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Current profile of cycling injuries: A retrospective analysis of a trauma centre level 1 in Queensland

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Abstract

Objectives

One out of 50 injury-related presentations to an ED is a transport-related cycling injury. Detailed information about the most frequent mechanism of cycling injuries, sustained injuries and patterns are under-reported. The objective of this research was to examine the pattern of injuries sustained by cyclists at a level 1 trauma centre.

Methods

A retrospective review of data of injured cyclists admitted and treated at a level 1 trauma centre between 2011 and 2012 evaluated demographic data, mechanism of injury, injury pattern, economic costs and outcome.

Results

Data of 261 patients (mean age of 39 years) were reviewed, of which 88% was male patients with an average age of 38 years. Non-collision cycling injuries were reported in 55% of cases followed by collisions with other motor vehicles in 25.6% of cases. The mean injury severity score (ISS) was 9, but an ISS ≥ 12 was documented in 24%. Predominantly upper limb injuries (24.8%) were found, followed by injuries to the head and lower limb (each with 16.8%). Traumatic brain and chest injuries were equally seen in 8%. The overall length of stay was 4 days, and survival rate was 98%.

Conclusion

This current data review reveals that non-collision traffic crashes accounted for the majority of injuries in cyclists treated in this facility, and the upper limb has replaced the head as the most injured body part. With a growing number of cyclists, this information contributes to considerations to improve road safety and trauma management.

Key findings

- Non-collision injuries are the most frequent cause of cycling-related presentations.
- Motor vehicle collision results in greatest severity and subsequent impact on health services.
- Head injuries are no longer the most common injury.

Introduction

Cycling as a recreational sport activity, as well as an alternative transport opportunity, continues to gain popularity. However, with increasing numbers of cyclists, there is an increasing number of cycling injuries requiring treatment in hospital facilities highlighting the importance of understanding the patterns of cycling-related injuries to target prevention initiatives.

Despite the known under-reporting of cycling injuries and the diversity of data collection sources, it is known that (i) approximately 2.5% of ED injury presentations are cycling related; (ii) between 25% and 40% of those injuries result in a hospital admission; (iii) these figures are rising across Australia (4370 in 2005/2006 to 5340 in 2009/2010 across Australia); and (iv) 60% of all cyclist fatalities are due to a collision with a motor vehicle.[1-3]

Data collected by the Australian Government[4] reveal that severe injuries and fatalities for cyclists are increasing with fatality rates 10–20 times higher than for car occupants. Cycling fatalities in Australia in 2013 (n = 50) were the highest in over a decade and accounted for 4% of road fatalities, while in Queensland, roadside collisions involving a cyclist account for 6–8% of all transport-related injuries.[4] Head injuries in cyclist and cycling injuries of children have been the focus of many papers,[5-11] with the prevention measure of legislated helmet use associated with a 63–88% reduction in the risk of head, face, brain and severe brain injuries for all ages of bicyclists.[6, 12] In fact, since the introduction of preventive measures, the most injured body parts are the upper limb region with 20.7% of fractures and the clavicle as the most frequently injured bone.[13, 14]

Trauma systems provide the opportunity to investigate cost and incidence with more precision, which has been possible in the past. The aim of this study is to use our hospital trauma data to examine patterns of serious cycling-related injury focussing on the relationship of sustained cycling injuries to mechanism of injury, pattern of injuries and economic costs. The information gained from this study will contribute to improvement of understanding of important factors to consider for roadside safety for cyclists, educational approaches as well as improvement of protective gear and trauma management of serious cycling-related injury.

