WHIPLASH UPDATE

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Compatibility Concerns Between Cars and Sport Utility Vehicles

The past decade has seen a dramatic shift in the fleet vehicle composition. Light trucks and vans accounted for 20% of the fleet in 1980 and rose to 35% of the fleet by 1997. This disparity change between vehicle mass and characteristics, has resulted in a growing disproportionate crash fatality risk in crashes between disparate vehicle type partners. The growth of the sport utility vehicle (SUV) market, in particular, is astounding, if not ridiculous. Most automobile manufacturers turn out SUVs, which the owners treat more like a luxury car than the sports vehicle they were designed to be. The problem is, should you find yourself–in your passenger car–on the business end of one of these Goliaths, you are very likely to be the big loser vis-a-vis risk for acute injury and outcome.

A recent paper by Gabler and Hollowell (1) looked into the compatibility of cars, light trucks, and vans (LTVs) involved in traffic crashes. They noted in their abstract, "An analysis of U.S. crash statistics shows that, although LTVs currently account for approximately one-third of registered U.S. passenger vehicles, collisions between cars and LTVs account for over one-half of all fatalities in light vehicle-to-vehicle crashes. In these crashes, 81 percent of the fatally injured are found to be occupants of the car. These statistics suggest that LTVs and passenger cars are incompatible in traffic crashes, and that LTVs are the more aggressive of the two vehicle classes." They examined crash test results, field crash statistics, and vehicle measurements, in order to evaluate the design imbalances between cars and LTVs, such as mass, stiffness, and geometry, which lead to these severe crash incompatibilities.

It is important to understand some basic definitions before looking any further into this subject, namely aggressivity and crashworthiness. *Aggressivity* refers to the ability of a car to cause damage to the other car or injury to the other car's occupants. It is the opposite of *crashworthiness,* which describes the subject car's ability to deal effectively with other vehicles in a crash and protect the occupants. The method used to measure the former is as follows: Aggressivity equals the fatalities in collision partner divided by the number of crashes of subject vehicle. This equation is referred to as the Aggressivity Metric (AM).

Passenger cars can be categorized as to relative weight as follows: Mini-car weighs less than 2000, Subcompact car 2000-2499, Compact car 2500-2999, Mid-sized car 3000-3499, and Large car approximately 3500.

The ratio of fatally injured drivers in LTV-to-car frontal collisions, based on the Fatality Analysis Reporting System (FARS) and General Estimates System (GES) database from 1992-1996, are illustrated below. Unity would be 1: 1 (i.e., the occupant of the crash partner would be killed as often as in the subject car).

Vehicle type vs. passenger car	Ratio of fatality
Full sized van	1:6.0
Full sized pickup truck	1:5.3
Sport utility vehicle (SUV)	1:4.1
Minivan	1:3.3
Small pickup	1:1.6

As striking as this relationship for frontal crashes is, the relationship between side-crashing partners is more profound. The first number in the ratio is the driver of the striking or bullet car; the second number of the ratio is for the side-struck occupant driver.

Vehicle type vs. passenger car	Ratio of fatality
Passenger car	1:6
Full sized van	1:23
Full sized pickup	1:17
Utility vehicle	1:20
Minivan	1:16
Small pickup	1:11

Thus, if your vehicle is a passenger car, and you are struck on your driver's door by a full sized van, you are 23 times more likely to die in the crash than the driver of the van. Even between two like-sized passenger cars, the side-struck driver is 6 times more likely to die than the bullet car driver.

The reason for the disparity in risk between cars is simply that the side of the car is relatively soft and only about 6-8 inches wide. By the time the front of the bullet vehicle comes into contact with your body, it is still at fairly high relative speed. Your body's change of velocity (**D**V) in that case will be greater than your car's eventual **D**V. In contrast, the bullet driver has more front end to crush, providing them with much more ride down. The reason for the even greater disparity between passenger cars and vans, for example, is two-fold: (1) these vehicle have generally greater mass, and so the conservation of momentum relationship tells us that the smaller vehicle will experience greater change of momentum and a greater **D**V; (2) just as importantly, the longitudinal portions of trucks, vans, and SUVs continue to be constructed as frame rails—as opposed to the more common unibody construction of most cars—and these are generally much higher than the door sills or rocker panels of most passenger cars. These door sills are the only rigid portion of passenger cars on the side. Moreover, perhaps due to a mandatory bumper requirement on passenger cars, these rocker panels are at relatively uniform height. In contrast, LTVs have no such standard and their bumpers are relatively ornamental and do not necessarily correlate with the level of longitudinal members. They are generally much higher than those of passenger cars. The combined result is that the LTVs greater mass and longitudinal stiffness, coupled with the higher center of mass and location of the longitudinals, gives a greatly enhanced ability of the larger vehicle to intrude into the occupant compartment of the side stuck passenger vehicle.

One final caveat: because LTVs have a higher center of gravity, they are generally less stable on the road than passenger cars, so this component of safety is also worthy of consideration when choosing a new vehicle.

1) Gabler HC, Hollowell WT: The crash compatibility of cars and light trucks. J Crash Prevention and Injury Control 2(l):19-31, 2000.