3
	Lateral	4	/2	6	side swipe /0
	Rear	2	/2		

Table 1 - The number of head impacts against the adverse vehicle is shown in the lower right hand corner of each box.

3° - Study of the obstacles struck

Alongside the 13 impacts against vehicles which we have considered, the ground is responsible for an equivalent number of lethal cranial traumas (12 cases), and more rarely a rigid and fixed obstacle (5 cases), secondary run-over after a fall (3 cas.), or a combination impact first against a fixed obstacle and then against the ground (2 cases).

4° - Anatomical locations of the traumas in terms of the type of obstacle struck

It is often difficult to specify the point of impact in the cranial skeleton ; in addition, one should bear in mind the incomplete nature of this information if the direction of the force exerted on the skull is not known. For these reasons, it is sometimes hazardous to compare the series which qualify the point of impact as in front of, alongside or higher

than those which use a bone reference, since an impact of the rear and lateral part of the frontal bone may be classified as lateral whereas it may lie anatomically on the frontal section.

Having said this, one should stress the frequency of temporal impacts (40% for the pure temporal impacts, 60% should one add frontal-temporal impacts concerning the temporal facette of the frontal bone and temporal-occipital impacts) and of those concerning the face and or forehead (31.5%), the parietal impacts are exceptional (8.5%).

TABLE II

	Vehicle/Ground	Fixed Obstacle	Crushing	Combined Impact	Tt1
Frontal	1	2	1		4
Fronto-facial	3		3		3
Facial	1				1
Frontal and temporal				1	1
Fronto- temporal	2	2			4
Temporal	4	6	1	2	14
Temporal- occipital	2			1	3
Parietal posterior		2			2
TOTAL (Tt1)	13	12	5	3	35

5° - Anatomical location of the trauma in terms of the configuration of the accident

Cranial lesions are "lateralized" in all cases of collision between the front of a private car and the side of a two-wheeled vehicle.

By contrast, facial and frontal lesions are more frequent (7/10) when the two-wheeled vehicle collides against the

adverse vehicle with its front wheel and the head strikes this vehicle.

The lesions provoked by the ground are more unevenly distributed, with a slight predominance of temporal and temporo-occipital impacts (7/12).

COMPARATIVE STUDY OF THE TWO SERIES OF ACCIDENTS OBSERVED

Despite the restricted number of accidents studied in these two series, they differ significantly in several respects. In the series of immediate deaths, in 6 cases out of 8, the trauma resulted in fracture either directly at the point of impact without any extension in distance (2 cases) or with an extension (2 cases), or again an indirect fracture at a distance from the point of application of the forces (2 cases of circular fractures of the base of the skull).

Meningo-encephalic lesions varied in victims killed immediately. Hematoma never gathered, but rather a diffused bleeding of the soft meninges accompanied by often considerable cerebral lesions (one fracture of the cerebral pedunculae, one fracture of the callosal body). The impacts were either frontal or facial 6 times out of 8.

In the series of neuro-surgical origin (death ensuing later), a fracture occurred 21 times out of 25, 11 situated at the point of application of the forces and 10 extending to some distance from this point. No indirect fracture occurred in this series. The relatively high frequency of extra and subdural hematoma (7/25) can easily be explained by the neuro-surgical origin of this series.

The impact zones were lateral in 19 cases and fronto-facial in the remaining 6.

It would therefore appear that the lesions observed in the victims originating in a geographically limited zone are characterized by the high frequency of injuries which are immediately lethal with frontal impacts, while on the contrary

the injured persons treated in a neuro-surgical service have more frequently suffered lateral impacts (temporal, fronto-temporal, temporal-occipital). These distributions of the impact zone both differ from what is observed in drivers of two-wheeled vehicles who do not die as a result of their accident ; in these cases, facial impacts occur most often.

The proportion of vehicles of over 125 cc. also differs in the two series : 6/10 in the Garches series and 3/25 in that of the St Anne Neuro-surgical centre.

It should also be remarked that the victims killed immediately had struck a vehicle or fixed obstacle head-on 5 times out of 8, whereas the proportion is 14 out of 27 for subsequent deaths.

A helmet was worn 5 times out of 8 by victims killed immediately and twice the helmet had been lost before the cranial impact responsible for death, while another time it was lost after the main impact. It should be noted that in the three cases where the helmet was not capable of ensuring survival, the impact occurred at the level of the chin-piece of an integral helmet in the case of circular fracture of the base of the skull and in another case the quality of the helmet could well be called into question (breakage of straps, which had been weakened by aging), while the third helmeted victim was killed at a very high speed by impact against a vertical obstacle.

In cases of secondary death, the helmet was worn only 5 times out of 27, and was lost only once.

CONCLUSION

One can schematically confront the motor cyclist whose forehead strikes the adverse vehicle or the fixed obstacle with death often occurring immediately, with the moped rider, when struck laterally, who almost invariably suffers temporal impact with death usually being delayed.

We consider the most important facts to be the variable frequency of impacts between the head and an adverse vehicle, depending on the configuration of the accident, the mean being 37% for the whole studied sample, and the high rate of temporal impacts which justify the development of helmets providing an effective protection for this zone.

