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Special Crash Investigations: On-Site Reported Vehicle Component Malfunction Investigation; Vehicle: 2017 Dodge Challenger; Location: Arkansas; Crash Date: June 2020

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Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was submitted.

16. Abstract

This report documents the reported right-front-wheel malfunction, crash, and fire of a 2017 Dodge Challenger that struck a metal gate and large tree. The crash resulted in police-reported "C" (possible) injuries to the 23-year-old male driver. The crash occurred on the north roadside of the 4-leg intersection of a three-lane, undivided city street and a two-lane, undivided residential street. The Dodge was approaching the intersection when it crossed over the three-lane roadway and continued off the north roadside. The front of the vehicle struck an iron fence (Event 1) mounted between a metal pole and a masonry column. The Dodge continued north, and the front plane struck a large tree (Event 2). A post-crash fire developed in the engine compartment (Event 3) and had consumed much of the vehicle prior to being extinguished by the fire department. The driver was removed from the vehicle by police officers and was transported by ambulance to a hospital, where he was admitted for 5 days. Through the course of the SCI investigation, it was determined that the damage to the right-front-wheel assembly was caused by the severe impact to the fence and tree. The claim that the right front wheel separated prior to the crash was inaccurate. The right-front-wheel assembly fractured and separated as a result of the crash.

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Special Crash Investigations
On-Site Reported Vehicle Component Malfunction Investigation
Office of Defects Investigation
Case Number: CR20020
Vehicle: 2017 Dodge Challenger
Location: Arkansas
Crash Date: June 2020

Background

This report documents the claim of a right-front-wheel malfunction separation and the crash and fire of a 2017 Dodge Challenger (Figure 1) that struck an iron fence and a large tree. The crash resulted in police-reported "C" (possible) injuries to the 23-year-old male driver. The crash occurred during the dark morning hours of June 2020 and was investigated by a local police agency. The driver claimed that the "entire front passenger wheel completely broke off" and resulted in loss of control of the vehicle. He notified the National Highway Traffic Safety Administration of the crash in July 2020. The investigation was assigned to the Special Crash Investigations team at Crash Research and Analysis, Inc., in July 2020. The team contacted the driver as well as the tow yard holding the vehicle and established cooperation to inspect the vehicle. The vehicle and scene inspections as well as the driver interview were all completed in July 2020.

Figure 1. The 2017 Dodge Challenger

The crash occurred on the north roadside of the four-leg intersection of a three-lane, undivided city street and a two-lane residential street. The Dodge was a two-door coupe occupied only by the driver. He was initially traveling north on the residential street approaching the intersection. The Dodge traveled through the intersection and off the north roadside, where the front plane of the vehicle struck an iron fence (Event1) and a large tree (Event 2). A post-crash fire developed in the engine compartment (Event 3) and had consumed much of the vehicle prior to being extinguished by the fire department. The driver was removed from the vehicle by police officers and was transported by ambulance to a hospital, where he was admitted for 5 days.

The SCI on-site investigation consisted of inspection of the Dodge to document its exterior and interior damage, with particular attention paid to the right-front-wheel assembly. A technical

representative from its manufacturer, Fiat Chrysler Automobiles (FCA), was present and participated in the investigation. The Event Data Recorder (EDR) of the vehicle was located under fire debris in the interior and had sustained fire damage to its internal components. It could not be imaged. The crash site was photographed and mapped by a Nikon total station during the SCI inspection.

Through the course of the SCI investigation, it was determined that the damage to the right-front-wheel assembly was caused by the severe impact to the fence and tree. The claim of the right front wheel separating prior to the crash was inaccurate. The police report did not mention a wheel separation and further indicated no vehicle defects. The right-front-wheel assembly fractured and separated as a result of the crash.

Summary

Crash Site

This crash occurred in the early morning on the roadside of an unlit street. The environmental conditions were clear skies with no wind and a temperature of 22°C (72°F), according to local weather reports. The two-lane undivided residential street had no markings and traversed in a north-south direction with one lane in each direction. The three-lane city street traversed in an east-west direction and had one through lane in each direction, bike lanes in both directions, and a center left turn lane. The roadway markings consisted of solid white edge lines and solid/broken yellow lane lines for the center turn lane. Both roadways were dry, bituminous, and level. The three-lane roadway was crowned with a 2.0% grade on both sides. A crash diagram is included at the end of this report.

