Mountain Biking Injuries

Majid Ansari, MD¹; Ruhollah Nourian, MD¹; and Morteza Khodae, MD, MPH, FACSM²

Abstract
With the increasing popularity of mountain biking, also known as off-road cycling, and the riders pushing the sport into extremes, there has been a corresponding increase in injury. Almost two thirds of acute injuries involve the upper extremities, and a similar proportion of overuse injuries affect the lower extremities. Mountain biking appears to be a high-risk sport for severe spine injuries. New trends of injury patterns are observed with popularity of mountain bike trail parks and freeride cycling. Using protective gear, improving technical proficiency, and physical fitness may somewhat decrease the risk of injuries. Simple modifications in bicycle-rider interface areas and with the bicycle (bike fit) also may decrease some overuse injuries. Bike fit provides the clinician with postural correction during the sport. In this review, we also discuss the importance of raceday management strategies and monitoring the injury trends.

Introduction
With the boom of outdoor activities in the United States, the popularity of mountain biking (MTB), also known as off-road cycling, has followed the trend (23). In the United States, the number of mountain bikers has increased from 6.75 million in 2006 to 8.32 million in 2015 (23). Despite the increase in popularity of the sport, the reported national frequency of acute injuries appears to be decreasing in the United States, conflicting the local patterns of injury frequency (35). With almost a third of injuries occurring during the race, MTB is among the sports leading to high overall injury rates in Olympic sports (20). During the 2012 Summer Olympics, 21% of mountain bikers reported acute or overuse injuries, half of which had led the cyclists to lose at least one training/race day (20). Fifty percent of recreational bikers and 80% of professional mountain bikers have reported at least one major severe injury directly related to the sport (35). Microtraumatization of contact and noncontact areas due to repetitive forces and vibration, in addition to fatigue, renders the rider vulnerable to overuse injuries (13). Such injuries are reported in 45% to 90% of mountain bikers (13). Injury-related cost of care for the cyclists can be a significant financial burden for cyclists and health care in general (46). However, the potential risks of cycling are outweighed by the health-related benefits of riding a bike.

On-the-site and clinical management plans for MTB injuries depend on the knowledge of the sport, understanding the injury mechanism, and precipitating factors. Prevention of MTB injuries entails recognition of both traumatic and overuse mechanisms (34). There is a paucity of high-quality evidence with regard to sport-specific pathogenesis, treatment, and prevention of the most common overuse MTB injuries. We present a brief introduction to common injuries and illnesses associated with MTB.

Bicycle Types
The bicycles enable the rider to navigate thru terrains, such as footpaths, single-tracks, forest, unconventional urban, and mountainous area. The slippery and uneven surface of these routes usually consists of rocks, mud, dirt, and tree roots. There is no uniform definition for bicycle types used in MTB. In this article, we will discuss injuries related to the following bicycles: 1) Cross-country (XC) bicycles are relatively light weight bicycles suitable for ascending and descending single-tracks or footpaths for long durations of time; 2) Downhill (DH) bicycles have stronger components and with the rider in a more upright position, enable them to make rapid descents from difficult terrains; 3) Freeride (FR) bicycles have somewhat similar geometry and components to DH bicycles which enable the riders to ascend various tracks, in addition to technical stunts and rapid descends in any challenging terrain (Table 1). The FR bicycles have a shorter wheelbase in contrast to DH bicycles (Fig. 1).

Bike Fit
Bike fit is the process of making the cyclist and bicycle geometry compatible to minimize the risk of injury and improve the performance at the same time (34,53). Improper bike fit is a precipitating factor for many overuse injuries. However, most studies on bike fit have addressed the cyclists’ performance rather than its effect on biomechanics and...
Traditionally, after goal-setting with the rider, the bike fit starts with obtaining a medical history and physical examination with special emphasis on spine and lower-extremity problems. Afterward, on-the-bike-fit begins with stepwise modifications in bike-rider interface. Then, the degree of trunk inclination, position of the shoulders, and cervical spine ergonomics are noted (34). The pedals, shoes, saddle type, height, and tilt, crank size, handlebar type and width, headset height, stem length and inclination might be adjusted or modified (Table 2) (13,17,19,62). Applying the motion-capture technology, 2- and 3-dimensional kinematic modelings have become available in addition to more traditional techniques with no proven superiority between the methods with regard to injury or performance or comfort (34).

