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Cannabis in Acute Injury Rehabilitation: Analgesic Efficacy, Functional Outcomes and Dependency Risks

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Abstract

Background: Musculoskeletal injury rehabilitation is challenged by inadequate pain management using opioids and NSAIDs, which pose risks of addiction, side effects, and delayed healing. Cannabis has emerged as a potential analgesic, yet its efficacy, safety, and impact on functional recovery in acute injuries remain unclear, particularly for athletes.

Purpose of Research: To evaluate the role of cannabis in acute injury rehabilitation, focusing on analgesic efficacy, functional outcomes, addiction risks, and implications for athletic recovery.

Materials and Methods: A systematic review of PubMed and Google Scholar (2015–present) identified 24 studies (RCTs, observational studies, meta-analyses) assessing cannabis in acute injury rehab. Inclusion criteria prioritized pain scores (VAS/NRS), functional metrics (mobility, strength), and dependency rates (CUDIT). Non-English articles and animal studies were excluded.

Basic Results: Cannabis demonstrated moderate analgesic efficacy, with 30% pain reduction vs. placebo in acute musculoskeletal injuries. Low-dose THC matched opioid efficacy with fewer side effects, while CBD showed anti-inflammatory effects (22% IL-6 reduction). Functional improvements in mobility and therapy adherence were noted, but psychoactive effects (sedation, cognitive impairment) and a 10–15% cannabis use disorder (CUD) prevalence were reported. Discrepancies emerged between subjective pain relief and objective biomarkers.

Conclusions: Cannabis may offer short-term analgesic and functional benefits in acute injury

rehab but requires careful risk-benefit assessment due to addiction potential, cognitive side effects, and variable dosing responses. Standardized guidelines, athlete-specific protocols, and multidisciplinary monitoring are critical to optimize therapeutic outcomes. Future research should prioritize long-term safety, dosing standardization, and sport-specific functional impacts.

Keywords: Cannabis, THC, CBD, Acute injury, Rehabilitation, Analgesia, Addiction

Introduction

Musculoskeletal injuries are a common problem in sports. Rehabilitation of fractures, sprains and post-operative injuries is a difficult and arduous challenge. This is due to the occurrence of pain, inflammation and functional limitations. These are the aspects that make it difficult for athletes to return to peak performance [1]. Current rehabilitation standards include early patient mobilization and focused exercise to restore neuromuscular control of tissues. Recovery time is often prolonged due to inadequate pain management. Pain makes it difficult to adhere to treatment regimens [2]. Currently, the basic drugs used to combat pain are opioids and non-steroidal anti-inflammatory drugs (NSAIDs). Their use is associated with the risk of side effects. Drugs with higher efficacy in treating severe and acute pain are opioids. However, their use is associated with the risk of developing tolerance, respiratory depression and addiction. These are the main reasons for the ongoing opioid crisis [3]. NSAIDs are safer than opioids for short-term pain management. Long-term use of NSAIDs can lead to gastrointestinal complications, renal dysfunction, and delayed tissue healing [4]. Due to the above limitations of the drugs used so far, attempts should be made to develop new painkillers. These actions should allow for achieving a balance between the safety of use and the effectiveness of drugs.

Cannabis can be used as a substitute or supplement to currently used painkillers. Recent years have shown an increase in interest in these drugs [5]. An analysis of controlled studies by Mücke et al. (2018) showed that cannabis-based drugs are characterized by low efficacy. The reduction in pain intensity was marginal (≥30% reduction) compared to placebo. In addition, these drugs showed numerous side effects, including drowsiness, dizziness, etc. The authors concluded that the clinical benefit remains uncertain. The uncertainty is due to methodological limitations, including small sample sizes and short study duration [6]. Other systematic reviews of cannabis-based medicines indicate modest efficacy in treating chronic neuropathic and postoperative pain. Adverse events were lower compared to opioids [5,7]. The anxiety and caution associated with cannabis use stem from its side effects. It impairs attention and perception, causes temporary cognitive deficits in working memory, etc. This poses a risk to athletes practicing competitive and contact sports, because quick decision-making, reaction time, and fine motor control are important for them [7]. In addition, the variability of legal conditions and the stigma associated with marijuana use in sports make it difficult to integrate it into standard rehabilitation frameworks [4]. A growing body of research highlights the need for rigorous evaluation of the role of cannabis in rehabilitation following acute injuries. Its comparative efficacy, safety profile, and impact on sports performance should be taken into account [5,6].

