The human body is not designed to handle a car crash, which means, that no matter the severity of an accident or how safe a car is rated, damage, including aches and pain or life-altering injuries can occur. Car accident effects on the body come in many different forms and may not be present immediately after the accident. When you sit in a car, you do not only trust your driving abilities on the road, but also trust the other drivers on the road. You must drive defensively and carefully at all times. Unfortunately, automobile accidents still occur, which is why you must understand how a car accident can affect your body. This article describes the anatomy of a crash in some detail. It deals with the various factors involved in a crash and the significance of the speed involved also the issue of kinetic energy. It graphically outlines what happens over seven tenths of a second when a vehicle crashes. It explains that there are three crashes involved in one crash and pen - ultimately it gives some tips on how to avoid a crash. Finally a conclusion is given.

Harrington Driver Training Services

The Anatomy of a Car Crash (It's Not Pretty)

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Introduction

Car crashes are mysteries. Even though thousands happen each year in GB and Ireland - and about 1.35 million worldwide - we seldom learn much. When some people drive by a crash, they often slow down to have a look. But there's not much to see. Two crumpled cars and maybe one upside-down. An ambulance closing its doors. We usually feel bad for those who may have gotten hurt (or worse), of course, because rubbernecking contributes to the logjam of vehicles behind us. Without details of how crashes happen, we tend to dismiss them as the work of "idiots" – drivers who occupy the lower echelons of driving skill and who are bereft of common sense. Car accidents (crashes) are horrifyingly common and, unfortunately, highly deadly. As mentioned, over a million people die in car accidents every year and millions seriously injured, the causes of death in these crashes are wildly numerous. High-speed collisions are some of the worst, and the effects of a car crash of that type on your body are as terrifying as they are fascinating. Between the way your brain reacts, the way your organs react, and the way you physically react, it's a wonder anyone survives these kinds of super-fast collisions at all! What happens to your body in a car crash can, at best, be called pretty gross, it's not pretty and, at worst, be called absolutely sickening. Because of this, be warned that what you are about to read gets graphic at times. Still, let's hope that you can read it here rather than experiencing it firsthand. So, if you're curious about how your body reacts in a car crash, then rev your engines and let's get on the road. And if you learn anything from these facts, it's that driving safely, while wearing a seatbelt is definitely the way to go.

Emotional & Mental Distress

In an *accident de la route* there is a direct relationship between speed and the force of impact. The greater the speed of a vehicle, the greater the impact force will be. Similarly, the greater the weight of the vehicle, the greater the force of impact will be. Therefore, if two vehicles are both going at 30mph and one is a passenger vehicle and the other is a large goods vehicle (LGV), the LGV will have the greater impact force. In contrast, if both vehicles are the same weight, the vehicle with the higher speed will have the greater force. The shorter the distance a vehicle travels before a collision, the greater the force will be upon impact. When dealing with speed, there is a mathematical equation called the squared relationship. It basically states that three times the speed will have nine times the force of impact. Four times the speed will have sixteen times the force of impact.

Five times the speed will have twenty five times the force of impact and so on. This is called the squared relationship. The direction of impact in a collision can greatly affect the severity of injuries. Head-on collisions are the most serious types of crash. Collisions where the sides of the vehicle are struck (T-boned) can also lead to serious injuries depending on what part of the vehicle is struck and if there were any occupants in that area of the vehicle. [1] Other crashes can include head-on, rear-end and veering off course on a straight road. Traffic accidents can cause physical, financial and mental effects for everyone involved. Drivers and passengers can suffer from cuts and bruises to broken limbs, whiplash, back and spinal injuries, paralysis and even death. Vehicles in traffic accidents are damaged and may be in need of minor or costly repairs or may be completely written-off and no longer drivable. Additional effects of the accident can include emotional and mental distress as people can suffer from post traumatic stress (PTS) or from losing a loved one.

Factors Involved in a Crash

Generally, the main factors affecting vehicle crashes can be classified into four groups: road (geometrical traffic flow characteristics), vehicles (vehicle ability, technical defects of elements), and human factors (driver characteristics, behaviours and physiological abilities), and the environment (weather conditions). These factors interact with each other to affect the occurrence of accidents, and if one of these factors becomes unstable, the possibility of a crash will be increased. Based on previous crash reports, the human element has been identified as the main reason for accident causation. Therefore, studying the behaviour of drivers is one of the most influential human factors in the occurrence of accidents and can play an essential role in preventing them? [2] Road traffic crashes occur from a combination of factors related to elements of the transportation system, made up of the road and its environment, vehicles, and road users, with crash outcomes ranging from property damage to death. Some factors contribute to crash occurrence, while others influence the outcome (or severity) of the crash or both. While the effects of some crash causal factors such as speed are fairly obvious, they may be linked to other unobserved factors, such as a sensation seeking nature of the driver, which is not typically accounted for during the crash reporting process.