Saddle Height
An increase in knee flexion during cycling (e.g., due to low saddle height) is correlated with patellofemoral pain syndrome (PFPS), while decreased knee flexion (e.g., due to excessive saddle height) has been linked to hamstring injuries (52). One of the common methods to determine the saddle height is the knee flexion measurement when the pedal is at the lowermost position (52). Changes in neuromuscular activation patterns after altering the saddle height have been observed in gastrosoleus, quadriceps, and hamstring muscles, with lowered seat reducing the activity of gastrosoleus and hamstring, and increasing the activity of quadriceps (53). A change of 2.6 to 2.9 cm in saddle height corresponds to about 10° change in knee flexion. A knee flexion angle of 25° to 30° appears to be suitable for manual (static) bike fit methods, while the value is 30° to 40° for most motion-capture methods (52). Calibrating the process with knee angle measurement during standing might lead to better accuracy for the latter method and minimize the observed difference (52). After adjusting the seat height, fine-tuning the process to prevent excessive pelvic sway in frontal plane also has been advocated (41). Saddle height determination based on leg length alone may be inaccurate (17).

Saddle Setback
Fore/aft positioning of the saddle also affects the kinematics of the knee joint (19). The Knee Over Pedal Spindle (KOPS) rule might be helpful in most of the cases. After early saddle height adjustment, a plumb-line anterior to the knee should cross the center of the pedal axis with cranks in horizontal position. For most of the bicycles with conventional seat tube axis, this adjustment will place the greater trochanter in alignment with the seat-tube (Fig. 1).

The Foot-Shoe-Pedal Interface
Frontal plane suboptimal moments in lower extremities (including knee varus or valgus, and tibial rotational forces) have been suggested as precipitating factors for chronic knee problems in cyclists (22). Various insoles and wedges are used for cyclists to address these problems, with no significant effect on performance (22). Varus wedges may be beneficial for cyclists with forefoot varus deformity, while forefoot inversion wedges may be beneficial for riders with foot pronation (17). Changing the Q-Factor (interpedal stance width) also is an easily performed, but not free of limitations, method of changing frontal plane kinematics (22). Cleat rotation (float) adjustment also might help cyclists with meniscal and intra-articular knee problems (22).

Acute Injuries
The most common mechanism of acute severe injury for competitive mountain bikers has been falling forward (64.9%), and 85.6% of such injuries have occurred while riding DH (14). Falling forward had led to a significantly higher Injury

![Figure 1: Schematic bicycle diagram. CS, chain stay; TT, top tube; R, reach; ST, seat tube; STA, seat-tube angle; HT, head tube; HTA, head-tube angle; WB, wheel base; TT, top tube; SH, saddle height.](image-url)
Severity Score (ISS) and emergency department admission rates than falling to the side (14). Different injury patterns have been reported in three studies (Table 3).

Patterns of Injury

Various terrain conditions and participants in the sport have led to a variety of injury patterns among mountain bikers. With only severe injuries included in a study conducted in 1995, injury rate per exposure was similar between DH and XC races (38). However, when comparing the injury rate per 1000 h, the DH cyclists had a significantly higher injury rate in comparison to XC cyclists. The injury rates were 7.5 and 3.1 per 1000 h for female and male XC cyclists, respectively ($p = 0.01$); while the rates were 46.8 and 42.7 per 1000 h for female and male DH cyclists, respectively ($p < 0.05$) (38).

A European study reports an injury rate of 1.1 per 1000 h of MTB similar between the competitive and recreational cyclists (25). Of all injuries during a seven-stage XC race requiring medical care in the United States, 68% affected the skin and soft tissue, and all musculoskeletal injuries (23% of all injuries) were in the wrist area (45).

