Protection issues for motorcyclist's airbag devices: A parametric study based on epidemiological and accidentological data

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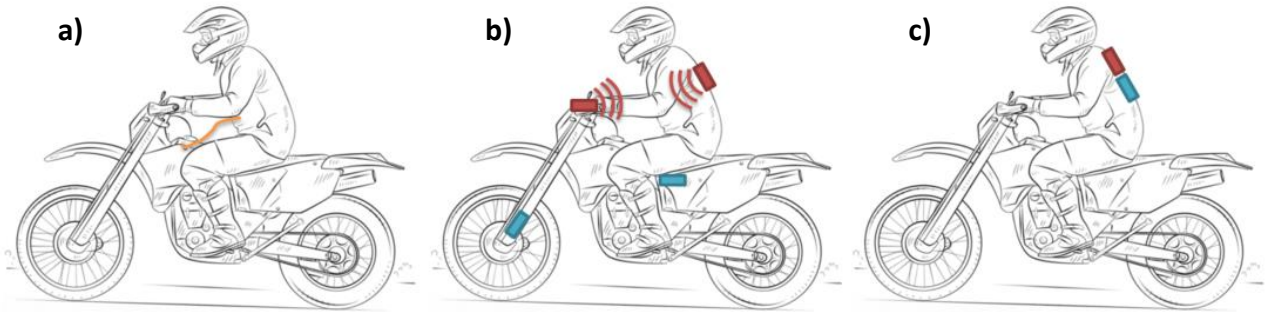
INTRODUCTION

- PTW (Powered Two Wheelers) road accidents:
  - **In Europe** *[Erso, 2017]* → **18%** of fatalities
  - **In France** *[ONISR, 2017]* →
    - **1,9%** of the traffic share
    - **21%** of fatalities
    - **30%** of injured and hospitalized victims
- Airbag devices fitted in the garments:



[In&Motion, 2018]

No standard recognised
How to evaluate the effectiveness of such devices?

OBJECTIVES

1) Determine the **most frequent injuries** and define the **most relevant accident scenarios**

2) Reproduce the accident and analyse the **impact conditions** of the motorcyclist and the **accident chronology**

Provide critical information to **evaluate and improve the performances** of airbag devices

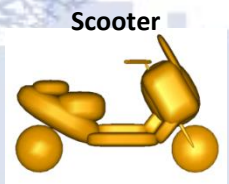
MATERIALS & METHODS

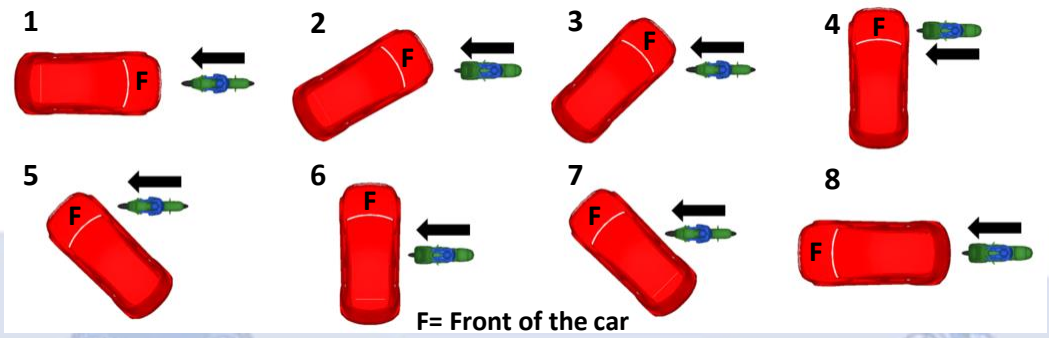
1) Epidemiological and accidentological data:

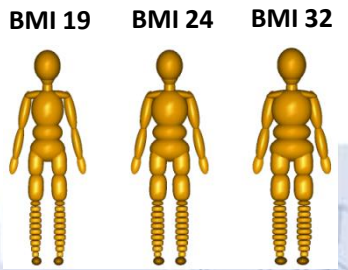
- Data collection of 252 PTW accident victims
- From 2016 to 2017 in Marseille and Lyon trauma centres
- Accident situation
- Injury assessment = Abbreviated Injury Scale (AIS) *[AAAM, 2005]*