[1] American Automobile Association, *Responsible Driving*, Chapters 7 and 13, Pages 120, 121, 122, 254, 255, 265, 266

[2] *scirp.org*

Having a holistic understanding of crash causal factors and how they impact on severities are necessary to develop and target countermeasures. [3] There is a significant body of road safety literature dedicated to the study of factors affecting crash occurrence and severities. Multiple proposals on countermeasures have ranged from roadway re-engineering, improved vehicle safety features, and strategies to influence driver behaviour. The development of these proposals or countermeasures have been anchored on understanding the factors that affect the likelihood of crash occurrence and/or circumstances that influence the severity of the crash outcome. A critical component of road traffic crash analyses has been the examination of the driver. Some drivers have habits or choose to drive in ways that increase their likelihood of getting into a crash. For instance, driving styles such as choice of speed, threshold for overtaking, tolerance for gap acceptance, and adherence to traffic control have been strongly linked to certain groups of drivers [4] According to ***Elander, J. (1993),*** [5] while certain groups of drivers may be disproportionately represented in crash statistics, this may be due to reasons not related to their risk of crash. One of the early attempts by researchers to gain in-depth understanding of crash causal factors was the Indiana Tri-Level Study. From this study, ***Treat, J. R. et al (1979)*** [6] observed that human errors and deficiencies were definite or probable cause in over 90% of the crashes examined. The leading direct human causes identified in the study included improper lookout (probable cause in 23% of accidents), excessive speed (17%), inattention (15%), improper evasive action (13%), and internal distraction (9%). In a similar study, ***Hendricks, D. L. et al, (1999)*** [7] investigated specific driver behaviors and unsafe driving acts that lead to crashes. The study further assessed the situational, driver, and vehicle characteristics associated with these behaviors. They found human error to be the most frequently cited contributing factor in 99.2% of crashes, followed by environmental (5.4%) and vehicle factors (0.5%).

[3] *Effects of Human-Centered Factors in Crash Injury Severities.* Journal of Advanced Transportation (Hindawi) Vol. 2017. Article ID 1208170. hindawi.com journals/jat/2017/1208170

[4] Elander, J. *et al.* (1993) *"Behavioural Correlates of Individual Differences in Road-traffic Crash Risk: An Examination of Methods & Findings"*, Psychological Bulletin, Vol. 113, No. 2, pp. 279-294,

[5] Elander, J. *et al.* (1993) *"Behavioural Correlates of Individual Differences in Road-traffic Crash Risk: An Examination of Methods & Findings"*, Psychological Bulletin, Vol. 113, No. 2, pp. 279-294,

[6] J. R. Treat, N. S. Tumbas, S. T. McDonald *et al, "Tri-level study of the causes of traffic accidents: final report, Vol. 1: causal factor tabulations and assessments,"* DOT HS 805, Indiana University, Institute for Research and Public Safety, Bloomington, Ind., USA, 1979.

[7] D. L. Hendricks *et al, "The Relative Frequency of Unsafe Driving Acts in Serious Traffic Crashes".* DTWH 22-94-C-05020. NHTSA, Washington, DC, USA, 1999.

Thus, most crashes and their associated injuries and fatalities can be linked to some form of unsafe driving habits. [8] It is therefore important to examine the causal driver characteristics and also assess their driving behaviors that increase the likelihood of crash occurrence.

Speed & Accidents

The greater the speed at impact, the more energy must be absorbed by hard metal, soft flesh and brittle bone. If you are in a vehicle travelling at 100kmh (62mph) and you weigh 50kgs (130 lbs), your stored energy at this speed is 22,774 joules. [9] If you are forced to stop in a short distance of say 3mts (9.8ft.), at this speed your body would be subjected to a 75kg force. Therefore, over three quarters of a tonne would in all probability be severely applied to your body by a combination of seat belt material, metal, plastic and engine parts. Modeling on the impacts of higher vehicle speeds has led to the following rule of thumb: a 5% increase in average speed leads approximately to a 10% increase in all injury accidents and a 20% increase in road fatalities. The same research indicates the positive impacts on reducing vehicle speeds: a 5% decrease in average speeds leads to approximately a 10% decline in injury accidents and a 20% decrease in fatal accidents. Reducing speed a few km/h can thus greatly reduce the risk of accidents as well as mitigating the consequences of an accident. [10]

***Energy Absorption*.**

When a vehicle is in motion, it develops kinetic energy. The faster it travels the more energy is created. Therefore, the more energy of motion a vehicle has, the more time and distance will take a vehicle to stop. So, when a moving vehicle hits another object, it is called the force of impact. There are three factors that affect the force of impact. The first the speed at which a vehicle is travelling, which means the greater the speed of the vehicle, the more force it will have on impact. The second is the weight of the vehicle. The heavier the vehicle, the more force it will have when it strikes another vehicle or object. The third factor affecting the force of impact is the distance a vehicle travels between its first impact with an object and the point where the vehicle comes to final rest. When a vehicle strikes a fixed object the impact distance is fairly short.