In a 6-month-long prospective study of self-reported DH injuries, there was an injury rate of 16.8 injuries per 1000 h of exposure with 31% requiring medical attention, and 13% severe enough to restrict participation in the sport (10). Lower leg and forearm were the two most common sites of injury, considering all reported injuries. The injury rate was significantly higher during the race. The injury rates for XC male and female cyclists was reported 6.8 and 12 per 1000 h, respectively (10).

An emerging trend is the growing number of mountain bikers attracted to mountain bike terrain parks (MBTP), which facilitate the DH rides and provide the cyclists with a variety of technical trail features, leading the riders to spend more time riding DH at high speeds (55). Mountain bike terrain parks have become a common location for MTB injuries where the overall acute injury rate for recreational mountain bikers is reported to be as high as 15 in 1000 exposures with 87% of injured riders being male (1). During the 2009 biking season in a MBTP, 86% of injury visits to a local emergency center were male, and 52% of cases were visited between 1 p.m. and 4 p.m. (5). Upper-extremity fractures consisted 74.2% of all fractures, and 11.2% of all patients had traumatic brain injury. Almost 9% of patients required transfer to a higher-level trauma center (5).

Predictive factors for increased risk of MTB crashes include prior history of crashing, riding in the dark or in a group (60). Riding errors, trail conditions, obstacles, fatigue,

### Table 2.
Common modifiable bike fit area problems based on common chronic injuries in mountain bikers (13,17,19,21,62).

<table>
<thead>
<tr>
<th>Injury/Interface</th>
<th>Saddle/Buttocks</th>
<th>Handlebar/Hand</th>
<th>Foot/Shoe/Pedal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck pain</td>
<td>Improper saddle tilt, too high</td>
<td>Long stems, low handlebars</td>
<td>NA</td>
</tr>
<tr>
<td>Ulnar/median neuropathy</td>
<td>Forward tilt, too aft</td>
<td>Low or narrow handlebars</td>
<td>NA</td>
</tr>
<tr>
<td>Chronic LBP</td>
<td>Improper tilt</td>
<td>Low handlebars</td>
<td>NA</td>
</tr>
<tr>
<td>Genitourinary complaints</td>
<td>Improper tilt/height</td>
<td>Long stems, low handlebars</td>
<td>NA</td>
</tr>
<tr>
<td>Patellofemoral pain syndrome</td>
<td>Too low, too fore</td>
<td>NA</td>
<td>Hyperpronation, improper positioning, cleat valgus tilt</td>
</tr>
<tr>
<td>ITBFS at the knee</td>
<td>Too high, too aft</td>
<td>Low handlebars</td>
<td>Hyperpronation, improper positioning and cleat float and tilt</td>
</tr>
<tr>
<td>Quadriceps/infrapatellar tendinopathy</td>
<td>Too low, too fore</td>
<td>NA</td>
<td>Hyperpronation, improper positioning and cleat float and tilt</td>
</tr>
<tr>
<td>Achilles tendinopathy</td>
<td>Too low</td>
<td>NA</td>
<td>Hyperpronation, posterior positioning and excessive float</td>
</tr>
<tr>
<td>Metatarsalgia</td>
<td>NA</td>
<td>NA</td>
<td>Cleat position too forward</td>
</tr>
</tbody>
</table>

NA, not applicable.

