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イタルダ インフォメーション

Special
feature

Characteristics of serious-injury accidents viewed from perspective of rollover-accident cases



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1 Introduction

We imagine that at the sites of traffic accidents, in the news, and so on, you occasionally see situations in which a vehicle has rolled over.

At the Institute for Traffic Accident Research and Data Analysis, we have been continuously carrying out comprehensive traffic accident case studies regarding major accidents in the area in and around Tsukuba City, Ibaraki Prefecture since 1992. Among such accidents are those in which a vehicle has rolled over. We have been investigating a variety of such accidents with regard to factors such as the status of road traffic at the time of the accident, the degree of injuries of the occupants, and the status of damage to vehicles, and we have been compiling this information in a database of traffic accident case studies (hereinafter “micro statistics”).

* Here, “rollover” refers to a situation in which a vehicle has rotated 90 degrees or more over its front-rear axis or left-right axis.

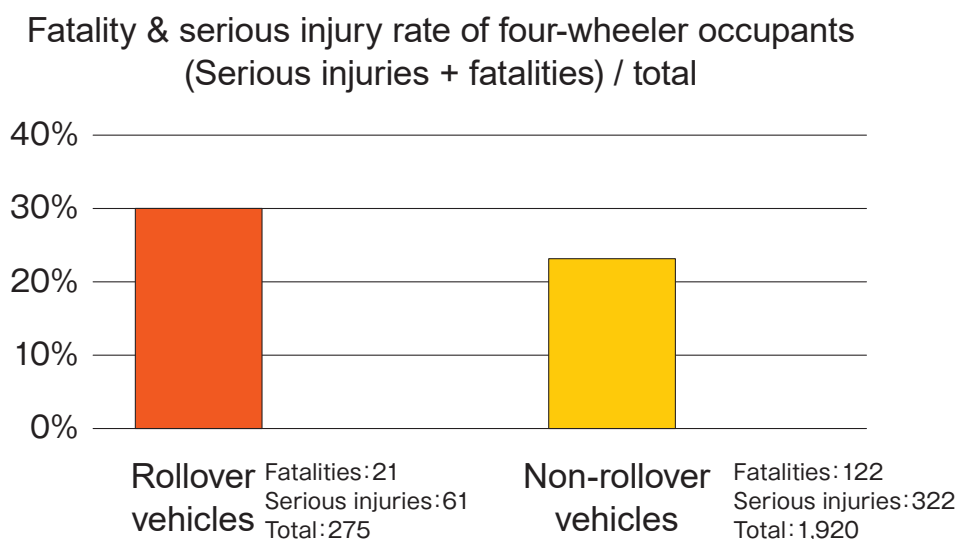


Figure 1. Fatality & serious injury rate of four-wheeler occupants in micro statistics (2010 to 2020)

In micro statistics from 2010 to 2020, 1,625 four wheelers were involved in vehicle-alone accidents and vehicle-to-vehicle accidents. In regard to these vehicles, Figure 1 compares the fatality & serious injury rate of occupants of rollover vehicles with that of non-rollover vehicles. It is apparent that the occupants of rollover vehicle have a higher fatality & serious injury rate.

In this paper, we will use micro statistics to look at why occupants end up sustaining serious injuries when vehicles roll over.

2 Status of occurrences of rollover accidents in micro statistics

Based on micro statistics from 2010 to 2020, Table 1 shows the numbers of four wheelers that caused vehicle-to-vehicle accidents in which vehicles collide with each other, and vehicle-alone accidents in which a lone vehicle collides with a telephone pole or protective barrier.

Looking at the table, it is apparent that among the 1,625 vehicles, 172 rolled over. Thus, among the vehicles in four-wheeler accidents, approximately 10% rolled over. We imagine that some of you may find it surprising just how often rollovers occur. The ratio of rollover accidents is the highest regarding “vehicle-alone,” at 21%, and this is followed by “side-collision vehicle-to-vehicle” at 14%.

In the next section, we will use specific cases that have occurred in order to shed light on rollover accidents that are in the forms of “vehicle-alone accidents” and “side-collision vehicle-to-vehicle accidents.”