Methods

Data were obtained from the trauma database of our institution, which is one of three tertiary level facilities (i.e. highly specialised referral and teaching hospitals) in Queensland, which operates as a level 1 trauma centre. Annually, there are approximately 60 000 emergency presentations with a 35% admission rate and up to 20 000 surgical procedures. The hospital's Trauma Registry database was searched to identify patients with a cycling injury as a result of trauma using a mixture of coded data fields and text searches for the term ‘bicycle’ and derivations of this term (such as bike, cycle, BMX, etc.). Only patients who were admitted under the Trauma Code over a 2-year period between January 2011 and December 2012 qualified for the retrospective review. The Trauma Code at our institution includes all patients who sustained serious injuries to two or more body regions or one body system severely injured, if the trauma team is activated, or if an intensive care unit (ICU) admission will be identified as being a result of the trauma.[15] Other patients presenting at our ED with sustained minor injuries following a cycling injury were not included in the study.

Patients with incomplete medical or radiographic charts were excluded (n = 66). Plain radiographs and computed tomography scans were reviewed, and injury identification and fracture classification were documented.

Patients were allocated to one of three groups because of the mechanism of injury. Group 1 consists of patients who sustained injuries by a collision with a motor vehicle (car, 4WD, bus and truck), and Group 2 consists of those who had a non-collision traffic injury such as falls from bikes. In Group 3, patients were represented following head-to-head collision with another cyclist or a collision with pedestrians or fixed or stationary objects. General demographics, injury mechanism, definite injury severity score (ISS), associated injuries and injury pattern, length of stay and overall costs were compared across the three mechanism groups. Costs were calculated using the Australian Refined Diagnosis Related Group system, which provides an estimate of the resource costs based on the patient's diagnosis, procedures and demographics.

The study protocol was approved by the local Human Research Ethics Committee.

Statistical analyses were performed using Intercooled Stata Version 12 (StataCorp LP, College Station, TX, USA). Statistical significance was set at $P < 0.05$, and survival rate was defined as the proportion of patients who survived until the date of discharge from hospital and was reported with its binomial exact 95% confidence interval.

Results

Between 2005 and 2013, there were 108 718 injury presentations to the ED, of which 2552 were recorded as cycling-related injuries. These constituted 2.35% of all injury presentations. Although total ED presentations increased by 50% between 2005 and 2013, the number of treated injured cyclists at this level 1 trauma centre has almost tripled from 172 in 2005 to 453 in 2013.

Between January 2011 and December 2012, 675 patients presented to the ED following a cycling injury. This represented 2.42% of all injury presentations at the hospital over this time period. Out of these 675 patients, 39% (n = 261) were seriously injured and admitted under the Trauma Code and retrospectively reviewed.

Two hundred and sixty-one cyclists (mean age 39 years, range15–77 years) were included in the study. The total consisted of 44 women (17.2%) and 217 men (82.8%). There were 67 patients (25.6%) admitted following a collision with a motor vehicle (Group 1). Although the majority of admitted patients were seen in Group 2 non-collision-related injuries (n = 144, 55.17%), 50 patients (19.1%) were admitted from Group 3 following a cycling-related injury involving a pedestrian, other cyclist or fixed object. Mean ISS was 9 (range 1–50) and average length of hospital stay was 4 days (1–38). The average consumable costs (excluding bed and nursing care costs) per patient were AU$9893.25. The average cost for patients who were admitted into the hospital (excluding two patients who were in excess of AU$155 000 because of long-term care in the ICU) was AU$10 265.69.

In total, three patients (ages 48, 60 and 60 years) died, after a mean of 4.6 days (range 3–7) and with a mean ISS of 36.3 (range 25–50). Therefore, the survival rate for patients in this study was 98.8%.

The vast majority (88%) of patients were discharged home, 6.5% required subsequent rehabilitative treatment and 4.5% were transferred to their hometown hospital after initial treatment and care at the tertiary unit.

Statistical comparison for age, overall treatment costs and overall length of stay between the three groups did not show any significant difference (Table 1). However, the mean ISS was significantly higher for the collision with motor vehicle group compared with the other two groups. Fifteen patients went to ICU, of which four were from Group 1 and 10 were from Group 2. All but two patients remained in ICU for less than 8 days (mean 5.82 days, median 3 days, range 1–29). Three patients (two in Group 1 and one in Group 2) died in the ICU. In all groups, the main injured body part was the upper limb with the clavicle as the most often fractured bone (10.7%) followed by distal radius fractures in 7.2% of cases. The second most commonly injured body part was equally the lower limb or head (Table 2). The most frequent combination of injured body parts was the upper and lower limb regions in 15.7% of cases, followed by the chest and upper limb injury combination (11.1%) and the head and upper limb injury combination (7.2%).