TABLE LEGEND

CL	-	cycle
MP	-	moped
mc	-	motorcycle 125 cc
MC	-	motorcycle > 125 cc
F	-	fracture
H	-	Hematoma
O	-	Oedema
C	-	complex lesions

Age:Two	: Obstacle	: Crash	: Area	:Helmet:Length	: Head	: F	: H	: O	: C	: Lesions
:wheel:	: configuration	: impacted	: by head	:survival:	: impact	:	:	:	:	: on other
:	:	:	:	:day	: area	:	:	:	:	: body areas
18 : MP	: truck	:Head-on (car)-side	: vehicle	: no	: 1	:temporal	: +	: 0	: +	: + : Abdomen
55 : MP	: truck	:Head-on	: vehicle	: no	: 2	:temporal	: +	: +	: +	: +
19 : CL	: Pte car	:Head-on (car)-side	: vehicle	: no	: 7	:temporal	: 0	: 0	: +	: +
18 : MC	: no obst.	:Fall	: ground	: yes +:	: 60	:temporal	: +	: 0	: 0	: +
37 : MP	: Pte car	:Side swipe	: ground	: loss	: 9 h	:frontal	: +	: 0	: +	: 0
28 : mc	: other obst:		: ground	: yes	: 3	:fronto-	: 0	: 0	: 0	: +
63 : MP	: Pte car	:Side(car)-head-on	: ground	: no	: 2	:fronto-	: +	: +	: +	: +
39 : MP	: Pte car	:Head-on(2wheel) rear	: vehicle	: yes	: 3	:fronto-	: +	: 0	: 0	: 0 : Fracture
65 : MP	: Pte car	:Side swipe	: ground	: no	: 1	:facial	:	:	:	: Int.Max.Art.
18 : MP	: Pte car	:Head-on (car)-side	: ground	: no	: 6 h	:temporal	: +	: +	: 0	: 0
41 : MC	: no obst.	:Fall	: run over	: no	: 9 h	:temporal	: +	: 0	: +	: 0 : Chest +
25 : MP	: Pte car	:Head-on	: vehicle	: no	: 2	:temporo-	: +	: +	: +	: Abdomen
15 : MP	: no obst.	:Fall	: ground	: no	: 2	:occipital	:	:	:	:
54 : MP	: Pte car	:Side-swipe	: ground	: no	: 1	:temporal	: 0	: 0	: +	: + : Chest
18 : MP	: truck	:Head-on	: vehicle	: no	: 60	:fronto-	: +	: 0	: 0	: 0 : Infectious
40 : MP	: rigid fixed obstacle		:fixed obst:	: no	: 4	:temporal	: +	: 0	: +	: + : meningitis
11 : CL	:run over by private car		: run over	: no	: 20 h	:temporo-	: +	: 0	: +	: 0 : Luxation C ³
:	:	:	:	:	:	:occipital	:	:	:	:

17	: mc	: Rigid fixed obstacle	: fixed obst:	no	: 19	: fronto- : facial	: + : 0 : 0 : + : Lower limbs
18	: CL	: Pte car :Head-on (car)-side	: ground	: no	: 1	: temporal	: + : + : + : + :
17	: MP	: Pte car :Side (car) head-on	: vehicle	: no	: 5	: fronto- : temporal	: + : + : + : + :
17	: MP	: Pte car :Side (car) head-on	: ground	: no	: 12	: temporal	: + : + : + : 0 :
13	: CE	: Pte car :Head-on (car)-side	: vehicle	: no	: 3	: temporo- : occipital	: + : 0 : + : 0 : Chest
26	: MC	: Pte car :Side-swipe	: guard-rail: : + ground	: yes	: 60	: frontal and : temporal	: + : 0 : 0 : + : Lower limbs
26	: mc	: Pte car :Head-on (2wheel)rear	: vehicle	: no	: 1	: temporal	: + : 0 : + : 0 :
29	: MP	: Pte car :Head-on	: vehicle	: no	: 2	: fronto- : facial	: + : 0 : 0 : + :
43	: MC	: Pte car :Side-swipe	: ground	: yes + : loss	: < 1 h	: parietal : posterior	: 0 : 0 : 0 : + : Chest + lux : : : : : : D1 D2
17	: MP	: Pte car :Head-on	: vehicle	: no	: < 1 h	: fronto- : facial	: + : 0 : 0 : + : Chest + Abdo : : : : : : lower limbs
17	: MC	: Pte car :Head-on	: vehicle	: yes	: < 1 h	: facial	: + : 0 : 0 : + : Chest
23	: MC	: Pte car :Head-on	: ground	: yes + : loss	: < 1 h	: parietal : posterior	: + : 0 : 0 : + : Chest + lower : : : : : : limbs
20	: MC	: Rigid fixed obstacle	: Fixed obst:	: yes	: 13	: frontal	: + : 0 : + : + :
21	: MC	: Rigid fixed obstacle	: Fixed obst:	: yes	: < 1 h	: fronto- : facial	: + : 0 : 0 : + :
23	: MC	: Run over by Private car	: Run over	: yes + : loss	: < 1 h	: temporal	: 0 : 0 : 0 : + : Chest + Abdo : : : : : : lower limbs
53	: MP	: Rigid fixed obstacle	: Fixed obst:	: no	: < 1 h	: fronto- : facial	: + : 0 : 0 : + : Chest and : : : : : : abdomen
15	: MP	: Pte car :Side(car) head-on	: vehicle	: no	: 27	: frontal	: + : 0 : + : 0 : Chest+Limbs
63	: MP	: truck :Side-swipe	: ground	: no	: < 1 h	: temporal	: + : 0 : 0 : + : Chest + abdo