2) Parametric study of 240 multibody simulations (Madymo):

- 2 types of PTW = Sport bike and scooter
- 5 PTW impact speeds = 30, 40, 50, 60 and 70 km/h
- 8 impact configurations PTW-car
- 3 morphologies of the rider = BMI 19, BMI 24 and BMI 32





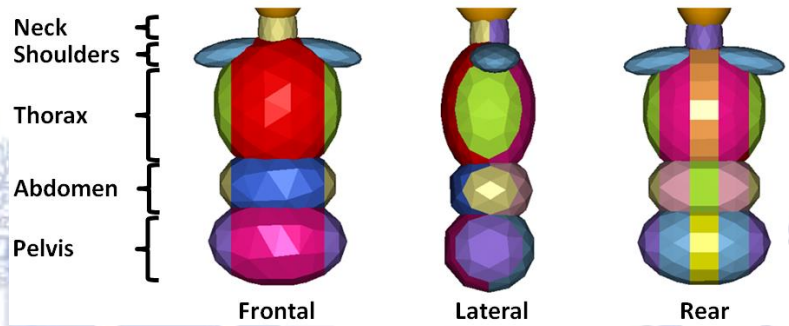


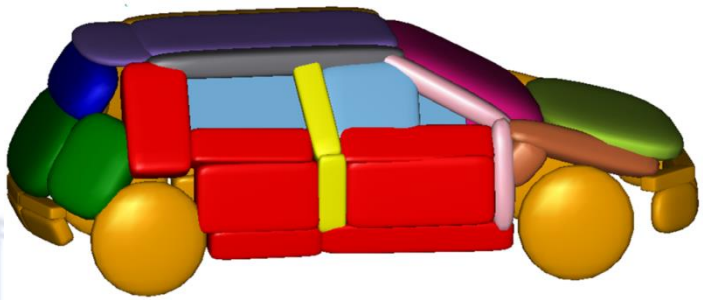
MATERIALS & METHODS

Numerical data analysis process:

- Number of impacts:
  - 15 human body zones with the car and the ground
  - 11 parts of the car with the trunk
- Impact velocity:
  - Velocity of the body region at the instant just before impact
- Accident chronology:
  - Period of time between PTW first impact and rider trunk first impact

$$Weight\ coefficient = \frac{n\ real\ cases}{n\ simulations} * 100$$





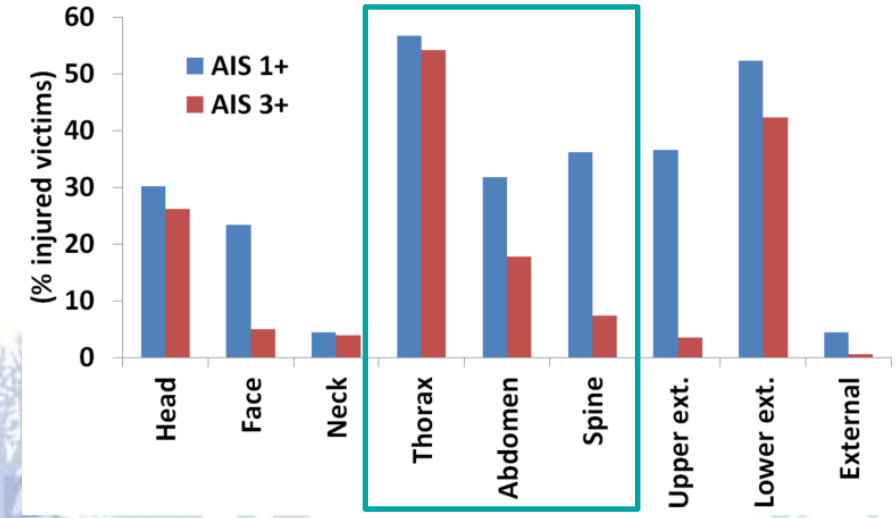
RESULTS

1) Real accidents study:

Epidemiology:

