



REVIEW

# Trauma and motorcyclists; born to be wild, bound to be injured?

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## KEYWORDS

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## Summary

**Background:** Regrettably motorcyclists frequently suffer related significant injuries. Doctors who manage trauma will encounter victims of motorcycle accidents and many aspects of care are unique to these patients due to the protective and performance enhancing equipment used by motorcyclists. This review examines the patterns of major injuries suffered by motorcyclists, the unique aspects of airway, circulatory and spine management, and suggests some interventions, which may allow primary injury prevention for the future.

**Data source:** Literature searches of the PubMed, EMBASE and Cochrane library with hand searches and author's experience.

**Interventions:** None.

**Data synthesis and conclusions:** The airway and (cervical and thoracolumbar) spine cannot be managed effectively in the helmeted patient with a speed hump in place and intubation by direct laryngoscopy is almost impossible with a speed hump in place. Helmets should be removed and the speed hump cut from the leathers. Leathers act as fracture splints, particularly for pelvis and lower extremities. Removal or extensive cutting away of the lower portion of leathers should be considered as part of "circulation", and only take place in a medical facility and in anticipation of circulatory deterioration.

Motorcyclists sustaining thoracic spinal damage more frequently than cervical and spinal fractures at multiple levels are common. Back protectors are used commonly and these may be left *in situ* for extrication on a spinal board, but they should be removed in-hospital to allow full assessment.

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Injury prevention will require coordinated research and development of a number of key pieces of equipment and design in particular helmets, speed humps and clothing/textiles. In managing the injured motorcyclist in the pre or in-hospital settings, health professionals require greater awareness of the implications of such devices, which at the present time appears largely restricted to motorcycling enthusiasts.

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## Introduction

Most motorcyclists appreciate that riding a motorcycle is a risky business.<sup>17</sup> United Kingdom (UK) figures suggest that a motorcyclist is killed or seriously injured approximately every 665,894 km ridden, compared to 18,661,626 km amongst car drivers<sup>8</sup>; although this relative risk of 28–1 may be falling with time Fig. 1.<sup>6</sup>

Therefore, if a motorcyclist attains a riding license aged 17 and rides 13,500 km per year until retirement lifetime risk of death or serious injury approaches 100%.

Doctors who regularly manage trauma will certainly encounter victims of motorcycle accidents and many aspects of care are unique to these patients due to the protective and performance enhancing equipment, which is used by competitive, and increasingly noncompetitive, motorcyclists.

In this clinical review we examine the patterns of major injury suffered by motorcyclists, the unique aspects of airway, circulatory and spine management, and will suggest some interventions, which may allow primary injury prevention for the future.

## Methods

A comprehensive literature search in PubMed, EMBASE and the Cochrane library supplemented

by hand searching bibliographies of retrieved articles using the keywords above. The resulting narrative review of the typical patterns of major trauma suffered by motorcyclists is supplemented by the author’s extensive experiences in pre and in-hospital trauma care.



**Fig. 1** Author JD Hinds, on rapid response medical bike at 2006 Ulster Grand Prix road race. Despite the main focus of this article on the negative aspects of injuries let us not forget why motorcyclists do what they do and why it is so addictive! Motorcycles allow an immediate deployment of medical aid to injured riders at road races, being much faster and less intrusive than a car, and more convenient and less restrictive than a helicopter on the shorter Irish circuits. Motorcycle medics on the MCUI team can triage and begin treatment, carrying equipment in the pictured pouch-system. Back up is available from fully stocked medical cars and ambulances (David Anderson, 2006).

## Interventions

None

## Motorcycling injuries

### Considerations

Motorcyclists typically suffer multiple injuries; head and lower limb/pelvic injuries being the most frequent.<sup>1,14</sup> Head injuries sustained through motorcycling are proportionately more severe than those from other road traffic or sporting accidents.<sup>9</sup> Indeed, a motorcycle accident is in itself a predictor of poor outcome in patients presenting with acute severe head injury.<sup>31</sup> Unfortunately, injuries sustained by motorcyclists tend to have chronic consequences, particularly following brain injury,<sup>10</sup> and this is typically and most tragically among young males in the most productive years of their lives.

