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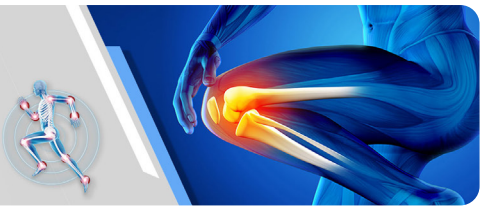
Review Article

JOURNAL OF ORTHOPAEDICS AND SPORTS MEDICINE

ISSN: 2688-5115



Epidemiology of Downhill Mountain Biking Injuries: 178 Injuries in 129 Patients

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Abstract

Purpose: The aim of this study was to analyze root causes and mechanisms of downhill mountain bike injuries through a consistent inventory of such injuries, and propose potential ways to circumvent them.

Methods: A prospective epidemiological study was conducted in a musculo-skeletal specialized Emergency department of a University hospital in France. All patients admitted to the department following downhill mountain biking accidents between July 2017 and November 2019 were included.

Results: There were 129 patients representing 138 admissions and 178 injuries, with 92% male and 8% female patients. The mean age was 27.9 years (11 – 69 years). 118 injuries involved the upper limbs (66.3%), and 37 the lower limbs (20.7%). The remaining 23 injuries (13%) involved the chest, abdomen, and spine, and were qualified as axial injuries.

Lesions of the shoulder girdle were by far the most frequent lesions as they corresponded to 66 injuries (55.9% of lesions of the upper limbs) including, among others, 25 fracture of the clavicle, 21 acromio-clavicular dislocations or sprains and 10 anterior shoulder dislocations. In the lower limbs, knee sprains were the most frequent injuries (7 sprains or 19% of lower limbs lesions). Finally, head trauma represented the most frequent injuries of the body axis (10 lesions or 43.4% of axial injuries).

Conclusion: Downhill mountain biking accidents are dominated by the injuries of the upper limbs, particularly the shoulder girdle. Despite the efforts made to develop efficient protection materials, these tools remain insufficient to prevent injuries or to reduce their incidence.

Keywords: Epidemiology; Traumatic injuries; Downhill Mountain Biking

Introduction

Downhill Mountain Biking (DMB) is a special type of sports with specific definition and rules provided by the International Cycling Union. It uses specially designed mountain bicycles for racing against time on descending rough, abrupt and irregular tracks that frequently include obstacles requiring alternations of speed and technical manoeuvres with jumps and bounds to avoid falls. The biker has to show commitment and a keen sense of piloting in order to overcome the obstacles encountered during the race, knowing that a biker's top speed may reach 80km/h.

Biker's equipment mainly includes protection tools. Their role is crucial preventing injuries during unpredicted falls and collisions against trees, rocks and other natural obstacles and barriers. It is usually much recommended

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Citation: Dominique Saragaglia, Guillaume Favarel, Jean Jacques Banihachemi, Ali Hassan Chamseddine. Epidemiology of Downhill Mountain Biking Injuries: 178 Injuries in 129 Patients. Journal of Orthopedics and Sports Medicine 4 (2022): 327-331.

Received: December 09, 2022
Accepted: December 16, 2022
Published: December 21, 2022

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DOI:10.26502/josm.511500070

to wear integral helmet, face mask with protective glasses, back protection, knee and elbow pads and supportive braces, and long protection gloves. Other protection tools are also advocated such as protective vest or waistcoat, neck collar protection, leggings, and protective undershorts. Special adapted clothes and shoes can also be added. Characteristics of a downhill bike are a combination of a mountain bike and motocross features. The said bike should resist shocks and be provided with efficient suspensions. The wheels and the frame should be specially conceived to resist important and major shocks and constraints. As lightness becomes more and more important, many riders re-machine and add components to save a few precious grams in pedalling and relaunching.

Practice of DMB has only increased in popularity during the last few years. The parallel upsurge of DMB-related injuries gave us the opportunity to conduct a prospective epidemiological study on such injuries that have been admitted to our Emergency department between 2017 and 2019. The primary objective of this study was to make a preview of the injuries characteristics of this sports practice. Secondary objectives consisted of evaluating the circumstances, causes, and mechanisms of accidents.