Table 1. Number of vehicles involved in rollover accidents (2010 to 2020)

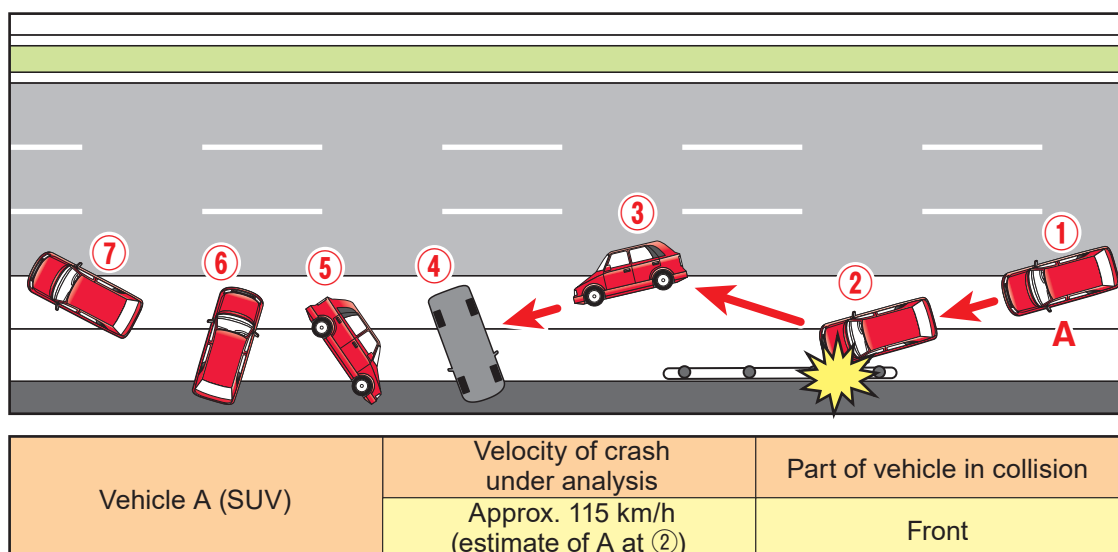
		Overall	Rollover	Non-rollover	Ratio (Rollovers / total)
Vehicle-to-vehicle	Front collision	380	9	371	2%
	Side collision	747	101	646	14%
	Rear collision	230	6	224	3%
Vehicle-alone		268	56	212	21%
Total		1,625	172	1,453	11%

3 Specific cases of rollover accidents that have occurred

[Case 1] Vehicle-alone accident in which vehicle collided with guardrail on expressway, rolled over, and rotated one time

<Overview of accident>

While running on an expressway with three lanes per side that had good visibility and was gently curving to the left, Vehicle A collided with the guardrail on the left side (②). Following this, the vehicle rolled over onto its right side (③), went up a slope, and then further rotated (④ to ⑥). As a result of this, it advanced onto the road and then came to a stop (⑦).


Figure 2. Status of occurrence of rollover accident (Case 1)

<Status of injuries sustained, and believed causes>

At ③ in Figure 2, Vehicle A rolled over and its curtain airbag was deployed. Nevertheless, it was observed that due to the vehicle's colliding with the road surface, there was breakage of the side window glass on the driver's seat side, breakage of the sunroof¹ glass, and deformation of the A-pillar² inside the vehicle on the right side.

Due to these circumstances, the head of the driver occupant went outside of the vehicle, and collided with the road surface. It seems that as a result of this, the occupant sustained head injuries such as a cerebral injury and a skull fracture.

In regard to the passenger seat occupant, the seatbelt pretensioner^{*3} was activated, so the occupant's shoulder was in a fixed state when the vehicle rolled over. Thus, when Vehicle A was at ③, the occupant's body was tilted forward on the right side and a heavy load was placed on the shoulder blade area, causing a bone fracture.

The rear seat occupant was not wearing a seatbelt so was thrown out of the vehicle through the sunroof area. The occupant's head collided with the road surface, and it seems that this caused injuries such as a cerebral injury and a skull fracture.