[8] *Effects of Human-Centered Factors in Crash Injury Severities.* Journal of Advanced Transportation (Hindawi) Vol. 2017. Article ID 1208170. hindawi.com journals/jat/2017/1208170

[9] One joule is one Newton of force acting through one metre.

[10] Nilsson G. (2004) Traffic Safety Dimensions and the Power Model to Describe the Effect of Severity on Safety. Lund Institute of Technology, department of Technology and Society Traffic Engineering.

The fixed object does not move much upon impact; therefore kinetic energy is spent almost immediately. Many of today's vehicles absorb energy in a collision by the way they deform or "crush" when involved in a crash. The energy of the collision is dissipated when the metal of the vehicle deforms. Modern vehicles include a number of features that help by absorbing the energy created in a crash. Vehicle manufacturers build in tempered safety-glass windows, impact resistant bumpers, protective dashboard padding, energy absorbing steering columns and childproof door locks. Occupant safety devices include the safety restraint system, airbags, head restraints and automatic door locks.

Anatomy of a Crash in 7 Tenths of a Second

The following is the slow-motion; split-second reconstruction of what happens when a car travelling at 65mph crashes into a solid, immovable oak tree, wall or other solid object. The driver is not wearing a seat-belt.

One Tenth of a Second. The front bumper and the chrome of the grill collapse. Slivers of steel penetrate the tree to a depth of one-and-a- half inchers or more.

Two Tenths of a Second. The bonnet crumples as it rises, smashing into the windshield. Spinning rear wheels leave the ground. The grill work disintegrates. The front bumper comes into contact with the tree, forcing the rear parts to spread out over the front doors. In these two tenths of a second, the structural members of the car begin to act as a brake on the forward momentum of the two-and-a-half-ton-car body. But the driver's body continues to move forward at the vehicle's original speed of 65mph. At a force of 20 times gravity, the driver's body weight equals 3,500 pounds. His legs ramrod straight and snap at the joints.

Three Tenths of a Second. The driver's body is now off the front seat, torso upright, broken knees pressing against the dashboard. The plastic and steel frame of the steering wheel begins to bend under his terrible death grip. His head is now near the sun visor and his chest above the steering column.

Four Tenths of a Second. The car's front 24 inches have been completely demolished, but the rear end is still travelling at an estimated speed of 35mph. The driver's body is still travelling at 65mph. The half-tonne motor block (engine) crunches into the tree. The rear of the car, like a bucking horse, rises high enough to scrape bark off the low hanging branches.

Five Tenths of a Second. The driver's fear-frozen hands bend the steering column into an almost vertical position. The force of gravity impales the body on the steering wheel shaft. Jagged steel punctures the lungs and arteries. Blood spurts into the lungs and mixes with whatever the driver had to eat earlier as his stomach tears open.

Six Tenths of a Second. So great is the force of the impact that the driver's shoes are ripped from his shoes. The brake pedal shears off at the floor board. The chassis bends at the middle, shearing body bolts. The driver's head smashes into the windshield. The rear end of the car begins its downward fall, spinning wheels digging into the ground.

Seven Tenths of a Second. The entire writhing of the car is forced out of shape, hinges tear loose, doors spring open. In one last convulsion, the seat ram forward, pinning the driver against the cruel steel of the steering shaft.
Shock has frozen his heart. He is now dead. Time elapsed is just seven tenths of a second.

Perishing in the Subsequent Fire

Even where a car accident does not lead to injuries sustained from impact with other parts of the car, or from crushing or cuts, the sudden immense acceleration or deceleration generated by a sudden impact can still cause serious internal injuries. This is because of the way the human body is put together. Delicate internal organs, including the brain, effectively float inside their respective cavities in the human body. During a car accident these organs will maintain, or suddenly gather, momentum until the rest of the body comes to an abrupt stop and they collide with the interior of the body cavity. Therefore even where a person is restrained and suffers no external injuries in an accident, the following can easily occur:

- Rupturing of internal organs, including the spleen and stomach, which can lead to
- digestive juices flooding the body cavity
- Burst veins, which can be particularly dangerous in the brain
- Traumatic brain injury created by the collision of the brain with the skull.

These types of injuries may not be immediately apparent after an accident, and it is not unusual for accident survivors to return home from the accident scene only to succumb to their injuries shortly afterwards. This is why it is always a good idea to go to a hospital for a check-up in the aftermath of a car accident, even if you have no severe external injuries. Car accidents can easily result in your vehicle catching alight if the accident causes a fuel leak, a car's battery ruptures, or if the accident generates sparks or extreme heat from friction. In such situations a spark or electrical impulse can lead to the vehicles involved catching alight. Where the accident was severe enough to trap car occupants or knock them unconscious, there is a significant risk of perishing in the subsequent fire.