AIS1+ = All injured victims

AIS3+ = Seriously injured victims



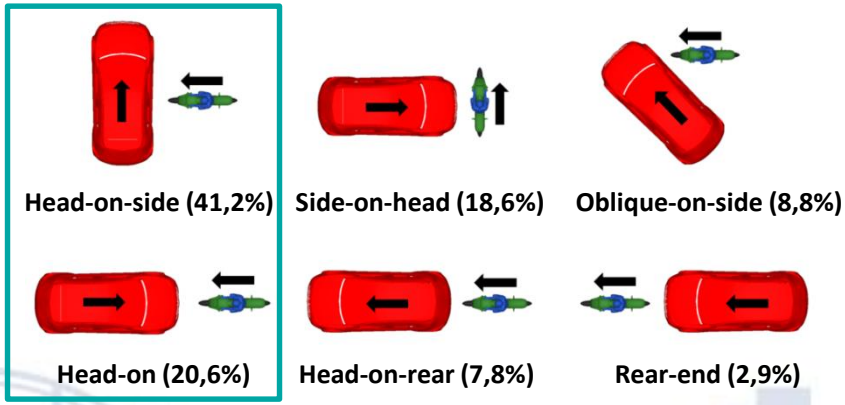
[n AIS1+ = 252] ; [n AIS3+ = 203]

Accidentology:

PTW collision partner

- 50% passenger cars
- 25,4% the ground
- 8,7% road fixed objects
- 6,4% heavy trucks

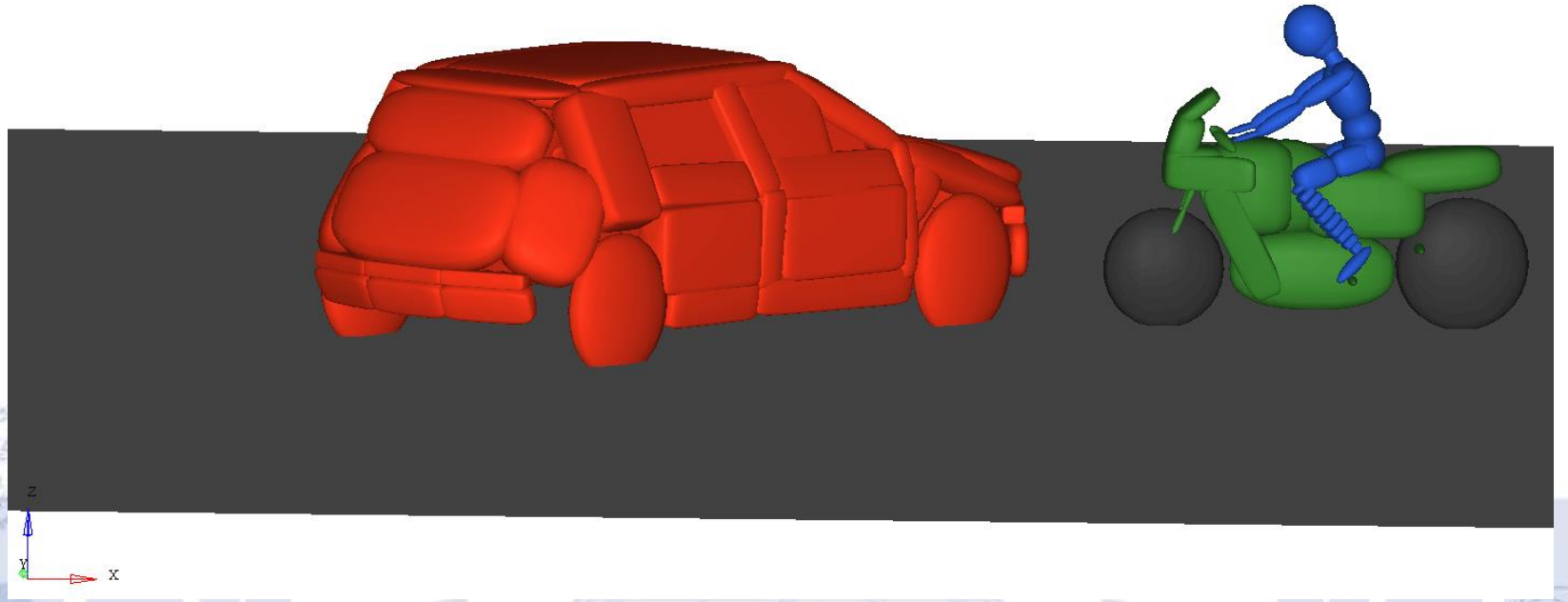
[n=252 victims AIS1+]