**Table 2. Injuries of occupants caused by rollover of Vehicle A,
and injury inflicting objects (Case 1)**

Riding position	Passenger restraint system	Degree of injury	Injuries	Injury inflicting objects
Driver's seat	Seat belt use Curtain airbag	Fatality	Cerebral injury Skull fracture	Road surface
Passenger seat	Seat belt use	Slight injury	Scapula fracture	Seatbelt
Left-side rear seat	Seat belt non-use	Fatality	Cerebral contusion Skull fracture Pelvic fracture	Road surface

*1 Skylight in roof area

*2 Pillars that connect the vehicle body with the roof on the two sides of the windshield

*3 This is a device that instantly tightens the seatbelt when there is a collision. The forward movement of the upper body is quickly reduced so the effectiveness of the seatbelt is increased.

[Case 2] Vehicle-alone accident in which vehicle collided with curb, iron railing, and standing tree, and was leaning against tree

<Overview of accident>

Vehicle A was running at approximately 70 km/h on a road that had one lane per side and was curving to the right, when there was poor forward visibility due to heavy rain. Subsequently, due to the driver's looking away from the road to the left and right, the vehicle ended up going into the lane of opposing traffic and then collided with the curb (②), a reflector (③), an iron railing(④), a standing tree, and a telephone pole (⑤ and ⑥). The vehicle rolled over and was in a state in which it was leaning against the standing tree and telephone pole.

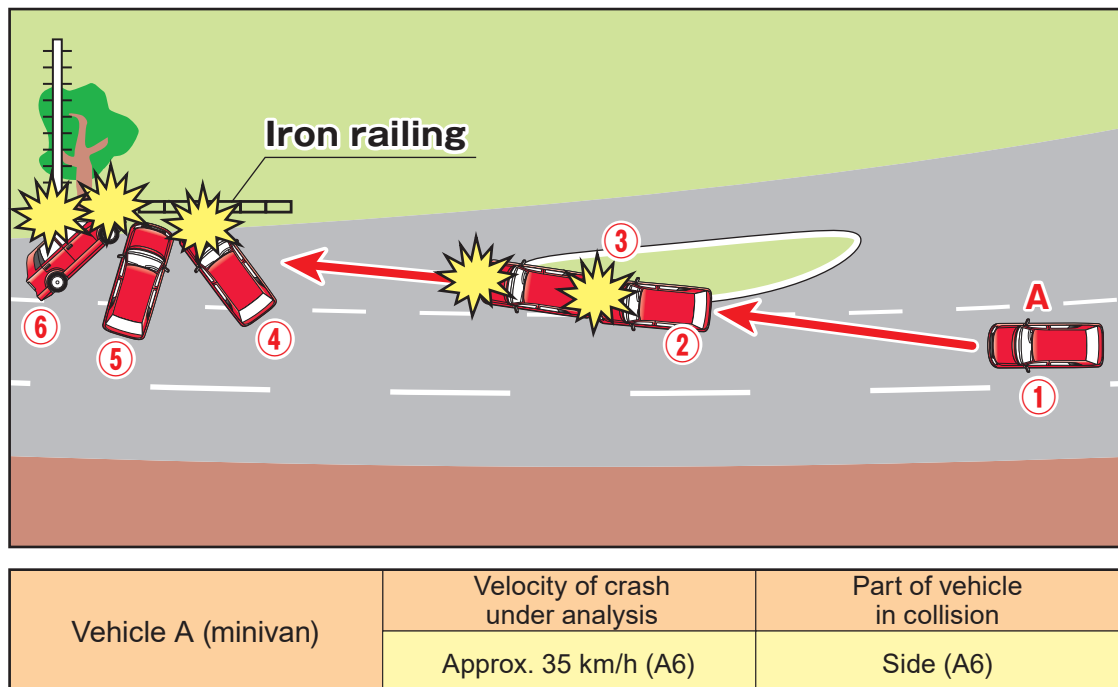


Figure 3. Status of occurrence of rollover accident (Case 2)

<Status of injuries sustained, and believed causes>

Due to the collision with the iron railing, the vehicle began skidding in the clockwise direction, and this led it to roll over onto its left side. It was observed that during this process, the left side of Vehicle A collided with a standing tree and a telephone pole. Due to these circumstances, the driver's body was swung substantially to the left, causing the left side of the chest to hit the console box between the driver's seat and passenger seat. Furthermore, due to the rollover of the vehicle, a heavy load was placed on the left side of the chest, and it seems that the above caused a pulmonary contusion and multiple rib fractures. Since it was the bottom portion of the vehicle that collided with the curb, the impact to the sensor area was small, and it seems that for this reason, the airbag was not deployed.

