

Pelvic Injury Mechanisms among Motorcyclists

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I. INTRODUCTION

Pelvic injuries are an often overlooked injury to motorcyclists involved in crashes, but represent a substantial proportion of injuries to motorcycle riders [1]. There has been minimal research into the mechanisms involved in these pelvic injuries. Studies which have investigated pelvic injuries have identified the petrol tank as a major cause of injury which is indicated by an indent in the motorcycle fuel tank from the crushing force of the rider's pelvis on the fuel tank following the crash [1-2]. Additionally, Wobrock et al. [3] discovered using Madymo simulation that the force on the pelvis increases with an increasing tank angle.

This study examined the injury mechanisms involved in pelvic injury in motorcycle crashes in Australia.

II. METHODS

In-depth data collected from 139 motorcycle crashes occurring in Sydney and Adelaide, Australia, were used to study pelvic injury mechanisms. NSW cases were included if the rider was at least 16 years of age, the rider was admitted to hospital and consent was obtained. Adelaide crashes qualified as a case if at least one crash participant (rider, vehicle occupant or pedestrian) had to be transported to hospital. In-depth methods included scene inspection, motorcycle inspection, clothing inspection, examination of medical records and in-depth rider interviews. Based on evidence gathered during data collection, rider kinematics during and immediately following the crash was investigated and from this, the cause of injury determined. Pelvic injury due to the motorcycle fuel tank, including fractures, soft tissue injuries and internal injuries of the lower abdominal cavity, was generally determined from denting of the motorcycle fuel tank.

III. INITIAL FINDINGS

From the sample of 139 crashes, pelvic injuries occurred in 30 cases (22%). The majority of pelvic injury cases occurred in frontal or oblique collisions with another moving vehicle (73%), one involved a car impacting the rear of the motorcycle and the remainder occurred in loss of control incidents. The loss of control incidents involved impacts with road side objects (4/30, 13%), other vehicles (2/30, 7%) or the roadway (1/30, 3%).

The petrol tank was the cause of pelvic injury in 27 cases (90%). There were a further three cases where the rider reported they had impacted the fuel tank and denting of the fuel tank was observed in two of these, but no injury occurred. Pelvic injuries due to the fuel tank only occurred in collisions where the rider experienced forward momentum following impact. Among the 139 cases, a total of 60 riders experienced forward momentum following impact and 45% of these sustained pelvic injury – see Figure 1. All except two of the riders were ejected from the motorcycle following the collision.

Motorcycles ridden by riders who suffered pelvic injuries from the fuel tank (n=27) were predominantly sports motorcycles (n=13), followed by cruisers (n=8), standards (n=4), touring (n=1) and café racers (n=1). Looking at the 60 cases where riders experienced forward momentum post impact, pelvic injury occurred more often in cruisers (80%) than in other motorcycle types (45%) – see Figure 2. Controlling for motorcycle type, the likelihood of pelvic/abdominal injury significantly increased with increasing petrol tank angle ($p < 0.05$).

The majority of injuries due to contact with the fuel tank involved fracture of the pelvic ring (19/27, 70%). Bladder injuries also occurred in four cases (15%) and involved haematomas (n=2), laceration and herniation (n=2). External injury to the scrotal/testicular, perineal and groin regions were common (67%). One rider also sustained injury to upper abdominal organs (liver, spleen and small bowel); however, it appears this rider may have impacted a concrete culvert after leaving the motorcycle.

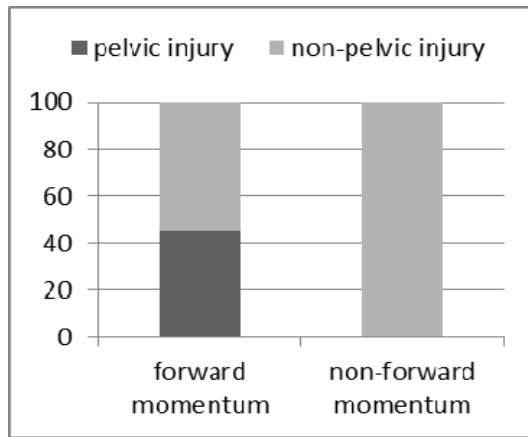


Figure 1. Occurrence of pelvic injury in forward momentum cases

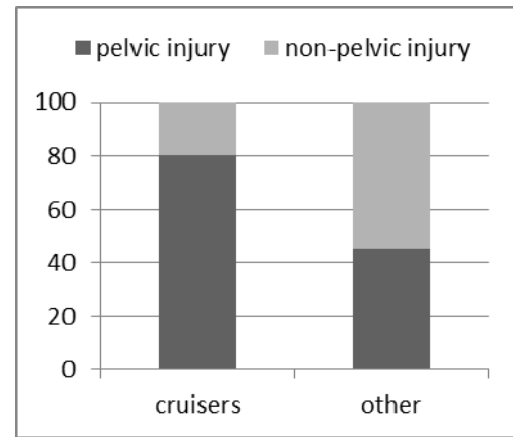


Figure 2. Number of pelvic injuries on different motorcycle types

The remaining cases of pelvic injury involved the rider contacting other vehicles (n=2) or road side objects (n=1). Injuries associated with contact with another vehicle included one rider who suffered a vertical shear fracture of the right pelvis due to an asymmetric axial load, transmitted through the feet of the rider on impact with the other vehicle. The other involved a rider who slid underneath a truck and was caught and dragged along with the truck for approximately 150m. This rider suffered a large degloving injury of the left thigh, groin, pelvis and abdominal wall and an open book pelvic fracture due to the tyre of the truck as it travelled over the rider. The third case involved a rider who sustained a fracture of the pelvic bone due to the impact with an Armco guardrail.

IV. DISCUSSION

This study demonstrates that contact with the motorcycle fuel tank is a major cause of pelvic injury in motorcycle crashes, and these predominantly occur in frontal or oblique collision configurations.

It was noted that riders of cruisers were more likely to sustain a pelvic injury than other motorcycle types. This appears to contradict the relationship between the petrol tank angle and level of pelvic loading reported by Wobrock et al. [3], as cruisers have a more gradual incline. However, it more likely represents two different mechanisms of injury associated with petrol tank contact. Pelvic injury in cruiser riders may be dependent on other fuel tank dimensions and/or rider posture, with the legs stretched out and the rider upright instead of leaning forward over the fuel tank. This posture may change the rider kinematics with the rider more likely to slide forward into the tank than be ejected upward and over the handlebars as is more likely to be the case in sports bikes etc. This latter mechanism is likely to be more reliant on tank angle and is supported by our observation that tank angle is significant when motorcycle type is controlled.

Common injuries seen among riders who had contacted the fuel tank included multiple and symmetrical fractures, bladder injuries and external injuries to the scrotal/testicular, perineal and groin regions. Pelvic injuries which did not occur from contact with the fuel tank differed in asymmetry of loading and did not commonly involve injury to the bladder.

This study was limited by the small convenience sample. Further investigation with a larger sample of riders with pelvic fractures would assist in understanding the patterns of injury to riders who contact the motorcycle fuel tank.

This research is important in investigating the cause of injury in an often overlooked injury which frequently occurs in motorcycle accidents. The next stage is to investigate how to reduce the occurrence and severity of these injuries. Future work will involve examining the effect of the tank angle and rider posture on the pelvic injury outcome in crashes.

V. REFERENCES

- [1] Ouellet JV, Hurt HH, AAAM, 1981
- [2] de Peretti F et al., Injury, 1994
- [3] Wobrock J et al., IRCOBI, 2006