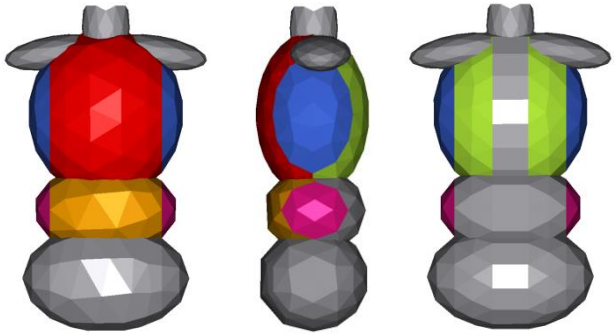
[n=102 victims AIS1+]

RESULTS

2) Numerical study:

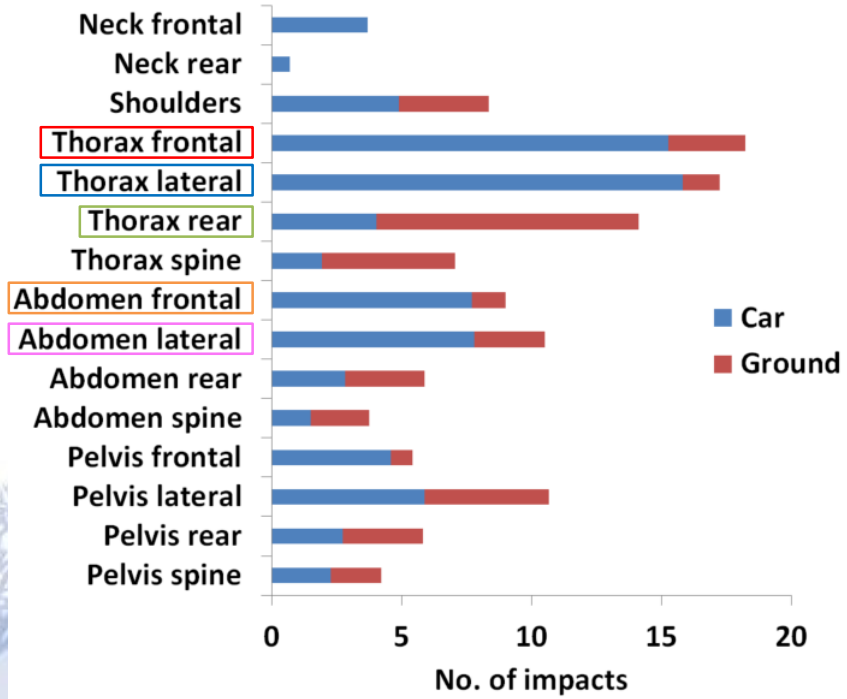


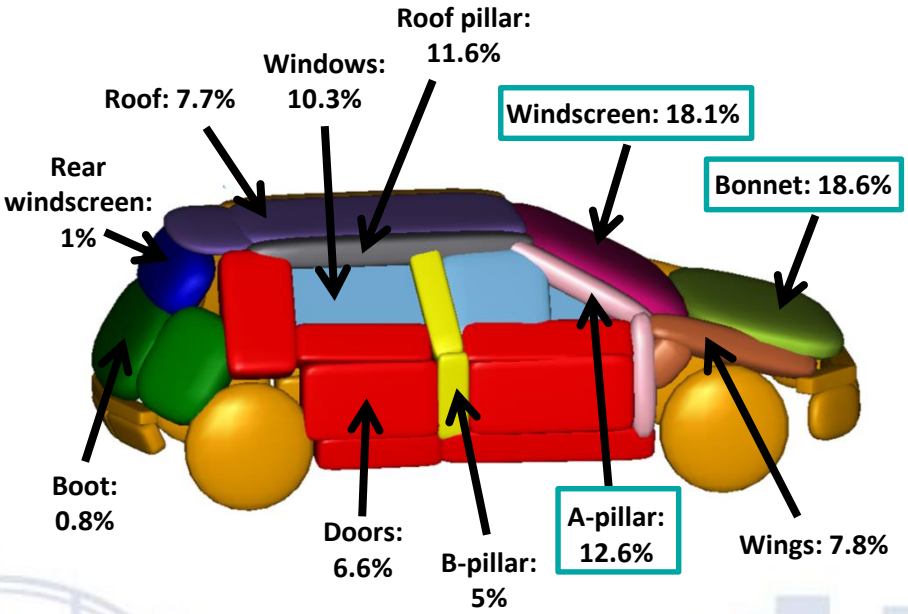
RESULTS