Table 1. Key characteristics between groups for trauma presentations in 2011 and 2012

Characteristic	Group 1 Collision with motor vehicle	Group 2 Non-collision transport injury	Group 3 Other collisions	*P* -value[†]
Number of patients	67	144	50	NA
Age, median (range) (years)	41 (17–77)	36.5 (15–76)	36 (16–71)	0.116
ISS, median (range)	9 (2–50)	5 (1–38)	4 (1–34)	<0.001
Hospital LoS, median (range) (days)	2 (1–35)	2 (1–54)	1 (1–26)	0.771
Costs, median (range) (AU$)	5671 (28–135 205)	4858 (21–233 285)	3570 (28–54 045)	0.494

† One-way between groups ANOVA.

ANOVA, analysis of variance; ISS, injury severity score; LoS, length of stay; NA, not applicable.

Table 2. Overview of main injured body region between groups analysed for 2011 and 2012

Location of main injury	Group 1 Collision with motor vehicle	Group 2 Non-collision transport injury	Group 3 Other collisions	*P* -value[†]
Number of patients	67	144	50	NA
Injury pattern				
Head	26 (14.7% [‡])	56 (18.0%)	15 (17.2%)	0.621
Brain	12 (6.8%)	32 (10.3%)	5 (5.8%)	0.242
Chest	22 (12.4%)	28 (9.0%)	10 (11.5%)	0.474
C-spine	10 (5.6%)	24 (7.7%)	6 (6.9%)	0.680
T-spine	6 (3.4%)	19 (6.1%)	3 (3.4%)	0.319
L-spine	1 (0.6%)	3 (1.0%)	0	NA
Abdomen	12 (6.8%)	21 (6.8%)	4 (4.6%)	0.752
Pelvis	10 (5.6%)	8 (2.6%)	1 (1.2%)	0.91
Upper limb	41 (23.2%)	72 (23.1%)	30 (34.5%)	0.077
Lower limb	36 (20.3%)	48 (15.4%)	13 (14.9%)	0.337
Mediastinum	1 (0.6%)	0	0	NA
Total injuries	177	311	87	575

† *P* -values Chi-square.

‡ Injury as a percentage of total injuries in the group. NA, not applicable.

The data represented in Table 2 include superficial injuries like skin lacerations, abrasions and contusions for each body region listed. The most common head injuries were facial fractures (8.8%) and skull fractures (8%). Traumatic chest and brain injuries were most often seen in the collision with a motor vehicle group (Group 1). Of the 22 patients with chest injuries, 12 (54%) were direct contusion trauma injuries. These injuries were found in 17.9% of patients in the group of collision with a motor vehicle. Traumatic brain injury was found in seven of the 12 patients (58%) who suffered head injuries in this group.

No spinal cord injuries were found in the 17 patients with spine injuries in the group of motor vehicle collision crashes, but occurred in six of the 48 (12.5%) patients with spine injuries in the non-collision group (Group 2) and three of the nine (33.3%) spinal injury patients who collided with a pedestrian, other cyclist or fixed object (Group 3). Overall, spinal cord injuries represent 3.4% of all sustained bicycle injuries.

Sixty-three patients presented with an ISS of ≥12 (24%). Comparison of these data showed significant differences for the mean ISS across groups with the highest score present in the collision with a motor vehicle group (Table 3). Overall costs, age and length of stay for these severely injured patients were not significantly different between groups. But the analysis of overall costs between injured cyclists with an ISS ≤ 12 (average AU$6 136.18) to severely injured cyclists with an ISS ≥ 12 (average costs AU$20 908.12) was highly significant (P < 0.001).