Methods

This is a prospective epidemiological study performed in the Emergency department of "Hôpital Sud" at Grenoble University Hospital and Medical Centre in France. It included all patients admitted to the department following downhill mountain biking accident between July 2017 and November 2019 without any restrictions regarding age, gender, or comorbidities. All patients consented to participate to the current study. All medical records were reviewed and discussed during the next day morning staff meeting of the department for validation of the final diagnosis; the staff was a specialized and experienced team in sports trauma. Statistical descriptive tools were used and quantitative parameters were noted according to their mean, minimal and maximal values as well as standard deviation. Chi^2 test was used to compare the percentage values in order to disclose any significant differences. Statistical analysis was performed using excel software.

Results

There were 129 patients with 138 admissions corresponding to 127 males (92%) and 11 females (8%) with large male prevalence. The mean age was 27.9 years with a median of 27 years and ranging from 11 to 69 years. Age distribution reveals that most represented age are 10-20 and 20-30 years with prevalence of 21% and 29% respectively. The total number of admissions for the 129 patients was 138 as 5 patients were admitted at several occasions. In addition there were 33 patients with multiple injuries; accordingly, the total number of injuries was 178.

Inventory of injuries

Among the 178 injuries, 155 were located to the limbs and qualified as peripheral (87%); 118 injuries involved the upper limbs (66.3%) and 37 the lower limbs (20.7%). The right side was affected in 80 occasions and the left in 75. Injuries to the chest, abdomen, and spine were qualified as axial injuries and were present in 23 cases (13%). Incidence of injuries per patient was 1.3. The most frequent lesions correspond to fractures, followed by sprains and contusions successively.

Upper limb lesions

The upper limb was involved in 118 occasions: 66 shoulder girdle injuries -55.9% of the upper limbs injuries- (25 clavicle fractures, 21 acromio-clavicular dislocations, 10 anterior shoulder dislocations including one recurrent, 7 shoulder contusions, one humeral surgical neck fracture, one acromial fracture, and one coracoid process fracture); 11 elbow area lesions (3 radial head fractures, 3 extra-articular wounds, 2 olecranon fractures, 2 contusions, and one posterior dislocation); 11 forearm lesions (5 both bones fractures, 2 Galeazzi type fractures, 2 metaphyseal fractures of the distal radius, and 2 deep skin abrasion); 16 wrist injuries (6 distal radius fractures, 3 scaphoid fractures, 3 contusions, 2 carpal dislocations, one physeal distal radius injury, and one distal ulna fracture); and 14 hand injuries (6 sprains of the metacarpo-phalangeal joint of the thumb including 3 severe cases, 3 phalangeal fractures, 2 simple uncomplicated wounds of the fingers, one avulsion of the nail of the left 3rd finger, one sprain of metacarpo-phalangeal joint of the right 4th finger, and one sprain of proximal inter-phalangeal joint of the right 3rd finger).

Lower limb lesions

The lower limb was involved in 37 occasions: 3 painful hip contusions without associated fractures; 12 knee injuries (6 sprains including 2 anterior cruciate and one medial collateral ligament rupture, one tibial plateau fracture, one posterior cruciate ligament rupture, 3 extra-articular wounds, and one painful contusion); 4 fractures of both bones of the leg; 2 extensive skin abrasions of the leg; 14 ankle injuries (5 bi and tri-malleolar fractures, 5 lateral sprains including one osteo-chondral talar dome injury, one ankle dislocation, one distal tibio-fibular sprain, one talar fracture, and one painful contusion); and 2 mid-foot sprains.

Axial injuries

There were 23 axial injuries: 10 head trauma without loss of consciousness (all of them had helmet protection); 6 chest trauma including 2 cases of rib fractures and one case of sternum fracture); 3 abdominal trauma corresponding to 2 benign contusions and one superficial wound of the abdominal wall; 2 minimally displaced fractures of the lumbar spine; one deep wound of the inguinal area; and one extensive skin

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DOI:10.26502/josm.511500070

abrasion of the iliac wing area. Head trauma was the most frequent amongst the axial injuries as it represented 43.4% of them.

Circumstances and characteristics of accidents

Despite the prospective type of the study, only 69 records were complete and exploitable for the items concerning the circumstances and characteristics of accidents.