2) Numerical study:

Number of impacts:





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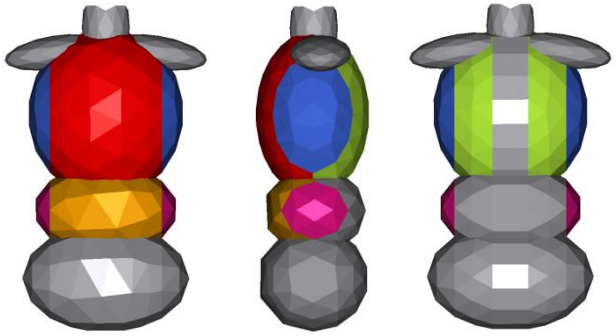
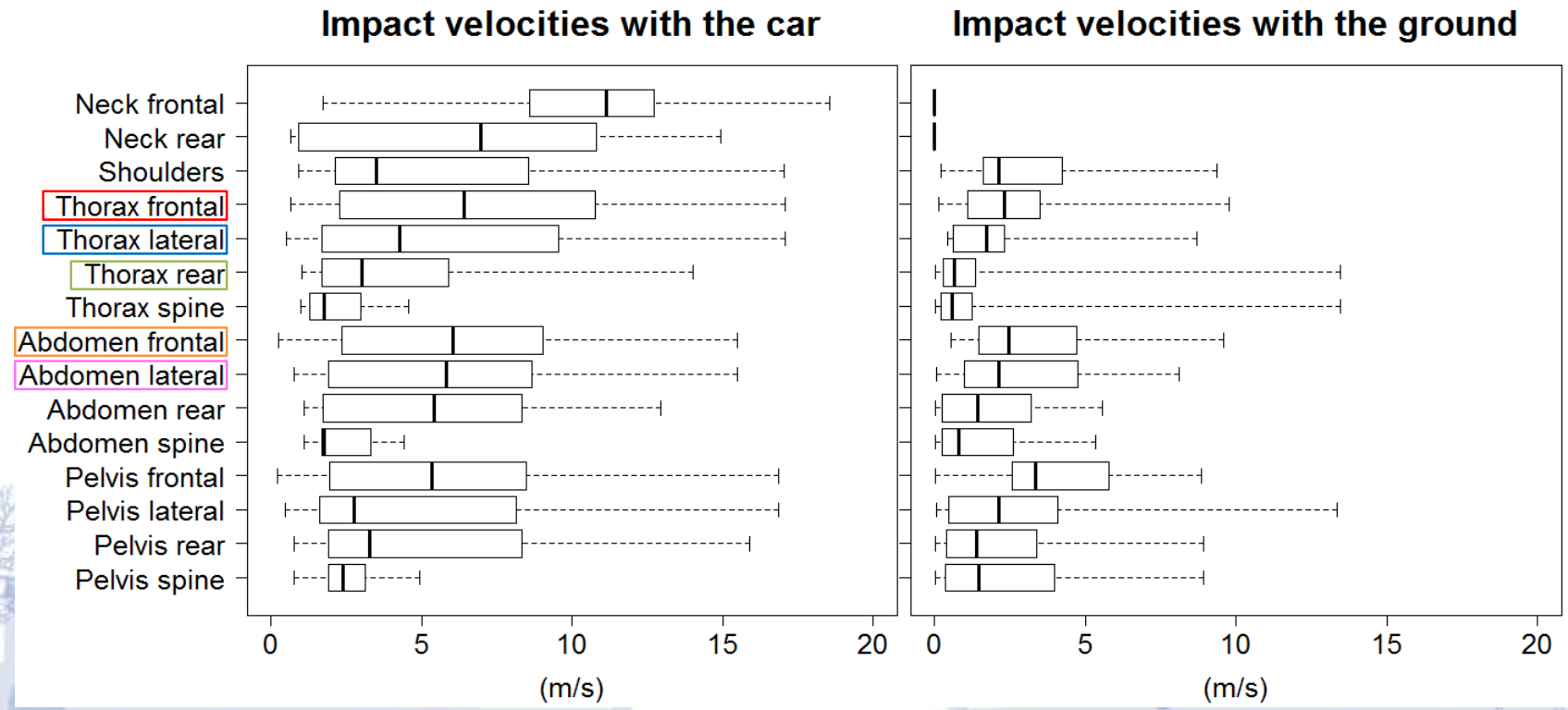


