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Brief Report

Elite Motorcycle Racing: Crash Types and Injury Patterns in the MotoGP Class☆

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ABSTRACT

Background: Crashes are a small but regular feature of elite motorcycle racing. These crashes provide a novel opportunity to benchmark and analyze motorcycle crash mechanics, crash types, and associated injuries at high speeds in a cohort of riders who are well protected and in a controlled environment.
Purpose: The purpose was to benchmark the prevalence of injuries, categorize crash subtypes, and determine associated injury patterns.
Methods: This was an institutional review board–approved, prospective observational cohort study of MotoGP riders for 1 racing season in 3 venues. Accident type was determined by race-marshal report and visual analysis of race footage for each crash. Accident types were defined as lowside (falling toward the inside of the turn), highside (falling over and toward the outside of the turn), and topside (going over the handlebars of the motorcycle). Specific injuries and hospital admission data were collected using a standardized data collection form. Basic descriptive statistics were performed on all categorical variables. We used the exact binomial test examine the association between accident type and retirement from race, transport to medical building, transport to hospital, and injuries sustained.
Results: Crash prevalence was 9.7 per hundred rider hours. There were 78 crashes: 58 lowsides, 13 highsides, 2 topsides, and 5 indeterminate. In the lowside group (n = 58), 19 (95% confidence interval [CI], 0.21-0.46) riders retired, 0 required emergent transportation to the track facility or to the hospital, and 1 (95% CI, <0.1-0.9) significant injury was noted. In the highside group (n = 13), 10 (95% CI, 0.46-0.95) retired, 9 (95% CI, 0.39-0.91) were transported to the track medical facility, and 3 (95% CI, 0.05-0.54) were admitted to the hospital. In the highside group, there were 7 (95% CI, 0.25-0.81) significant injuries. In the topside group, both riders were retired with 1 hospital admission. Lowside crashes had a lower rate of retirement from race, emergent transport, and significant injuries compared with highside crashes.
Conclusions: Lowside crashes are lower risk than highside crashes. Most highside crashes are caused by oversteering to prevent an impending lowside crash. Strategies to reduce oversteering to prevent a lowside crash may reduce highside crashes, enhance the safety for riders in MotoGP racing, and be applicable to recreational motorcycle riding.

1. Introduction

Motorcycle racing in the elite MotoGP class attracts millions of spectators worldwide. MotoGP riders compete in 18 circuits around the globe each year. Between practices, qualifying heats, warm-ups, and the race, riders spend an average of 4 hours at speeds up to 214 mph (344 km/h) at each event.

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Fig. 1. Lowside crash. Arrows represent strength and direction of force vectors. Copyright DORNA 2015. Reprinted with kind permission.

Crashes are a rare but regular feature of elite motorcycle racing [1-3]. There are 4 basic crash types:

1. The "lowside" crash: Loss of traction in a turn causes loss of vector forces that keep the motorcycle upright. The rider falls to the lowside of the lean angle and skids out at a tangent to the turn (Fig. 1).
2. The "highside" crash: When the tires start to lose traction in a turn, the rider overcorrects, and the motorcycle flips violently toward the highside of the turn, catapulting the rider from the motorcycle (Fig. 2).
3. The "topside" crash: The motorcycle suddenly decelerates relative to the rider, who is propelled over the handlebars (Fig. 3).
4. The "collision" crash: The rider strikes or is struck by a stationary object or another motorcycle and is subjected to blunt trauma and extreme deceleration forces.

The crash prevalence and pattern of injuries associated with each crash type are not well described. This prospective study was undertaken to benchmark the prevalence of crashes and crash types and to better understand the pattern of injuries associated with each crash type. A scientific understanding of crashes and injuries is essential to the safety of the riders and may also provide valuable insights to benefit the larger, noncompetitive motorcycle riding population.

Fig. 2. Highside crash. Arrows represent force vectors. Copyright DORNA 2015. Reprinted with kind permission.

2. Methods

This was a multisite prospective observational study. The cohort consisted of the elite riders in all 3 US MotoGP races during the 2013 season of the "American Red Bull MotoGP" series. One race was held at the Circuit of the Americas in Austin, TX, one race at Indianapolis Motor Speedway in Indianapolis, IN, and one race at the Laguna Seca Raceway in Monterey, CA. The Seton Institutional Review Board approved this study.

At least 1 author was present at each race. The authors were members of the medical team and had access to all race control, emergency medical services, and clinical data for each crash. Data were collected using a standardized collection form. Crash type was determined by report from the rider and/or race control and/or race marshals, and video footage available for each crash on MotoGP's Web site (www.motogp.com). Each crash was classified according to primary type: lowside, highside, topside, collision. If a crash type could not be established, it was classified as "indeterminate."

For each crash type, we recorded event and clinical outcomes. Event outcomes were defined as whether the rider rejoined the ongoing event (practice, qualifying, warm-up, or race) after each crash. Clinical outcomes after each crash were recorded as "transported to track medical facility," "transported from the track to trauma center," or "admitted to the trauma center." For each injured rider, we characterized injuries sustained and calculated an Injury Severity Score (ISS).

We compared outcomes percentages across crash types using confidence intervals (CIs) calculated with the exact binomial test. The statistical analysis was performed using Stata Version 11.1 (Statacorp LP, College Station, TX).

3. Results

Including all practices, qualifying heats, warm-ups, and race sessions, there were 806.9 rider hours recorded in the 3 US MotoGP races in 2013. There were 78 crashes, for a crash incidence rate of 9.7 crashes per hundred rider hours. The Table (in Appendix) shows the distribution of crash types and outcomes.

There were 58 lowside crashes, with 39 riders returning to competition and 19 (95% CI, 0.21-0.46) riders retiring after the crash. None of the lowside crash riders were transported to the track medical facility or the trauma center. There was 1 (95% CI, <0.1-0.9) significant injury in the lowside group: a thumb sprain on a rider who presented for examination the day after his crash (ISS = 0).

There were 13 highside crashes, with 3 riders returning to completion and 10 (95% CI, 0.46-0.95) retiring after the crash. Nine (95% CI, 0.39-0.91) highside crash riders were transported to the track medical facility, and 3 (95% CI, 0.05-0.54) were transported to the trauma center. There were 7 (95% CI, 0.25-0.81) significant injuries in the highside group: 2 clavicle fractures, 3 acromioclavicular separations, and 2 concussions. The ISS for the highside injury group ranged from 0 to 2.

There were 2 topside crashes. Both topside crash riders retired after the crash. One rider was transported first to the track medical facility and then later admitted at the trauma center with a nonoperative vertebral body fracture and a metacarpal fracture (ISS = 2).

There were no collisions. Five crashes could not be categorized because of lack of reporting and unavailability on video archive and were categorized as indeterminate. There were no retirements, transports, or injuries in the indeterminate group.

The incidence of unfavorable outcomes was statistically higher in the highside crashes compared with lowside crashes: The retirement rate was greater in the highside group than the lowside group (10/13 vs 19/58); transport to track medical facility was greater in the highside group than the lowside group (9/13 vs 0/58); transport to trauma center was greater in the highside group than the lowside group (3/13 vs 0/58); and the significant injury rate was greater in the highside group than in the lowside group (7/13 vs. 1/58).