### Airway management and motorcycle helmets

Helmets reduce morbidity and mortality, reduce hospitalisation and ICU admission and improve outcome compared to non-helmet users, as well as reducing the financial burden created by motorcycle-related injuries.<sup>4,22,27</sup> Head injury risk is reduced by around 72%<sup>16</sup> and helmeted riders have a higher GCS at presentation<sup>3</sup> and at discharge from hospital.<sup>23</sup> However, benefit is only gained from wearing type-approved standard helmets (British standard BS 6658:1985 or UN ECE regulation 22.05). In fact, wearers of non-standard helmets sustain head injuries more frequently, and of greater severity, than those who wore no helmet at all.<sup>15,20</sup> The benefit of wearing a helmet is only conferred if it is correctly fitting, and the chin-strap appropriately tightened, lest the helmet be displaced or completely removed on impact.<sup>24</sup>

It is common practice for pre-hospital medical personnel to transport the helmet to the hospital with the patient, to allow inspection by the hospital medical team.

However, the helmet is designed to act like a car's crumple-zone, and with high quality helmets the exterior is typically extensively damaged as the outer layers dissipate the forces of impact; indeed if the outer layer remains intact a greater force is transmitted to the patient's head. Vital information can be gleaned if the inside of the helmet is inspected, where a dissection of the inner layers is a worrisome sign. However, the author also has



**Fig. 2** Though examination of the helmet may provide clues as to the mechanism, degree of injury may be over or under estimated (motorcycle union of Ireland medical team photo archive, 2005).

experience of severe closed-head injury where a rider slid feet-first into a high kerb at speed, with subsequent transmission of energy through the long bones and spine leaving the helmet unmarked [Fig. 2](#).

Despite proven benefit in primary injury prevention, full-face helmets make the task of airway evaluation and management extremely difficult. Hospital practitioners should not rely on the helmet having been removed at the scene. In cases of significant maxillofacial trauma, delay in first aid/retrieval and subsequent swelling may make it impossible to remove the helmet safely at the scene. In addition, the tough weave in some chinstraps may preclude cutting with tools available on-scene if the buckle has been damaged.

The chin bar of full-face helmets restricts manipulation of the jaw for simple airway manoeuvres, and precludes the insertion of oropharyngeal airways and oral suction devices, occasionally necessitating the use of the nasal route in a group at risk of basal skull fracture. We have experienced difficult helmet removal following multiple facial fractures, where bilateral nasopharyngeal airways combined with log-rolling the patient to the lateral position allowed both a source of suction via a fine bore catheter for profuse airway bleeding, and a patent airway to provide oxygen through the visor aperture via an inverted Hudson mask thus avoiding hypoxaemia and airway soiling prior to helmet removal and tracheal intubation.

Though a surgical airway would theoretically be the gold standard in these cases, it may be extremely difficult given the degree of cervical flexion associated with helmeted patients lying in the neutral position, distorting the anatomy. Coupled with the presence of chinstrap and chin bar overlying the surface anatomy, surgical airways in the helmeted patient may be extremely challenging.

## Techniques for helmet removal

Modern helmets are quite amenable to removal using a bone-saw, since once the hard outer carapace is breached the inner layers are easily dissected, though this can be a time consuming task. If the tools are available, a technique for cutting the chin-bar from the helmet—effectively converting a full-face helmet into an open-face helmet—has been described,<sup>5</sup> allowing rapid and definitive access to the airway.

Helmet removal is a safe procedure if performed correctly by experienced personnel<sup>5</sup> and is free from secondary neurological sequelae [Box 1](#).

## “Speed humps” during intubation and cervical spine control

There remains a great degree of confusion about the role of speed humps, even within the motorcycling fraternity itself. They were initially conceived to

### Box 1. Helmet removal

General principles, based on the recommendations of the Trauma working party of the joint colleges ambulance liaison committee (JRCALC),<sup>5</sup> ATLS guidelines<sup>2</sup> and our own clinical experience of around 200 helmet removals per year:

- It is safest to allow the conscious motorcyclist to remove his own helmet, if alert and cooperative. While this may encourage spinal flexion, alert patients should be limited and protected by pain.<sup>29</sup>
- If not, the principle of “two people using two hands”, with the patient lying flat, is required for optimal technique. One person should remove the helmet in a cephaloid direction, the other controlling the head and cervical spine.
- The chin-bar of the helmet should be held by the assistant at the top of the bed, since this allows better control of the head than the temporal or occipital portion of the helmet; which may be slick with blood, mud or rainwater.
- While the helmet must be manipulated off the head, there is little room for medio-lateral movement, but sufficient scope antero-posteriorly if the head is stabilised.
- The helmet edges should be pulled in a lateral direction, deforming the helmet carcass and allowing further loosening prior to removal.

improve the aerodynamics of a helmeted rider in a racing crouch on a competition motorcycle. In some instances they contain data-logging devices to allow race teams to collect information on the various forces acting on rider and motorcycle, and in hotter climates they have been modified to contain fluid. In recent years they have become a fashion item for the non-competitive motorcyclist, and are now a common feature on leathers. They are not, and never have been, a safety device, and indeed make management of the airway and spine more difficult in the injured motorcyclist [Figs. 3 and 4](#).