Table 3. List of key characteristics between groups for severely injured patients (ISS ≥ 12) who were treated between 2011 and 2012

Characteristic	Group 1 Collision with motor vehicle	Group 2 Non-collision transport injury	Group 3 Other collisions	*P* -value†
Number of patients	26	27	10	NA
Age, median (range) (years)	43.6 (17–60)	47 (15–68)	43.2 (22–63)	0.992
ISS, median (range)	21.5 (12–50)	17 (12–38)	14 (12–34)	0.043
LoS, median (range) (days)	8.1 (2–35)	8 (3–54)	3 (2–12)	0.239
Costs, median (range) (AU$)	11 785 (1259–68 826)	14 641 (4426–61 068)	4049 (1666–17 344)	0.212
Deaths	2	1	0	NA

† One-way between groups ANOVA.

ANOVA, analysis of variance; ISS, injury severity score; LoS, length of stay; NA, not applicable.

There was a significant correlation between age and ISS ($R^2 = 0.169$, $P = 0.007$). There was a significant effect between the three broad age categories (<40, 41–60, 60+ years) and ISS ($f = 8.955$, d.f. = 2, $P < 0.001$) with the 41–60 group higher in mean ISS (11.55 compared with 7.17 in the <40 years age group and 7.42 in the 60+ years age group) (Fig. 1). Overall treatment costs were highly variable, and no differences were detected among costs and age.

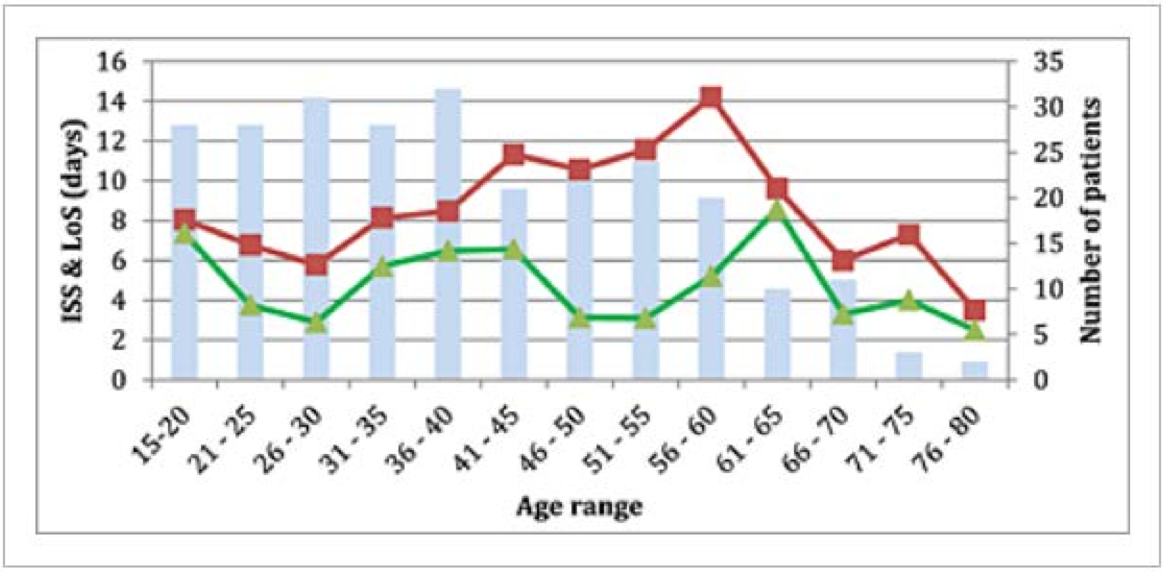

Figure 1.

Demonstration of mean injury severity score (ISS) and mean length of stay (LoS) in relation to number of patients in eac h of the different age groups for the years of 2011 and 2012. ( ), Number ; ( ), ISS ; ( ), LoS .

Discussion

This study showed that the majority of injuries to cyclists in this sample who met the criteria for the trauma code were related to non-collision events. Mainly male participants are involved in cycling injuries, and serious injuries with an ISS of ≥12 are more often seen in older cyclists (mean age 43 years). Overall survival rate was 98% with an average length of stay of 4 days.