Pre-Crash

The Dodge was northbound on the undivided street and approached the intersection (Figure 2) at high but unknown rate of speed. This determination is based solely on the significant damage to the front plane of the vehicle since there was no supporting EDR data and the driver could not remember anything from the crash sequence. As the Dodge approached the intersection, its right front tire/rubber created a mark (Figure 3) that began on the two-lane street and extended into the crossing street. The tire mark arced to the left and began as a full tread width mark. The mark then appeared to narrow and wobble, transitioning to a scratch on the sidewalk located at the curb cut-out in the northwest quadrant of the intersection. This scratch was most likely caused by contact from the right front wheel rim, as the tire may have deflated at some point along this trajectory. The total length of the tire and wheel mark was 31.5 m (103.3 ft). There was no evidence of a curb strike along this trajectory. The physical evidence of the mark on the roadway appeared to be consistent with a tire that was airing out or going flat, allowing the rim edge to scratch the road/sidewalk. The cause of the air-out remains undetermined. It was possible that the Dodge struck a curb earlier during this drive-cycle. A small dent to the right front rim was observed during the SCI vehicle inspection.

Figure 2. North view, the Dodge's approach to the T-intersection

Figure 3. North view, start of tire mark and approach to the intersection

Crash

The front of the Dodge struck and penetrated the iron fence (Event 1, Figure 4) that was located 6.4 m (21 ft) north of the curb and extended east and west, parallel to the roadway. The fence was an aged, decorative structure that was attached at four points to a masonry column and a steel post. The Dodge then continued north 6 m (19.7 ft), where the front plane struck a tree (Figure 5) which was 63 cm (24.8 in) in diameter (Event 2). During the SCI interview, the driver presented a video he had obtained from the police, which showed the vehicle remaining in contact with the tree at final rest. The video also showed that a major fire (Event 3) developed as a result of the crash, which consumed a significant portion of the vehicle. The fire was extinguished by the responding firefighters. This video could not be copied to an SCI thumb drive and was not obtained.

Figure 4. North view, roadway departure and impact with fence (replaced since crash)

Figure 5. North view, tree point of impact and fire

Post-Crash

The doors were jammed shut, and according to the fire department's report, the driver was removed by police officers. The fire consumed much of the vehicle, and the driver did sustain some burns. The driver was transported from the crash scene by ambulance to a level 1 trauma center, where he was admitted for 5 days.

2017 Dodge Challenger

Description

The Dodge was a rear-wheel drive, 5-passenger, 2-door coupe identified by the vehicle identification number 2C3CDZBT4HHxxxxxx. It had a 5.7 liter, 8-cylinder engine; an 8-speed automatic transmission; 4-wheel antilock brakes; emergency brake preparation; emergency assist braking; stability control; and traction control. The wheelbase was 295 cm (116.1 in) and the curb weight was 1,852 kg (4074 lb). The vehicle's gross vehicle weight rating was 2,404 kg (5,300 lb). Front and rear weight ratings could not be determined. The vehicle was equipped with the manufacturer's recommended tire size of P245/45ZR20. All tires had a minimum 5 mm of tread.

Exterior Damage

The Dodge sustained damage to the front plane during the impact with the iron fence. Presumably, the bumper fascia and hood were directly contacted, but specific damage is unknown due to the overlapping damage from the ensuing tree impact damage. The WinSMASH program could not be used to determine velocity change for this event because impacts with yielding objects are out of scope for the program. The collision deformation classification was 12FDEW99 ("99" represents an unknown extent zone).

The Dodge sustained front plane damage from the impact with the tree, which measured 63 cm (24.8 in) in diameter. The bumper beam, bumper fascia, grille, hood, left and right headlamp and turn lamp assemblies, radiator, and engine were directly damaged (Figure 6). It was during this impact that the right-front-wheel assembly became detached from the vehicle. The direct damage started 16 cm (6.3 in) left of the right end of the bumper beam and extended 107 cm (42.1 in) to the left. The crush measurements were documented on the front bumper beam; the Field L was 117 cm (46.1 in). The final residual crush values were C1 = 5 cm (2.0 in), C2 = 53 cm (20.9 in), C3 = 91 cm (35.8 in), C4 = 123 cm (48.4 in), C5 = 108 cm (42.5 in), and C6 = 93 cm (36.6 in). The maximum residual crush was 123 cm (48.4 in) and was located 70 cm (27.6 in) left of the right end of the bumper beam.