The number of scientific articles on the effects of cannabis in the context of acute injuries has increased significantly in recent times. Despite this, there are still many gaps in the research. Systematic reviews by Mücke et al. (2018) and Häuser et al. (2018) showed the effectiveness of cannabis in the treatment of chronic neuropathic pain [5,6]. The effects of cannabis in acute injuries remain poorly studied. For example, a pilot study by Schneider-Smith et al. (2020) found that dronabinol reduced acute post-traumatic pain scores. It also identified methodological limitations, such as small sample sizes and short follow-up periods, emphasizing the need for refined studies [9]. Nugent et al. (2017) note that marijuana may reduce opioid dependence. The effects of marijuana on sport-specific functional outcomes- such as neuromuscular coordination or reaction time- are poorly characterized. This makes integration with protocols such as those proposed by Chan et. al. (2017) difficult [7].Variability in dosing, cannabinoid ratios, and delivery methods further obscures clinical translation, as standardized guidelines for acute injury rehab remain absent [3,9]. Interactions

with conventional therapies, such as NSAIDs or early mobilization strategies [2], also lack empirical scrutiny, creating uncertainty in multimodal rehabilitation frameworks.

The potential benefits of cannabis in acute injury rehab must be carefully weighed against dependency risks, particularly among elite athletes. Ware et al. (2018) emphasize that while cannabinoids may mitigate pain during recovery, athletes exhibit higher susceptibility to cannabis use disorder (CUD), with prolonged use linked to impaired cognitive function and reduced athletic performance [8]. Nugent et al. (2017) further caution that psychoactive effects, such as delayed decision-making, could compromise adherence to rehabilitation regimens, particularly in high-stakes sports environments [7]. Although emerging evidence suggests short-term analgesic benefits [9], long-term safety concerns, including cardiovascular strain from THC during intensive rehab phases, remain unresolved [8]. Current guidelines lack evidence-based thresholds for dosage, duration, or THC/CBD ratios, necessitating longitudinal studies to establish risk-stratified protocols. A harm-reduction approach, integrating patient-specific factors and monitoring for dependency, is essential to optimize therapeutic outcomes without jeopardizing athlete health or career longevity [7,8].

Cannabis's analgesic efficacy in acute injury populations is supported by evidence indicating its potential to reduce pain intensity through cannabinoid receptor modulation. A 2020 systematic review and meta-analysis found that cannabinoids significantly decreased acute pain scores compared to placebo, though effects were moderate and varied by formulation [10]. Similarly, clinical trials involving dronabinol demonstrated short-term pain relief in trauma patients, albeit with diminishing efficacy beyond 72 hours [9]. The problem with standardizing protocols is variability in dosage and bioavailability [6]. Early mobilization is of great importance in rehabilitation pathways. So far, the impact on improving mobility and return to work has not been sufficiently studied [1,2]. Motor coordination and cognitive functions are impaired by the psychoactive effects of marijuana. This results in delayed recovery [8]. A scoping review of chronic musculoskeletal pain patients noted self-reported improvements in mobility among cannabis users, yet rigorous clinical data are lacking [12]. Pilot data from acute injury cohorts found no significant difference in return-to-work timelines between cannabis and control groups [9]. Caution should be exercised when using cannabis. Cannabis use is associated with the risk of addiction. Chan et al. (2017) found that

addiction rates were as high as 12% in populations using cannabis for pain management. Especially when used for a longer period of time [11]. Adherence to therapy may be hampered by common adverse effects, including dizziness, drowsiness, and impaired cognitive function [4,5]. Despite the promising results of cannabis for acute pain relief, its benefits must be weighed against the functional limitations and risk of addiction, which requires further high-quality research to optimize treatment protocols.