2) Numerical study:

Impact velocities:

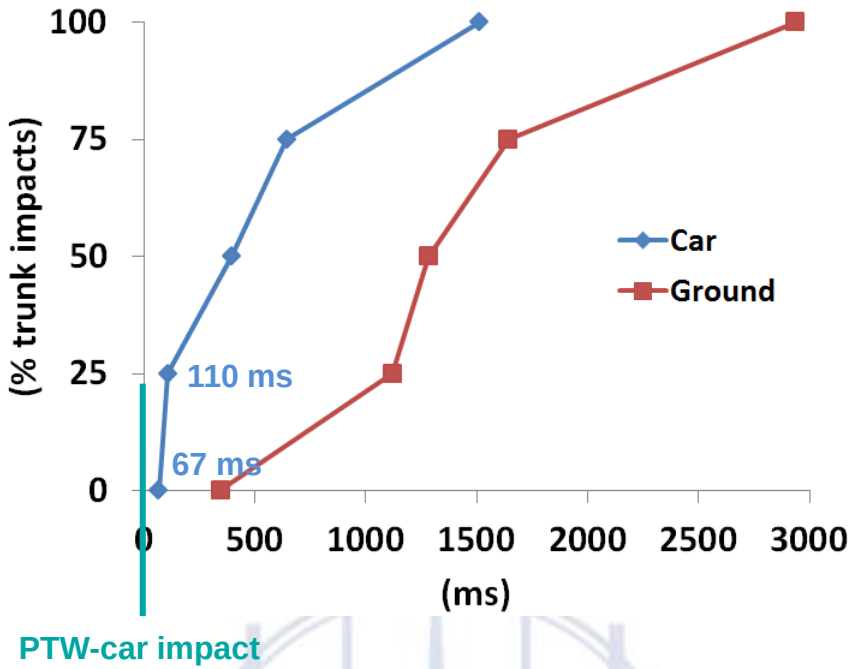


RESULTS

2) Numerical study:

Accident chronology:

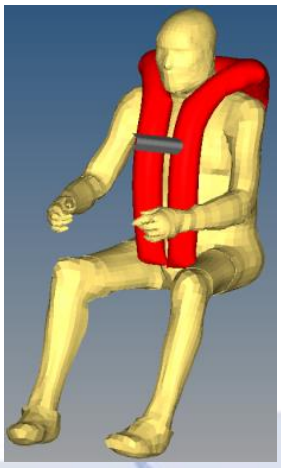
$$Impact\ time = t_{trunk\ impact} - t_{PTW-car\ impact}$$



CONCLUSIONS

Identified accident scenarios	Collision with cars (head-on-side, head-on)
Body impacts with the highest injury risk	With the car
Most vulnerable anatomical regions	Thorax and abdomen
Airbag protection zones	Frontal and lateral thoracic and abdominal regions
Airbag intervention time	< 70 ms
Duration time maintaining the pressure	> 3 s

Future work: Simulate local impacts on specific trunk body segments with FEM



THANK YOU!

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- ONISR, 2017. La sécurité routière en France. Bilan de l'accidentalité de l'année 2016. Paris
- AAAM, 2005. Abbreviated Injury Scale (AIS). Association for the Advancement of Automotive Medicine
- https://www.inemotion.com/#inemotion