Figure 6. Front plane damage on the Dodge

The damage algorithm of the WinSMASH program was used to calculate the severity of the crash. The Dodge's total delta V was 101 km /h (63 mph). The longitudinal and lateral velocity

changes were -101 km/h (-63 mph) and 0 km/h, respectively. The results were reasonable. The CDC for the front plane impact was 12FDEW5 (0 degrees).

The post-crash fire (Event 3) resulted in severe damage to the entire vehicle. All combustible materials in the engine compartment and much of the interior were severely to completely consumed in the fire.

Interior Damage

The interior of the Dodge was mostly consumed by the fire (Figure 7). No glazing remained, and both doors were jammed shut. All combustible material in the vehicle's interior, including the seat coverings and cushions, polymer trim panels/fascia, door and floor coverings, headliner, and all other interior components were mostly or totally consumed by the fire. Charred and melted remnants of the various materials covered the floor of the vehicle.

Figure 7. Completely burned front row

Manual Restraint Systems

The Dodge was equipped with manual 3-point lap and shoulder seat belts for the five seat positions. Buckle and retractor seat belt pretensioners were present in both front row seating positions. All belt webbing and hardware were consumed by the fire, and the driver's seat belt latch plate could not be located. Injury data and the driver's kinematic pattern indicate that the driver was not belted at the time of the crash.

Supplemental Restraint Systems

The Dodge was equipped with certified advanced 208-compliant frontal air bags, front seat-mounted side impact air bags, and side impact/rollover IC air bags. The driver's and passenger's frontal air bag deployed upon impact with the tree. Portions of the combustible material and components of the air bags were burned by the fire, but remnants of both frontal air bags remained. Due to the extent of the fire, it could not be determined if the side impact and IC air bags deployed.

NHTSA Recalls and Investigations

A VIN-based query of the NHTSA's recall database (www.nhtsa.gov/recalls) for the 2017 Dodge Challenger as of the date of this report indicated that there were no open recalls or investigations.

Right-Front-Wheel Assembly Discussion

The concern of the driver was the possible malfunction/separation of the right-front-wheel assembly, which was claimed to have separated from the vehicle while traveling and led to loss of control and the subsequent crash. This claim was not supported by the physical evidence observed during the SCI scene inspection. Had the tire separated during the vehicle's approach to the fence and tree, the right front undercarriage would have contacted and gouged the ground leading up to the impacts. Additionally, a ground contact of this nature would likely have altered the vehicle's pre-crash dynamics, causing it to rotate clockwise as it slid toward the tree.

The driver's impression of a control loss may be related to the possibility that the right front tire had aired out on the approach to the crash site. This air-out was evidenced by the transition of the pre-crash tire mark from a wide tread pattern that narrowed to a scratch mark caused by the outer rim edge as it contacted the surface of the sidewalk. At the inspection, a small dent was noted on the inside surface of the right front wheel rim that might be the source of the air-out. This dent may have been caused by a curb strike earlier during the vehicle drive cycle. Alternatively, it may have occurred at the tree impact. The exact cause of this dent remains undetermined.

Figure 8. Image depicting the separated right-front-wheel assembly of the Dodge. The fracture points are denoted by arrows.

Figure 9. Image depicting the fractured lower knuckle and steering components of the Dodge

At the inspection, the right-front-wheel assembly and its support knuckle were lying with the damaged vehicle (Figure 8). It was observed that the cast knuckle had fractured at its connections with the steering struts (Figure 9). The nature and pattern of the casting fracture was indicative of a blunt impact force. The orientation of the tree impact was offset to the right of the vehicle centerline, and the depth of crush involved the right-front-wheel assembly and its supporting structures. This blunt impact fractured the casting and caused the right-front-wheel separation. The SCI investigation determined that there was no anomaly concerning the Dodge's right-front-wheel assembly.

For reference, Figure 10 is an image of an undamaged right front suspension knuckle for a Dodge Challenger with the fracture areas highlighted. The knuckle was identified by the MOPAR part number 5168420AE.