Mechanism of injury

In 57 cases (82.6%), the causative mechanism was a direct trauma which was against an environmental agent (soil, tree) in 86%, his own bike in 12%, and another fellow cyclist in 2%. In 4 cases (6%), the trauma was indirect (especially for shoulder dislocations). Finally, 8 cases (12%) corresponded to torsional mechanism of the lower limb. In 63% of cases the determinant or causal factors of the accident were qualified as human.

Level of practice

There were no sedentary patients in the series. The majority -42 patients (60.8%)- were practicing DMB for 3 to 10 hours per week. 17 patients (24.6%) had more than 10 hours practice per week, and 5 (7.2%) less than 3 hours. 5 patients (7.2%) were high level sportsmen. Finally, 67 patients (97.1%) were practicing several sports types or disciplines.

Technical level of practice was considered "beginner" by 17 patients (24.6%) including 9 patients who had never practiced DMB before. 38 patients (55%), considered they were "confirmed bikers", and 14 (20.2%) "expert or experimented bikers". The DMB was practiced since an average of 4.9 +/ - 5.5 years.

Accident circumstances

In 62 cases (89.8%), DMB was practiced as leisure activity at the moment of injury. The accident occurred at the beginning of activity in 11 patients (15.9%), in the middle in 26 (37.6%), and the end in 32 (46.3%). 58 patients (84%) were in group biking activity with 3 +/ - 1.8 average number of persons (1 to 10), and 11 (15.9%) were biking alone. Accident occurred in summer time in 65 patients (94.2%) and good weather in 61 cases (88.4%). Regarding type of land, 53 accidents (76.8%) occurred on soil ground with 52 of them (75.3%), on ski resort track. All patients had helmet protection corresponding to integral helmet in 60 patients (86.9%) and semi integral in 9 patients (13%). On the other hand, 53 patients (76.8%) had elbow pads and supports, and 50 patients (72.4%) were dressed with vest or waistcoat protection. The bike type was a mountain bike downhill in 71% of injured patients (with front and rear suspension > 150 mm), enduro bike in 26% (suspension between 120 and 150 mm), and hardtail mountain bike in 3% (with only front suspension).

Type of Treatment

Among the 138 patients (178 injuries), 57 patients (41.3%) were hospitalized; 56 of them received surgical treatment (40.5% of patients and 31.4% of injuries). The remaining 81 patients were given ambulatory treatment such as functional or orthopaedic treatment. The average hospitalization time was 1.17 +/ - 2.1 days (1-10).

Discussion

The current study gathers an important number of injuries strictly and exclusively related to downhill mountain biking admitted to a University Hospital Emergency department in France in the period between July 2017 and November 2019; injuries related to other types of biking have been excluded. In opposition, earlier literature brings together injuries related to different types of biking [1-6]. Among the 178 injuries of our series, 155 (87%) were located to the limbs; 118 (66%) involved the upper limbs and 37 (21%) the lower limbs. The shoulder girdle was the most affected anatomic area as it accounts for 66 injuries with 42.5% of all limbs injuries. Other previous reports [1-4] on injuries from varied biking types have confirmed the high prevalence of upper limbs injuries. In an extensive review of 217,433 lesions related to DMB accidents, Nelson et al. [5] also stated that upper limbs are the most frequent site of lesions. Although the authors didn't give an overall number for all upper limbs lesions, they stated that upper limbs fractures are the most frequent injuries with 18.9% of all injuries of their series; our current study has shown higher rate of upper limbs fractures with 31%. We have found a comparable rate of 60% of upper limbs injuries in the thesis by Anne Chevalier in 1994 (Grenoble university thesis) concerning 173 lesions with 137 so-called peripheral injuries (79.2%) involving indifferently the upper or lower limbs. These injuries can be explained by the mechanism of fall: the biker is projected forward or to the side with landing on his shoulder [4]. The mechanism of fall and the way of landing elucidate the relative low rate of lower limbs injuries compared to upper limbs (37 versus 118). A fall with direct hip impact can induce femoral neck or pelvis fracture. However, except for 3 cases of painful hip contusion that could make fracture suspicion, femoral neck and pelvis fractures were completely absent in our series.