Table 3. Injuries of occupants caused by rollover of Vehicle A, and injury inflicting objects (Case 2)

Riding position	Passenger restraint system	Degree of injury	Injuries	Injury inflicting objects
Driver's seat	Seat belt use Airbag non-deployment	Serious injury	Pulmonary contusion (left) Multiple rib fractures (left)	Console box

[Case 3] Vehicle-to-vehicle accident in which two vehicles collided and then one of them collided with signal pole while on its side

<Overview of accident>

At a signalized intersection, Vehicle A began turning right from the right-turn lane, and then discovered Vehicle B, which had proceeded straight forward from the first lane on the opposing side, just before colliding with Vehicle B. Although Vehicle A applied the brakes, this failed to prevent the collision, and thus Vehicle A collided with Vehicle B on its right side (A ③ and B ②).

After colliding with Vehicle A, Vehicle B rolled over onto its left side and began sliding (B ③). At this time, its windshield collided with the signal pole of the intersection (B ④) and then came to a stop while it was still rolled over (B ⑤). Vehicle A came to a stop in front of the pedestrian crossing following the collision (A ④).

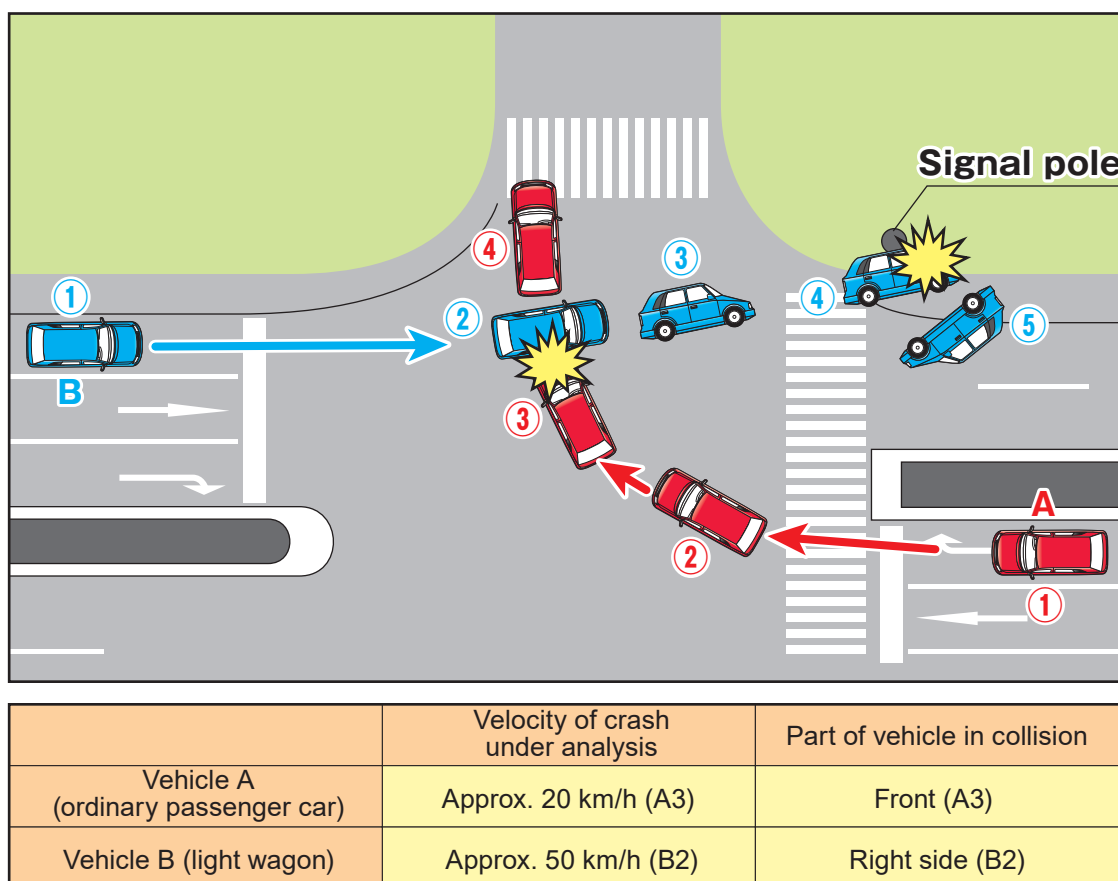


Figure 4. Status of occurrence of rollover accident (Case 3)

<Status of injuries sustained, and believed causes>

Vehicle B collided with the signal pole on the left side of its direction of travel while in a state of being rolled over. Deformation was observed regarding its windshield, pillar on the left side of the windshield, and roof^{*4} on the left side inside the vehicle.