### Table 3.
Patterns of acute injury in different reports.

<table>
<thead>
<tr>
<th>Country</th>
<th>United States (35)</th>
<th>Australia (9)</th>
<th>Canada (54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISS</td>
<td>NA</td>
<td>Median, 9</td>
<td>$\geq 12^{a}$</td>
</tr>
<tr>
<td>The most common site of injury</td>
<td>Soft tissue</td>
<td>Spine</td>
<td>Spine</td>
</tr>
<tr>
<td>Male patients (%)</td>
<td>65</td>
<td>93</td>
<td>88</td>
</tr>
<tr>
<td>Spine injuries (%)</td>
<td>NA</td>
<td>36</td>
<td>65</td>
</tr>
<tr>
<td>Head injuries (%)</td>
<td>6</td>
<td>25</td>
<td>57</td>
</tr>
<tr>
<td>Upper-extremity fractures (%)</td>
<td>28</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Lower-extremity fractures (%)</td>
<td>4</td>
<td>21</td>
<td>0</td>
</tr>
</tbody>
</table>

$^{a}$ Severe injuries.
and poor weather also are among the most commonly cited causes of injury (10). Riding DH, at higher speeds and competing in MTB races also are reported as predisposing factors (36,38). For recreational riders in MBTPs, riding unfamiliar bicycles and being faster than usual can be regarded as injury risk factors, while jumping, using safety equipment other than helmets, and using a new bike increase the risk of hospitalization due to trauma (55).

Head, Face, and Neck Injuries
Head injuries lead to concussions, skull and facial fracture, cerebral contusion, and intracranial hemorrhage. In one study, oromaxillofacial trauma, fractures, soft tissue injuries, and dental trauma accounted for 55%, 23%, and 22% of cases, respectively (24). Dental trauma also has been reported in 25% of the mountain bikers. In case of avulsion-type dental trauma in remote areas with minimal access to dental health services, preservation of the avulsed tooth in commercially available cell physiological wet media is advisable until replantation (48).

Acute Spine Injuries
Mountain biking may lead to catastrophic spine injuries, especially while riding DH (44). Mechanical bicycle dysfunction should be considered as a cause, while high DH speed, technicality of the terrain, and the rider’s poor judgment of the terrain situation also may be the precipitating factors. A broken helmet and head trauma might be a clue to the likelihood of spine injury.

In 107 cases of acute spine injuries in MTB in a level 1 trauma center, 95% were male (18). Only two were professional cyclists and injured during a race. Mountain biking spinal injuries consisted almost 4% of all spinal injuries (18). Cervical spine injuries were diagnosed in 74% of cases. Eighty-four percent of riders had used helmets and/or body armor. Fifteen percent of patients had documented coexisting brain injury. The ISS did not differ significantly in those with helmet (16.4) versus those without helmet (16.3).

Chest and Abdominal Trauma
Bicycle handlebars and bar ends are the common causes of chest and abdominal injuries in MTB. Chest wall injuries are common (35), and pneumothorax/hemothorax may follow (29). Blunt abdominal trauma may lead to solid-organ injuries, with spleen being the most frequently injured organ (33).

Skin and Soft Tissue Injuries
Skin and underlying tissues are vulnerable to injury secondary to trauma, mechanical friction, pressure, and the environment. As a result, management of skin trauma is commonly mandated for mountain bikers.

Traumatic
Lacerations are quite common among mountain bikers mainly due to direct trauma as a result of a fall or equipment failure (Fig. 2) (10,35,37,40,45). A primary step is to control the bleeding which is typically performed by direct pressure. Tetanus immunization status should be evaluated. Early anesthesia leads to easier wound inspection and neuromuscular examination. Irrigation with normal saline (tap water if not available) particularly with a protective cup is recommended.

Environmental-Related Injuries
Mountain biking races are held in a variety of geographic locations with some extreme climate changes (e.g., heat, cold, altitude, wind, lightning, and thunder).

Altitude Illness
With athletes experiencing rapid ascent, usually at altitudes of 2500 m or above, come the risk of altitude illness. Risk
Cold Injuries

_Hypothermia_ occurs when the core body temperature drops below 35°C (95°F). Hypothermia can happen at the end of an ultraendurance mountain bike race or when a cyclist stops on the course for a long time. Inexperienced athletes can become exhausted faster when the weather changes unexpectedly (wind, rain, and snow) (57). Ultraendurance mountain bike courses with the possibility of water immersion (crossing rivers) and nocturnal cycling in lower temperatures increases the risk of hypothermia. Obtaining core body temperature measurement (rectal) is essential in the diagnosis of hypothermia. The first priority in management of athletes with hypothermia is stopping heat loss by removing wet clothes and insulating the body with blankets and garments (passive rewarming).