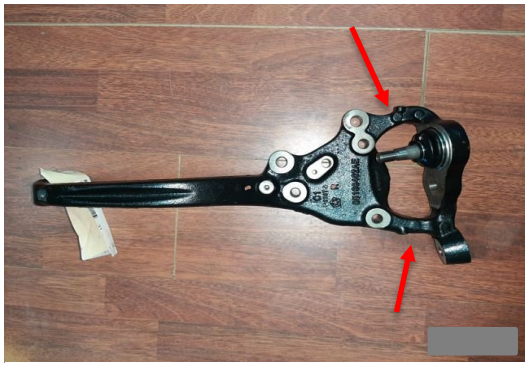


Figure 10. Exemplar Dodge Challenger right front suspension knuckle

Dodge Challenger Occupant

Driver Demographics

Age/sex:	23 years/male
Height:	191 cm/75 in
Weight:	67 kg/148 lb
Eyewear:	None
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Full rear
Manual restraint usage:	None
Usage source:	None
Air bags:	Frontal, deployed; seat-mounted and IC air bags, unknown if deployed
Alcohol/drug data:	No test administered
Egress from vehicle:	Removed while unconscious
Transport from scene:	Transported by ambulance
Medical treatment:	Hospitalized for 5 days

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Right proximal femoral shaft fracture with butterfly fragments	853261.3	Isolated IPC Front – Left lower instrument panel (includes knee bolster)	Probable
2	Small bilateral pulmonary contusions to both lower lobes and right middle lobe	441411.3	Tandem IPC Primary: Left Air Bag – Steering wheel hub Secondary: Front – Steering wheel (combination of rim and hub/spoke)	Possible Probable
3	Right medial malleolus pilon fracture	854331.2	Isolated IPC Primary: Floor – Foot controls including parking brake Alternate: Floor – Floor (including toe pan)	Probable Possible
4	Anterior right talar neck chip avulsion fracture	857251.2	Isolated IPC Primary: Floor – Foot controls including parking brake Alternate: Floor – Floor (including toe pan)	Probable Possible
5	Right lateral 2nd rib fracture	450201.1	Isolated Front – Steering wheel (combination of rim and hub/spoke)	Probable