The occupants were not using seatbelts, and due to the above circumstances, the occupants' bodies moved in the forward direction. As a result, the head, face, and chest areas of the driver and passenger seat occupant collided with the broken windshield and pillar on the left side of the windshield, and it seems that this caused their injuries to be serious ones.

**Table 4. Injuries of occupants caused by rollover of Vehicle B,
and injury inflicting objects (Case 3)**

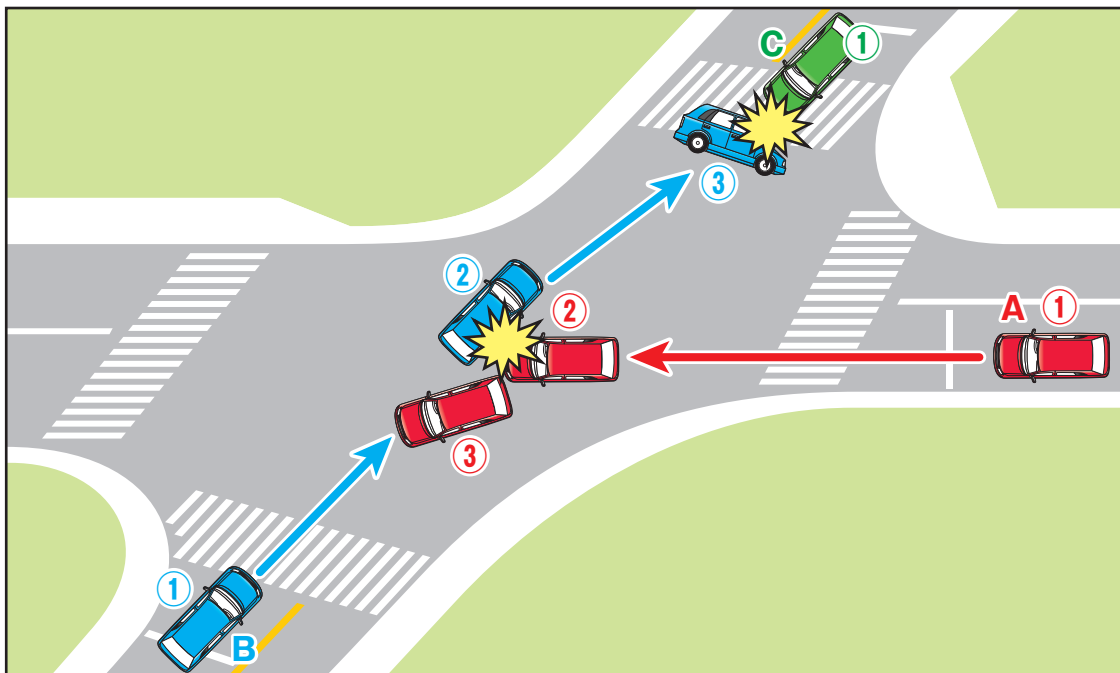
Riding position	Passenger restraint system	Degree of injury	Injuries	Injury inflicting objects
Driver's seat	Seat belt non-use Airbag non-deployment	Serious injury	Subdural hematoma Cerebral contusion Skull fracture, etc.	Caused by deformation of interior
Passenger seat	Seat belt non-use Airbag non-deployment	Serious injury	Double-lung pulmonary contusion Cerebral contusion Facial bone fracture, etc.	Caused by deformation of interior

*4 Roof of wheeler

[Case 4] Vehicle-to-vehicle accident in which two vehicles collided and then one of them collided with another stopped vehicle while on its side

<Overview of accident>

While proceeding straight ahead at a signaled intersection with poor visibility, Vehicle A collided with the right side of Vehicle B, which had been proceeding on a road coming from the left (A ② and B ②). Following the impact, Vehicle B began skidding in the clockwise direction, and then began sliding with its left side on the ground. At this time, the roof portion of Vehicle B collided with Vehicle C, which had been stopped while waiting to turn right, and then Vehicle B came to a stop (B ③ and C ①).