_Frostnip_ is the result of superficial cold-induced vasoconstriction in the skin usually occurring at freezing temperatures. The superficial layers of skin crystalize in the cold or wind, resulting in skin blanching and numb patches mostly in the nose, ears, chin, and cheeks. Because the tissue does not freeze, immediate rewarming can prevent tissue loss and long-term damage (15). Frostnip is reversible and resolves rapidly with gentle rewarming without any sequelae, but it warns of risk of frostbite (57).

_Frostbite_ is a freezing cold injury to the skin and underlying tissues with formation of crystals in the extracellular space between cells (15,57). Frostbite occurs at a temperature below 0°C (32°F). Exposed areas (nose, ears, cheeks, and digits) are affected usually with more than half of the cases occurring in the toes (57). Constrictive and wet clothes increase the risk of frostbite. The best treatment approach is rapid rewarming with warm water (37°C to 40°C) (15,57).

Chronic/Overuse Injuries

The overuse injuries occur in a wide spectrum of cycling proficiency levels and among all disciplines of cycling (17). The riders are prone to overuse injuries due to repetitive nature of cycling and their need to maintain a close contact with bike interfaces. The average mountain biker will rotate the pedals almost 3600 to 6000 times per hour, and rides taking up to 12 h·d^{-1} have become commonplace for many riders. Force is mainly generated in a sagittal plane. Thus, any muscle imbalances in other planes may contribute to such chronic injuries (13). For example, abnormal hip abductor function has been linked to PFPS and iliotibial band friction syndrome (ITBFS) through pelvic coronal stabilization deficit. Suboptimal foot position also can negatively affect the kinetic chain during cycling and possibly lead to a significant number of injuries in cyclists (34).

Upper-Extremity Overuse Injuries

_Ulnar and median neuropathies_ are common among cyclists, with ulnar neuropathy (cyclist’s palsy) being present in 19% to 35% of the cyclists (4). Ulnar neuropathy is possibly caused by continuous pressure, tension, and vibration of the nerve in Guyon’s canal and is usually manifested by paresthesia and pain in the fourth and fifth fingers and hand intrinsic muscle weakness (3,58). Improper reach, narrow handlebars, gloves with poor padding, poor postural habits, longer rides, and increased weight may be precipitating factors are rapid ascent, living at a low altitude, intense physical exertion, young age, and history of altitude illness. Altitude illness spectrum may be present in mountain bikers in milder forms, acute mountain sickness, or more advanced stages like high-altitude pulmonary edema (HAPE), or very rarely high-altitude cerebral edema (HACE). Acute mountain sickness is the most common presentation of altitude illness with symptoms, such as headache, anorexia, nausea, vomiting, dizziness, fatigue, and difficulty sleeping (32). Slow ascent to altitude is the hallmark of prevention for all acute high altitude illnesses, which is usually not applicable because of the nature of the MTB. Acclimatization is another effective preventive strategy. Pharmacologic prevention includes the use of acetazolamide. Athletes with acute mountain sickness should not continue ascent until symptoms resolve and should consider descent if medical management does not resolve symptoms (30,32). Athletes with HACE or HAPE should immediately descend to a lower altitude and be followed up for medical management (32).

Heat-Related Illness

Heat-related illnesses represent a variety of disorders from mild heat edema to heat stroke. Other than sunburn, other forms of heat-related illnesses are uncommon among mountain bikers. Risk factors for heat-related illnesses include extremes in age (<15 years or >65 years); comorbid medical conditions; medication use (e.g., alcohol, diet pills, thyroid agonists, β-blockers, diuretics, and illicit drugs); fitness status; poor acclimatization, long high-intensity physical activity; environmental conditions (temperature, humidity, and sun exposure); and the availability of water, rest, and shade (57).