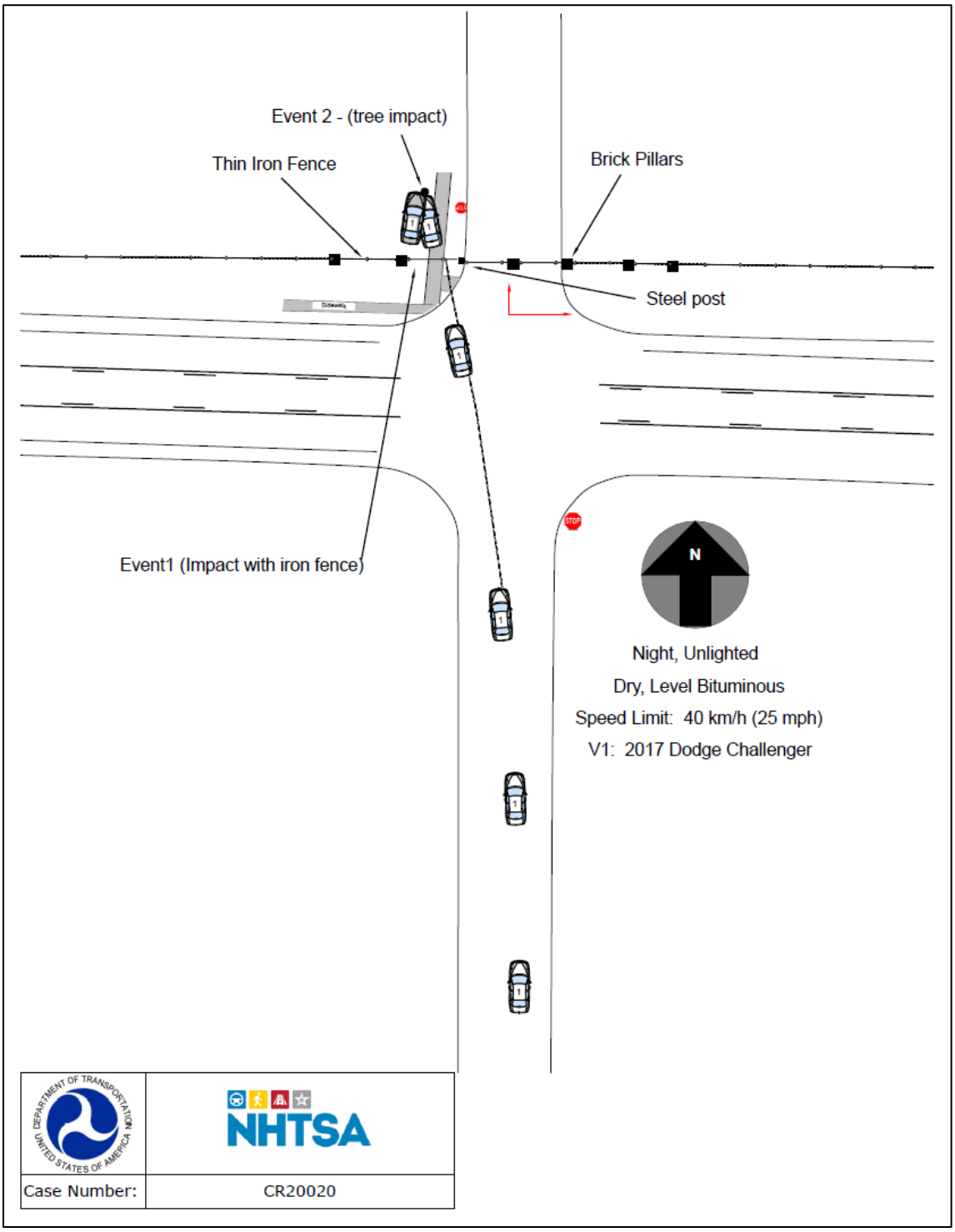
Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
6	Right L1 transverse process fracture	650620.1	Isolated Front – Steering wheel (combination of rim and hub/spoke)	Possible
7	15 x 15 cm burn to right thigh*	912006.1	Isolated Non-contact Injury – Fire in vehicle	Certain
8	Multiple burns to right upper arm*	912002.1	Isolated Non-contact Injury – Fire in vehicle	Certain
9	Multiple burns to right forearm*	912002.1	Isolated Non-contact Injury – Fire in vehicle	Certain
10	25 cm burn to upper left arm*	912002.1	Isolated Non-contact Injury – Fire in vehicle	Certain
11	Second degree burns to fingertips of left hand	912006.1	Isolated Non-contact Injury – Fire in vehicle	Certain
12	Chest abrasions, NFS	410202.1	Isolated Front – Steering wheel (combination of rim and hub/spoke)	Probable
13	Small right arm abrasions	710202.1	Isolated Left Air Bag – Steering wheel hub	Possible
14	Small left arm abrasions	710202.1	Isolated Left Air Bag – Steering wheel hub	Possible
15	Right thigh hematoma	810402.1	Isolated Front – Steering wheel rim	Possible
16	Small abrasions over right tibia	810202.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Probable
17	Small abrasions over left tibia	810202.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Probable
18	Small abrasions over left knee	810202.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Probable

*Source: hospital records. *Driver interview (in-person observation).*

Driver Kinematics

The driver was seated with his seat adjusted to the full-rear track position. His body posture is unknown. The driver's injuries and his kinematic pattern indicate that he was not belted. The front plane impact with the fence probably did not affect the driver's seated position. At impact with the tree, the driver responded to the 12 o'clock direction of force with a forward trajectory. He loaded the deployed air bag and steering assembly. This impact caused a transverse process fracture of a lumbar vertebrae, an upper front left rib fracture with lung contusions, and arc-shaped abrasions on his chest. He also sustained a fractured right femur from contact to the lower instrument panel and a closed pilon fracture of his right tibia and talar neck, probably from his foot on the brake pedal or possibly from contact with the toe pan. The driver also sustained a 15 cm x 15 cm (5.9" x 5.9") severe burn on the middle of his right thigh, sporadic burns from shoulder to wrist on his right arm, and a 25 cm (9.8 in) burn on the inside of his left upper arm from the post-crash fire. The driver was removed from the vehicle while unconscious by the responding police officers and was transported by ambulance to a level 1 trauma center, where he was admitted for 5 days.

Crash Diagram



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