In a questionnaire-based prospective study by Becker et al. [7] exclusively devoted for DMB induced injuries, the high prevalence of upper limbs injuries was not confirmed. These authors reported predominance of lower limbs injuries corresponding mainly to contusions and skin abrasions; they collected 494 lesions in 249 bikers qualified as severe lesions in 13% and benign in 65%.

Knowing the high velocity of DMB accidents one would expect more axial injuries. The relative low incidence of these lesions in our series (13%) can be explained by the

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DOI:10.26502/josm.511500070

biased recruitment of our Emergency department focused on peripheral musculo-skeletal injuries and simple benign axial injuries instead; other more severe accidents and lesions such as polytrauma patients, severe head and maxillo-facial injuries, and visceral lesions (thoraco-abdominal) are drained to another more appropriate neighbouring emergency department. Actually the literature declares low rate of vital or life threatening emergencies related to DMB. Jeys et al. [2] reported 5% of vital emergencies in a series of 84 cases and Kim et al. [3] reported 5% of abdominal lesions and 2% of genito-urinary lesions among 399 injuries. Finally, the intensive care referral centre for severe polytrauma patients in our University Hospital and Medical Centre (Hôpital Nord of Grenoble, a neighbour facility) received and treated only 18 patients admitted for DMB accidents in the period 2012-2014.

In opposition, some benign accidents were not included in this study as the patients considered unnecessary to seek medical care or treatment in emergency departments. The study by Becker et al. [7] was free of this bias as the data was collected by sending a questionnaire based on a register of a very popular bikes magazine; the important number and high prevalence of benign injuries (65%) in this study by Becker et al. [7] minimizes the belief that DMB is a sport of high risk. However, studies with large number of patients such as the study by Nelson et al. [5] based on 217,433 DMB injured patients between 1994 and 2007 make doubt on the relevance and pertinence of the overall data as well as the diagnosis of different injuries. Medical records of our patients were reviewed during the next day morning staff meeting of the department for final diagnosis validation or correction if necessary; our staff is made of a specialized and experienced team in sports trauma.

Male prevalence and mean age of our patients are higher than other series such as for example the series by Jeys et al. [2] with 92% and 27.9 years, versus 70% and 22.4 years respectively.

Considering the relative high price of a downhill mountain bike (2000 to 3000 euros minimum) in addition to the price of accessories, one can expect that patients are usually financially independent and autonomous, or issued from wealthy families for the youngest of them.

It is difficult to compare DMB accidents with those of other so-called leisure biking because -as mentioned above- the majority of studies usually mix together injuries related to different types of biking activities. Although the thesis by Anne Chevalier (performed also in our department and over an equivalent period about 25 years earlier) shows an exactly comparable epidemiology of accidents, the prevalence of hospitalized patients and surgically treated ones is clearly more significant: 28% and 21% for the thesis of Anne Chevalier in 1994 versus 41.3% and 31.4% for the current study respectively. This difference can easily be explained by a more dangerous and riskier biking practice of many bikers wanting to mimic competitive bikers.

Prevention of shoulder girdle injuries can be achieved by using a shock absorber airbag system or a deformable plastic shell for the shoulder. Fractures related to indirect trauma of the upper limbs (such as fall on the outstretched hand) can be avoided by teaching the bikers to roll up the fall in curled-up position, with arms crossed against the chest, in order to circumvent axial compression mechanism through the upper limb; this mirrors the so-called “ukemi” falling techniques taught in Judo. Finally, the incidence of skin abrasions frequent in the study by Becker et al. [7] can be largely decreased by dressing an adapted suit.

Conclusion

DMB-related accidents are dominated by upper limbs trauma and more specifically shoulder girdle injuries. Although protection materials are more refined, sophisticated, and developed than before, they remain insufficient and fail to successfully prevent or decrease incidence of injuries. Further research is recommended to attempt producing more efficient protection tools.

Declarations

Funding

There is no funding source.

Conflict of interest

The authors declare that they have no conflict of interest related to this article.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent to participate and to publish

Informed consent was obtained from all individual participants included in the study.

Availability of data and materials

All data and materials are available.

Code availability: Not applicable

Authors contributions

DS: construction, methodology and writing of the article; GF: data collection; JJB: literature analysis; AHC: translation and proofreading of the article.

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