_Sunburn_ is caused by sun’s ultraviolet radiation especially during midday. Sunburn is a significant risk factor for further heat-related illness. High altitude increases the ultraviolet intensity, so participants of events at high altitude should be aware of this risk (30). Frequent use of a broad spectrum sunscreen with SPF >30 and wearing protective clothing is recommended (57). Cold compress or rinsing/bathing the area with cool water might be helpful (28). Mild sunburns can be treated with aloe vera while more severe burns should receive silver sulfadiazine creams (28). The presence of blisters, swelling, and exudates signifies increased severity and should be treated as direct contact burns (28).

![Figure 3: Lateral thigh abrasion as a result of a fall during a mountain bike race.](Image 70x571 to 250x721)
Knee Pain

Prevalence of knee pain is 20% to 27% among mountain bikers (13). The PFPS, ITBFS, and tendinopathies have been mentioned as common chronic knee injuries in cyclists (34).

Patellofemoral pain syndrome is a commonly encountered diagnosis among cyclists and is typically manifested by retropatellar or anterior knee pain (16). Risk factors for developing PFPS are high training volume (longer training hours) and intensity (e.g., prolonged climbs and higher gears), low pedaling cadence, low- or excessively anterior seat position (increased intra-articular friction forces), and higher knee flexion range of motions (poor bike fit including long-for-height cranks). Patellar maltracking, functional malalignment during cycling (resulting from improperly wide seats or Q-factor, genu valgum or pes planus) and decreased lumbo-pelvic stability and impaired hip abductor function also may exist (13,34,62). Diagnosis and correction of contributing factors, vastus medialis obliquus (VMO) retraining, pain medications (7), and proper bike fit may be effective in treatment of PFPS (13,34).

The ITBFS is thought to be due to repetitive friction of the ITB while moving from anterior position (in knee extension) to posterior position (in knee flexion) and vice versa at the so-called impingement zone located adjacent to lateral condyle while extending the knee from 30° of flexion (34). Positioning the saddle too high, or too “aft [posterior],” or improper cleat position, and an increase in overall training volume may be precipitating factors. Knee malalignment, foot hyperpronation, and internal tibial rotation may be precipitating factors (62). Correction of bike fit, myofascial release techniques for ITB band, hip abductor stretches, acupuncture, physical modalities, and local corticosteroid injections are effective treatments.

Pes anserine bursitis and medial plica syndrome are other causes of anterior knee pain in mountain bikers. Analgesics, physical modalities, hamstring stretching, and local corticosteroid injections may be beneficial (62).

Tendinopathies

Tendinopathies may be a sequel of excessive repetitive angular traction during cycling.

Patellar tendinopathy is a common condition among cyclists which usually present with focal tenderness over the injured part of the tendon (62). Precipitating factors include genu valgum, foot hyperpronation, and internal tibial rotation (62), increased training volume, repetitive jumps, and concurrent sporting activities.

Achilles tendinopathy may develop after microtraumatization of the tendon after repetitive plantar flexion during power phase of pedaling. Precipitating factors include with gastrosoleus shortness (62), improper saddle height, foot hyperpronation, soft shoes, and improper cleat position (34).

Other tendinopathies encountered in mountain bikers involve iliopsoas, hamstrings, and tibialis anterior tendons.

Improper bike fit, training errors, and concurrent sport activities may underlie these pathologies.

Ice, relative rest, range of motion, eccentric, and lumbo-pelvic stability exercises bike fit, cleat modification, and foot orthotics have been successfully used to treat these tendinopathies (62). Extracorporeal shockwave therapy and platelet-rich plasma may help with symptoms, but more methodologically sound studies are needed to routinely incorporate them in treatment plans (11,59).

Foot Injuries

With clipless stiff-soled cycling shoes primarily used in XC cycling, riders in DH and free ride disciplines usually use shoes with more pliable soles. While the clipless shoes provide the cyclist with mechanical advantage in energy transfer chain during cycling, they potentially expose the cyclist to some injuries including metatarsalgia (62) and Morton’s neuroma (34).

