

An Investigation of Local Accelerator Pedal Geometry Effects on Ankle Motion

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Introduction:

Lower extremity injuries are common outcomes of frontal vehicle collisions. These injuries can result in long-term disability and decreased ambulation. While a large body of research has been performed on injury modes (i.e. dorsiflexion, inversion/eversion, and other combinations), little existing literature has been produced to assess the variation in local geometries in the footwell and their impact on gross kinematic motions of the foot and ankle. This study aims to address how variations in vehicle pedals affect foot interactions for a diverse collection of motor vehicles using an existing database of crash test data.

Objective:

The study aims to understand how vehicle and collision attributes influence pedal geometries, independent brake pedal movement, and ankle kinematics using publicly available full-vehicle crash tests.

Methodology:

This study collected cars' physical features, origins, and occupant ankle responses to identify patterns in testing outcomes. Data was collected utilizing formal reports and available high-speed video from the Insurance Institute for Highway Safety's TechData website for all frontal and side impact tests (Jan. 2023- July 2025). Information on vehicle origin (make, model, year, manufacturer, and manufacturing location), physical attributes (weight, accelerator pedal shape, vehicle classification), and primary ankle kinematic response (inversion/eversion) were recorded for each test. Manufacturers were anonymized during data collection. Duplicate vehicle tests were compared to each other for repeatability but were excluded from other analysis.

Results:

Vehicles primarily consisted of sedans (26) and SUVs (70) across 15 manufacturers. Eight of nine vehicles with multiple tests provided consistent results. Of the 157 total crash tests, 46 resulted in ankle inversion, 85 in ankle eversion, and 26 were inconclusive. Two accelerator pedal types were present, floor mounted and floating. Floating pedals (93) resulted in eversion (51) more often than inversion (23). Floor mounted pedals (64) correlated with eversion in 34 tests and inversion in 21.

Four accelerator pedal geometries were present, bottom thick, diamond, rectangle, and top thick (Figure 1). 129 total brake pedals were recorded from test photos or publicly available documents. The bottom thick pedal (45), diamond (13), and top thick pedal (12) exhibited in equal instances of inversion and eversion. The rectangle accelerator pedal shape (59) showed a greater instance of eversion (48) than inversion (11).

When analyzing brake pedal movement during the crash test (e.g., from intrusion), hatchbacks (100%), wagons (100%), sedans (85%), SUVs (65%), and pickups (63%) did not exhibit evidence of independent brake motion. Minivans (75%) were the only vehicle that exhibited brake pedal movement more often than not.

Independent brake pedal motion by vehicle manufacturer ranged from 0-75%. Manufacturer I resulted in the highest (75%) with Manufacturers J and E between 40% and 50%. The remaining manufacturers exhibited independent brake pedal motion less than 33%.

Conclusions:

The rectangular pedal shape demonstrated a greater incidence of eversion during testing, suggesting that local accelerator pedal geometry might impact ankle motions. Vehicle manufacturer corresponded to independent brake motion better than vehicle type. This suggests that design choices of the pedal geometries and braking system design might unknowingly influence crash outcomes.

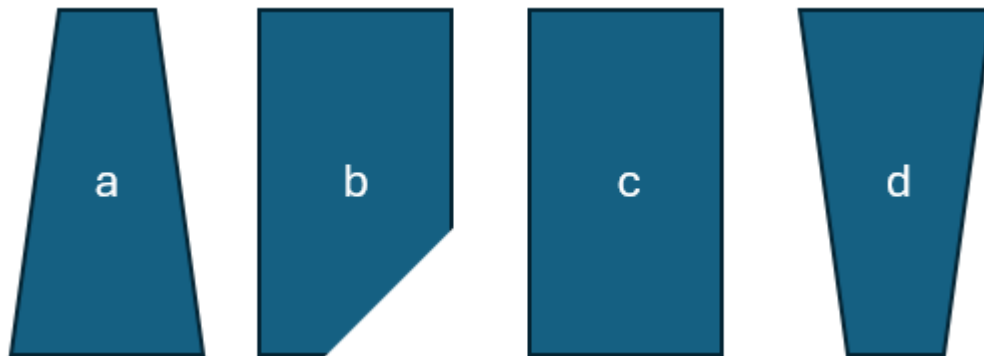


Figure 1. Bottom thick (a), diamond (b), rectangle(c), and top thick (d) accelerator pedal shapes