Three Collisions in One

There are three collisions involved in a car crash:

- ***First collision***: The vehicle collides with an object or the obstacle.
- ***Second collision*:** The human body – an unstrained occupant collides with the interior of the vehicle e.g. dashboard, steering wheel, windshield or rear seat passengers will collide with front seat occupants.
- ***Third collision***: The brain and internal organs moves towards the position of impact, tearing connective tissue or being bruised by colliding with bones of the skeleton. Travelling at 40mph, an unrestrained occupant would strike the windshield or dashboard with the same force as hitting the ground after a fall from a five-storey building.

Concept of 2nd & 3rd Collisions

In an *accident de la circulation* [11] and at the exact moment of impact in a collision, there is a release of energy when a vehicle strikes another vehicle or object. Prior to an impact, a vehicle and everything inside the vehicle is travelling at whatever speed the vehicle has been travelling at. As the collision continues, the vehicle gradually loses energy. However, the vehicle occupants and any other items in the vehicle continue to move forward at the same speed as the vehicle had been travelling prior to impact. If the occupants are wearing seat belts they begin to deform by stretching and decelerate the passenger in a comparatively gentle manner. Unbelted passengers continue forward striking the interior of the vehicle and may even be ejected from it.

[11] Traffic accident.

Also, loose articles from the back seat and parcel shelf continue forward at the speed the vehicle was travelling prior to impact with enough force to cause serious injury or death. This is also known as the second collision. The internal organs of the vehicle occupants have also been travelling at the speed of the vehicle prior to impact. As the passengers bodies decelerate, the internal organs move forward striking the skeletal parts of the body with enough force to cause serious injury. This is known as the third collision. [12]

Tips to Avoid Crashes

- Pay attention when you're driving, concentrate, be observant and plan ahead, leaving plenty of room around you but especially in front of you.
- Stick to speed restrictions and follow the rules of the road.
- Modify your speed if the prevailing road, weather and traffic condition warrant it.
- Never use your phone while driving or indulge in other dangerous distractions.
- Never drive under the influence of alcohol or drugs. (Even prescription drugs can affect your driving. Check with your doctor or pharmacist to see if it's safe to drive when taking these).
- Check your car's safety ratings.
- Reevaluate your car insurance and health insurance every year.
- Always wear a seat belt. According to road safety experts, seat belts reduce the risk of serious injury by 50% and the risk of death by 45%.

Conclusion

What happens to our bodies in a car crash? Obviously - nothing good. Cars are, after all, hulking metal containers and we are mere flesh capsules. But are you aware of the actual impact a high-speed car accident can have on your body, and how their sometimes-fatal transfer of energy actually works. When you are driving or are a passenger in a car, the vehicle and your body have kinetic energy. When a sudden stop occurs, the energy from your movement is transferred to the brakes to help you stop quickly. In a sudden car crash, this kinetic energy is released and impacts the body, which can cause injury and pain. Luckily, modern cars are designed to help protect the car's occupants from absorbing the energy experienced during a car accident. However, in most crashes, especially those that occur at high speeds, the body will absorb energy and the risk of an injury increases.

[12] *Governor's Office of Highway, Safety, Speed and Speed Limits,* Atlanta, Georgia October 1998.

Immediately following an impact, the body continues to move at the speed it was moving before the vehicle is stopped or slowed down. In a typical car accident, there is no gradual release of energy, and instead that energy is released in one sudden burst by an impact. ... This impact is then transferred to the car occupants, and the human body will then typically be forced into motion and will impact the seatbelt or another part of the car. Kinetic speed stops when the body contacts another object within the automobile, such as an airbag, the car door, the seat belt, the windshield, the dashboard, or another object in the automobile. It is said that the best way to avoid a crash is not to get into it in the first place. However, crashes will continue where the human element is involved. But can extra professional training bringing the driver's standard of driving up to advanced level help to stem the annual carnage on our roads? Future vehicles will have electronic systems that can avoid crashes in some cases where a human driver is unable, unaware or reacts insufficiently to avoid the crash without assistance. Also, can the adoption of advanced driver assistance systems (ADAS) such as forward collision warning, adaptive cruise control, blind spot detection, lane departure warning, and self-parking systems prevent many needless crashes which normally are not a pretty sight? Finally, and at present, it is this writer's firm belief (and that of many more professional and expert drivers) that the single most effective way to reduce crashes and improve road safety is to press for a much higher standard of driving. This then, would significantly reduce the number of KSIs that occur daily on our roads and considerably improve road safety for all road users.