Cervicalgia

With a prevalence of 16% to 43%, neck pain is a common complaint among mountain bikers (13). Weakness and fatigue of cervical stabilizers lead to recruitment of muscles, such as levator scapula and trapezius, to keep the neck extended. Microtraumatization and fatigue of these accessory cervical extensors may lead to pain and formation of trigger points within them (13).

In contrast to road cycling and especially aero positioning, MTB imposes less cervical extension and protrusion (34). Combined with a significantly higher degrees of thoracic kyphosis (49) and flexed arms with scapular protraction and pectoral shortness, mechanical disadvantage of cervical spinal stabilizers is likely. The abovementioned malalignments are similar to the circumstances of “upper crossed syndrome” (47) contributing to cervicalgia, thoracic outlet syndrome, and cervicogenic headaches.

Bike fit, postural corrective exercises, strengthening of cervical spine stabilizers, physical modalities, acupuncture, and osteopathic manipulative techniques are helpful. Using a lighter helmet, removing the helmet shades and cameras, and correcting the helmet position also should be considered.

Low Back Pain

Low back pain (LBP) is a common complaint among mountain bikers with a prevalence of 24% to 41% (13). Despite its high prevalence, there is a paucity of high-quality research on precipitating factors of LBP in mountain bikers. The majority of available studies point out improper bicycle fit, riding technique, and training methods thru epidemiological data (56). Hamstring shortness, anterior pelvic tilt, and hip flexor hyperactivity (13), and deficiency of lumbo-sacral core stabilizers (56) also may contribute to chronic LBP. Similar to nonathletes, smaller diameter of transversus abdominis and cross-sectional area of lumbar multifidus muscles are reported in mountain bikers with chronic LBP in contrast to healthy counterparts (56).

No research has addressed sports-specific treatment of chronic LBP in mountain bikers (34,56). Core stability exercises (56) may be useful in the prevention and treatment of LBP in mountain bikers (56). In addition to these exercises, bike fit, correction of technical errors, physical modalities, postural corrective exercises, osteopathic manipulation, and

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acupuncture may be of value in the treatment of chronic LBP in mountain bikers.

For acute LBP in mountain bikers, a thorough evaluation with special attention to disc disease is necessary (34). Therapeutic exercises, myofascial release techniques, physical modalities, and acupuncture may be of benefit.

Genital and Saddle Area Injuries

Genital area numbness (GAN) and erectile dysfunction (with prevalence of 50% to 91% and 13% to 24%, respectively) are two of the most common chronic injuries of genitourinary system in male cyclists (27). Other complaints include dysuria, scrotal abnormalities, urogenital, and perineal pain. Impingement of the pudendal nerve in Alcock’s canal due to stretching, vibration, and ischemia has been proposed as the cause of pudendal neuralgia and paresthesia in cyclists (51). In contrast to road cycling, the more upright riding posture of mountain bikers leads to higher loading of buttocks area (42). Poorly fitted bike, saddle type, increased riding distance, prolonged seated position without standing, and high body weight appear to be contributing factors. Correction of these factors, physical and manual therapy, and minimally invasive interventions to block or ablate the pudendal nerve may be effective treatment methods. Male mountain bikers also have a significantly higher rate of abnormal ultrasonographic findings in scrotums compared with noncyclists and road cyclists, (94%, 16%, 48%, respectively) (46).

There is a paucity of published data regarding the chronic urogenital problems in female cyclists (27). Female cycling-related urogenital complaints include perineal dermatologic problems, vulvar edema, incontinence, stranguria and dysuria, external genital and perineal numbness, and pain (27). Body mass index, estimated cycling distance per season, and increased saddle width were modifiable precipitating factors for various complaints. Posterior insertional dyspareunia was reported in 40% of sexually active female cyclists with no significant precipitating factor in multivariate analysis (27).