The effect of a speed hump in the supine position is analogous to having two firm pillows placed under the shoulder-blades, that is, thoracic flexion with cervicothoracic junction hyperextension and potentially craniocervical junction flexion as helmet touches ground. This risks gross spinal displacement, and direct laryngoscopy and intubation become virtually impossible. It is the author’s opinion that for spine protection and airway control the speed hump must be removed as soon as possible. The easiest method is to logroll the patient into the lateral position, and run a scalpel blade around the outline of the hump; allowing rapid separation from the leathers. The patient can then be returned to the supine, and now neutral, position [Fig. 5](#).

It is hoped that designers and manufacturers will recognise the problems faced by medical staff in these instances and modify the design of humps in the future. Possible solutions include filling humps with air rather than foam to allow deflation or making humps externally detachable, for instance with a zipper or Velcro.

## “Total” spine management

While cervical spine control is quite rightly emphasised alongside airway management in modern trauma care,<sup>2</sup> in fact motorcyclists sustain thoracic spinal injuries more commonly.<sup>12,25,26</sup> The mechanism typically involves flexion injury.<sup>7,25</sup> Some workers advocate performing an over penetrated upper thoracic film as part of the “motorcyclist trauma screen”<sup>7</sup>, although a strong case for CT can be made. Non-contiguous spinal injuries are common, and protocols concentrating on the clearing of the cervical spine may miss a significant proportion of thoracolumbar spinal injuries.<sup>11,25,26</sup>

Helmets do not in themselves confer protection against cervical spine injury, but neither do they increase the risk.<sup>15,16,19,28</sup> Certainly management of the spine is complicated by the presence of a helmet; indeed the injured adult helmet-wearing motorcyclist can be thought of much like a neonate,





**Fig. 3** 2006 Irish road race superbike crash, where the mechanism of injury was exacerbated by the motorcycle “following” the rider and impacting rear of helmet. Note “speed hump” on leathers and how this complicated attaining in-line immobilisation in this instance. (Stephen Davidson—Pacemaker Press, 2006).



**Fig. 4** Helmet off, in-line immobilisation, speed hump cut from rear of leathers and only then spinal-boarded with collar/tapes/sandbags (Stephen Davidson—Pacemaker Press, 2006).

with relatively large occiput and disproportionately large head compared to body weight, and the smooth surface of the helmet promotes a significant degree of rotation of the head. In what may appear to be the “neutral” position, the helmet causes flexion of the cervical spine, and may be further compromised by the presence of a speed hump, where mid-thoracic flexion and pseudo-extension of the cervicothoracic occurs. Furthermore, the application of a cervical collar is impossible in the presence of a full-face helmet and risks further airway compromise.

Therefore, spinal immobilisation in the injured motorcyclist requires helmet and speed hump removal, and the patient returned to the neutral position on a firm surface (we advocate a spinal mattress or firm mattress of a transfer trolley) with cervical collar, sandbags and tapes or manual in-line immobilisation.<sup>2</sup> The efficacy of spinal immo-



**Fig. 5** Scalpel used to remove foam from speed hump with minimal manipulation of patients position (motorcycle union of Ireland photo archive, 2007).

bilisation techniques has been considered elsewhere,<sup>13,18,29</sup> and the ubiquitous use of spinal boards risks cutaneous necrosis and malalignment of the spine. They were designed as a pre-hospital extrication device and patients should be removed from them following the primary survey.<sup>2,30</sup>

## Back protectors

Back protectors have yet to be studied as a protective item, but circumstantial evidence abounds, and almost no competitive motorcyclist participates without one. Back protectors come in a range of designs, but the philosophy is similar between brands.