	Velocity of crash under analysis	Part of vehicle in collision
Vehicle A (light wagon)	Approx. 25 km/h (A2)	Front (A2)
Vehicle B (minivan)	Approx. 60 km/h (B2)	Right side (B2)
Vehicle C (ordinary passenger car)	0 km/h (C1)	Front (C1)

Figure 5. Status of occurrence of rollover accident (Case 4)

<Status of injuries sustained, and believed causes>

Since Vehicle B collided with Vehicle C while in a state of being rolled over, it was found to have substantial deformation of its roof area on the interior. Due to such circumstances, the driver's head collided with the roof, and this caused injuries such as a cerebral hemorrhage and a cerebral contusion. The passenger seat occupant's head collided with the roof and pillar, and it seems that this caused injuries such as head trauma.

Table 5. Injuries of occupants caused by rollover of Vehicle B, and injury inflicting objects (Case 4)

Riding position	Passenger restraint system	Degree of injury	Injuries	Injury inflicting objects
Driver's seat	Seat belt use Airbag non-deployment	Serious injury	Cerebral hematoma Cerebral contusion, etc.	Other party's vehicle Roof
Passenger seat	Seat belt use Airbag non-deployment	Slight injury	Cervical sprain Head banging, etc.	Roof Pillar

4 Summary

Based on micro statistics that we have been compiling regarding the area in and around Tskuba City, Ibaraki Prefecture, we have examined why injuries become serious ones when vehicles roll over, as well as the situations that lead vehicles to roll over following impacts, the injury inflicting objects, and so on. In regard to the accident cases that were covered, the reasons that the rollover accidents led to serious injuries seem to be as follows.

- When occupants are not using seatbelts, they end up being thrown outside of their vehicle through a broken sunroof or side window, etc.
- Bodies are flung to the sides so injuries are sustained from collisions with interior parts such as console boxes.
- When a vehicle's roof or pillar directly collides with a structure on the road or another vehicle during or after a rollover, the interior of the vehicle may be significantly deformed, and the deformed portions of the vehicle may collide with the head or chest, causing serious injuries.
- When the A-pillar becomes deformed on the interior side during a rollover, there is an increased likelihood that the head will end up going outside of the vehicle.

5 Conclusion

When a vehicle has rolled over, operation by the driver becomes difficult, and significant harm can be caused. Therefore, in order to prevent rollover accidents, it is first of all necessary to pay close attention in the direction of travel, and to avoid driving operations that may destabilize the vehicle, such as speeding and abrupt steering. Furthermore, in order to reduce the harm from rollovers, it is necessary for seatbelts to be properly used, including in the rear seats.

In addition, when one's vehicle collides with the side of another vehicle that is traveling, the other vehicle may be rolled over even if one's vehicle is traveling at a low speed. As such, it is necessary to be especially careful regarding vehicles approaching from the sides at intersections and so on.

It has become clear¹⁾ that in recent years, vehicles that are relatively high off the ground and are especially prone to rollovers, such as minivans and light "height wagons," have been gaining popularity, and thus even safer driving is needed in order to avoid causing and becoming involved in rollover accidents.

(Hiroki Kobayashi)

参考文献

- 1) 小林弘樹：車両横転事故の傾向と特徴～マイクロデータによる分析～、
(公財)交通事故総合分析センター 第24回交通事故・調査分析研究発表会、2021
- 2) 「特集 車両の横転事故」イタルダインフォメーションNo.65 ITARDA(2006)

<お詫びと訂正>

イタルダ・インフォメーションNo.139とNo.141に誤記がありました。正しくは下記になります。お詫びして訂正いたします。

■No.139:P1の図1の横軸【運転者年齢】

・55～64歳の ■ 人対車両の数値は<28>、 ■ 車両単独の数値は(誤)<28>⇒(正)<31>となります。

■No.141:P7の図9円グラフ左上、人的要因の有無(n=65)⇒人的要因の有無(n=68)

■No.141:P9の表-2【発生場所】で (誤)道路線形⇒(正)道路形状

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