Preventive Equipment

There are no regulations to mandate the use of helmets for recreational riders throughout the United States (34). However, using helmets is required by many MBTPs. Wearing helmets by cyclists during competitive US races is mandated by the governing organizations. Despite the supportive biomechanical data on likely benefits of helmet use on attenuation of impact forces during head trauma, the role of helmet use in actual prevention of brain injuries in cyclist populations is not clear (8,39). Helmet use in mountain bikers has not been fully studied, and most studies address the urban cyclists (34). Despite conflicting results, helmet use may have some protective effect against head injuries (50). Only 4.4% of mountain bikers have been reported to use mouthguards in a multinational study (48). This low prevalence of usage has been attributed to several reasons by cyclists including interrupting communication with other cyclist and breathing (48). There is no regulation or evidence of benefits on the use of other preventative equipment, such as full facemasks, goggles, and elbow pads.

Race Day Management

Medical coverage of mass MTB events are complicated tasks and bring unique logistical challenges which often requires hours of preparation and planning (40). Course medical directors and volunteer physicians should be familiar with the common injuries and illnesses unique to their races. The medical director needs to work closely with the race director and local officials to create a medical protocol appropriate for their specific race. Because these events typically take place over a large geographic area, developing a clear communication plan within the medical team is crucial in ensuring that proper care is being provided to the athletes. Cyclists must often navigate long distances over a variety of terrain in temperatures ranging from below freezing to above 40°C. Despite the fact that most injuries encountered by the mountain bikers during a race are minor, occasional life-threatening injuries can happen (10,35,37,40,45). So, the medical team should be prepared and plan for evaluation, stabilization, and evacuation of the injured athletes in different sections of the race.

Discussion and Recommendations

The observed variety of severity and patterns of injury in different studies are likely due to different injury definition and methodology (1,2,5,10,25,36,38,45,55,60). Because seeking the new challenges and riding the “gnarlier” terrains are part of the sport, the injury patterns might be changing over time. Thus, the authors recommend employment of active injury monitoring systems especially in areas more attractive to mountain bikers such is MBTPs and also during the races to identify new acute injury trends and to prevent potentially unsafe practices. For overuse injuries, most studies have used a self-reporting system. A standardized injury definition and implementation of an injury surveillance program is recommended.

An interesting recent trend to monitor is the availability and increasing popularity of electrical mountain bikes (eMTB), specifically for the XC discipline. While the eMTB is primarily intended to assist the cyclists ascend, they can potentially be used to reach higher-speed DH, increasing the injury rate. Meanwhile, these bicycles can be attractive for more senior cyclists with a variety of medical predispositions to ride terrains previously not accessible, and likewise potentially increase their injury rate.

In MBTP areas and during MTB races, the prehospital medical team should be prepared to manage fractures, head, face, and spine injuries, lacerations, abdominal trauma, and rib fractures (35). Facilitation of early responders’ access to the site of incident, providing them with proper equipment, and coordination of patient transfer plan with near trauma centers appear to be of utmost importance.

Further research is required to study crash characteristics and reach preventive strategies for MTB acute injuries (9). Including the bicycle industry and component manufacturers in these studies may lead to availability of bicycles less prone to mechanical failure during such circumstances. Also, further investigation of the effects of protective gear design on injury prevention should be stressed. One particularly interesting area for future research is the recent use of anisotropic foams in bicycle helmets to reduce acceleration forces during impact (61).

Many mountain bikers do other sports, including road cycling, skiing, running and mountaineering, with almost all having their respective patterns of chronic injuries. The
interaction of these sports in the epidemiology and pathogenesis of MTB injuries can be of interest for further research.

Conclusion

Mountain biking is a popular sport with significant health benefits. However, depending on the type of MTB and the technical difficulty of the terrain, there are potential risks for acute and overuse injuries. Appropriate bike fit and use of protective equipment, such as a helmet, can decrease the risks of some of these injuries. Clinicians taking care of these athletes should be familiar with common injuries. Proper stabilization and transportation to a medical facility is crucial for the management of cyclists with life-threatening injuries.

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References