Essentially they are a piece of armour, either strapped to the body, or attached to the inside of the leathers, extending from the upper thoracic to lower lumbar region. Some designs also incorporate sacral portions or kidney protectors. Back protectors tend to be rigid on the outside and padded on the inside, and the design of some brands also limits extension of the spine, thereby theoretically providing a degree of protection against penetrative, impact and hyperextension mechanisms.

Due to their ergonomic shape, back protectors may be left in place for transport to hospital, along with standard spinal precautions, to avoid having to remove the riders' leathers (see below), but they should be removed as part of the riders' "exposure" during the in-hospital primary survey. It is not uncommon for healthcare staff unfamiliar with motorcycling paraphernalia to mis-diagnose injury and "steps" at several spinal levels when a back-protector is palpated underneath a rider's t-shirt!

## Circulatory management

Wearing a good quality set of leathers proffers a great deal of protection to the motorcyclist. Despite developments of space-age materials, no synthetic fibre has yet been developed to match the friction resistant qualities of leather. While cow-hide had pre-

vailed, there has been a trend towards kangaroo leather, since it offers similar abrasive-resistant qualities with the benefit of being significantly lighter.

In combination with internal armour and Kevlar reinforcing competition riders have walked away unscathed from what would otherwise have been fatal accidents. The Kawasaki rider Shinyo Nakano walked away from his 2005 Moto Grand Prix accident at 200 miles-per-hour, and his kangaroo-skin leathers withstood sliding to a standstill on highly abrasive tarmac.

Leathers help to prevent or reduce injury by abrasion and impact, but they may also serve as an effective splinting system when injury does occur. This is of particular importance if trauma has occurred below the waist, where a good fitting set of leathers can effectively splint otherwise open pelvis and femoral shaft fractures. Considering the high incidence of this type of bony injury in motorcyclists,<sup>3,21,22</sup> removal of motorcycle leathers should be considered as part "circulation" in the primary trauma survey, and should certainly only be considered after establishing adequate intravenous access and in anticipation of circulatory deterioration. Complete removal of leathers outside of a dedicated medical facility in the motorcyclist with trauma below the waist is contraindicated.

The authors have experienced complete circulatory collapse of a previous awake and alert patient following the cutting-away of the lower portion of a set of one-piece race leathers, which had stabilised an open-book pelvic fracture and bilateral fractured femurs.

Ideally, leathers should be removed by cutting along the natural seams; this avoids the tough reinforced panels common in newer suits, and allows the suit to be repaired for future use since good leathers are hand-made to measure and typically very expensive.

## Summary

All motorcyclists who suffer significant trauma will require helmet removal if only for assessment, and techniques for doing so are described.



The airway and (cervical and thoracolumbar) spine cannot be managed effectively in the helmeted patient with a speed hump in place and intubation by direct laryngoscopy is almost impossible with a speed hump in place. The helmet should be removed and the patient logrolled to the lateral position, where the speed hump can be cut from the leathers quickly and effectively using a scalpel.

Leathers act as fracture splints, particularly for pelvis and lower extremities. Removal or extensive cutting away of the lower portion of leathers should be considered as part of "circulation", and only take place in a medical facility with adequately established IV access and in anticipation of circulatory deterioration. Cutting along the natural seams avoids reinforced panels common in newer suits, and allows the suit to be repaired for future use.

Motorcyclists sustaining thoracic spinal damage more frequently than cervical and spinal fractures at multiple levels are common. Whilst back protectors have not been formally evaluated in the prevention of spinal injuries, few competition riders participate without one. It is quite acceptable to leave these *in situ* for immobilisation on a spinal board, but they should be removed in-hospital to allow full assessment of the spine.

Injury prevention will require coordinated research and development of a number of key pieces of equipment and design in particular helmets, speed humps and clothing/textiles.

In managing the injured motorcyclist in the pre or in-hospital settings, health professionals require greater awareness of the implications of such devices, which at the present time appears largely restricted to motorcycle enthusiasts [Box 2](#).

### Box 2. Additional educational resources

- American college of surgeons. Advanced Trauma Life Support (ATLS) student manual. 6th ed. Chicago, IL: American college of surgeons, 1997.
- Recommendations of the trauma working party of the joint colleges ambulance liaison committee (JRCALC)<sup>5</sup>
- motorcycle accident in depth study (MAIDS) <http://maids.acembike.org>
- "Hats Off" emergency helmet removal system <http://www.hatsoff.info/index.htm>
- Ambulance service association/Institute health and care development ambulance service basic training manual, 3rd Edition 2003 (Revised April 2006), Section 10.8

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