Head injuries accounted for the second most often injured body part. Traumatic brain injuries were found in 8% of all patients and were mainly represented in the group of collisions with motor vehicles group. Upper limb in agreement with previous research,[16-20] especially clavicle and distal radius fractures, is the most often injured and therefore most vulnerable body part.[13, 14] Lower limb injuries, including malleolar and neck of femur fractures, account equally as often as head injuries with chest injuries seen in one in every three injured cyclist. Overall, traumatic chest injuries are found in 8% of all patients and again occur most often in collisions with motor vehicles. In addition to increased awareness of wearing protective gear including helmets, our peak cycling body in Queensland has suggested that the increasing numbers of cyclists of 'sport' bikes is a factor contributing to the shift in injury pattern according to mechanism of injury (personal comment Bicycle Queensland).[11, 17]

These data are consistent with recent reports[16, 17, 21-24] including the identification that non-collision crashes are most often found in cycling injuries,[5] but collisions with other motor vehicles are responsible for the most severe injuries in cyclists.[9, 23, 25]

Reliable data regarding whether a helmet was worn during the collision or not is limited, but numerous studies investigated prevention and educational measurements and showed evidence for reduction of severe head, brain and facial fractures.[11, 22, 23, 26-28]

Medical experience in treatment of those frequent trauma admissions are that the injury pattern might be underestimated. As the chest is frequently injured, the associated recovery time and rehabilitation care is extended because of pain and ventilation problems. The velocity of the collision and its consecutive injuries may initially appear minor, but contusions and bruises may extend during the course and lead to a difficult and challenging treatment course. When young, athletic patients present for treatment, high demands and expectations in outcome and function of joints and limbs are of primary concern. Overall costs calculated and presented in this study include general hospital costs, radiographic and other interventional costs like surgical treatment. On average, the consumable costs per injured cyclist are estimated to be in excess of AU$10 000 in these presented data. Unknown at this point are the indirect costs of additional physical therapy, absence from work and supportive domestic care. A study from the Australian Capital Territory revealed an estimated cost to the community of AU$869 per injured bicyclist with reported 7.5 days off work on average and an overall hospital stay of 1.8 days.[29]

Patients with the highest ISS did not consume the highest amount of costs, which may be related to a younger median age range, fewer co-morbidities, fewer complications during treatment and hence shorter rehabilitation time.

Limitations

There are several limitations to the study. This is a retrospective study of an adult level 1 trauma centre and therefore does not present the pattern of injuries seen in children, nor those patients who were not admitted under a Trauma code. Fatalities at the scene are not included, and a follow up including functional results after surgical treatment is not provided.

Finally, a larger data set may have permitted more rigorous testing of differences according to mechanism of action. However, notwithstanding these limitations, overall, the reviewed data and number of patients provide a profile of cycling injury for adult patients in a capital city tertiary trauma facility to inform further research.

Future research will determine a more complete picture of the circumstances. This will use questionnaires handed out to affected cyclists determining circumstances around the accident (such as specific location (on road versus off road), speed, rider experience, types of bike, etc.) and preventive measures taken. This information aligned to clinical outcomes of different collision profiles will facilitate a more comprehensive trauma management and prevention strategy.

Conclusions

Non-collision events represent the highest diversity of injury patterns sustained in trauma coded cycling injuries and account for the majority of cycling injuries with upper limb injuries most frequently sustained followed by head and chest injuries. Collision with motor vehicles leads most frequently to pelvic and lower limb injuries and has on average the highest ISS with the most cost-intensive medical treatment.

Treating physicians should be aware of the injury pattern and collateral injuries as well as co-morbidities to address objective treatment during the medico-therapeutical course. Prevention strategies could be improvement of cycling lanes, development of ergonomic protective gear like joint protectors and the introduction of laws to keep distances to cyclists during overtaking.

Competing interests

None declared.

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