Methods

PubMed and Google Scholar databases were searched to identify peer-reviewed studies published since January 2015. Articles were searched using keywords such as “cannabis,” “THC,” “CBD,” “acute injury,” “rehabilitation,” “analgesia,” and “addiction.” Inclusion criteria included randomized controlled trials (RCTs), observational studies, and meta-analyses evaluating the role of cannabis in rehabilitation following acute injury. Publications in languages other than English, animal studies, and non-peer-reviewed articles were excluded. Data extraction prioritized quantitative metrics such as pain scores (e.g., Visual Analog Scale [VAS], Numeric Rating Scale [NRS]), functional outcomes (range of motion, muscle strength, return-to-sport timelines), and dependency rates, assessed via validated scales (e.g., Cannabis Use Disorder Identification Test).

Results

Current evidence suggests that cannabis has moderate analgesic efficacy in the rehabilitation of acute injuries. Results compared to placebo and standard painkillers vary. A 2019 controlled study examined pain intensity in patients with acute muscle injuries after treatment with cannabis-based medications. 30% of patients reported a reduction in pain intensity after the treatment. Compared to placebo, the improvement was significant [13]. A 2017 meta-analysis compared the analgesic effects of THC (tetrahydrocannabinol) formulations to opioids. These studies showed that low-dose formulations provided comparable pain relief to opioids. They also showed fewer adverse events [7]. Dose-dependent effects were evident. Higher concentrations of THC correlated with greater analgesia but increased sedation. CBD (cannabidiol) demonstrated a ceiling effect at intermediate doses (20–40 mg/day) that did not

provide additional pain relief [14]. Of note, patient-reported subjective pain relief often deviated from objective biomarkers. A 2015 neuroimaging study found reduced activation in pain-processing brain regions (e.g., anterior cingulate cortex) following cannabis use, despite minimal changes in patient-reported pain scores [15]. Similarly, a 2020 RCT found that while CBD reduced serum levels of IL-6 (interleukin-6)- a biomarker of inflammation- by 22%. The anti-inflammatory effect did not always align with subjective pain ratings [16]. These discrepancies require improved methodology in future studies. It is also worth considering whether subjective pain scores are sufficient to make clinical decisions. These are challenges that sports physicians face when treating patients with injuries.

Studies support that cannabis improves functional outcomes in rehabilitation after acute injury by reducing both physical and psychological barriers to recovery. It improves adherence to physical therapy. It reduces pain-related interruptions, which positively affects early mobilization and accelerates rehabilitation milestones [1,2]. A 2020 pilot study of dronabinol showed significant improvement in mobility scores among trauma patients. This was due to its analgesic properties that reduced discomfort during therapeutic exercises [9]. Other systematic reviews also show that cannabinoids enhance engagement in rehabilitation programs by relieving pain. This is essential for maintaining continued participation in physical therapy [10,12]. From a psychological perspective, marijuana has been associated with reduced anxiety levels. Modulation of amygdala activity attenuates pain-related distress and emotional reactivity [11,15]. Improvements in sleep quality have also been observed. Sleep is a key factor in tissue repair and psychological resilience. It has been shown to have anti-inflammatory and calming effects in cannabidiol users [12,16]. Long-term use is associated with the risk of addiction. Especially in the case of formulations with a predominance of tetrahydrocannabinol (THC) - caution in dosing and monitoring of treatment is indicated [7]. Among athletes, data suggest that cannabis may aid recovery. It works by alleviating acute pain and stress. However, further research is needed that takes into account psychomotor impairment and long-term dependence [8]. These findings demonstrate the potential of cannabis for the treatment of acute pain. Further research is needed to assess its risks and benefits in this population.

The problem with treatment is the prevalence of cannabis use disorder (CUD). Studies have shown that in cohorts using cannabis for pain management, the prevalence is 10–15% [17]. An increased risk occurs in populations with pre-existing substance use disorders. People with a history of alcohol and opioid abuse, and those using high-THC preparations or increasing doses without medical supervision are at greater risk [18]. A 2018 cohort study found that long-term use beyond 30 days is a significant predictor of developing CUD. Dosing guidelines are needed [19]. In comparison, rates of opioid dependence in similar cohorts with acute injuries are estimated to be 8–12%. Cannabis users have a slightly higher risk of addiction. However, opioids are still associated with increased mortality and potential overdose [20]. These findings suggest the need for monitoring treatment when using cannabis for pain management.

Discussion

Results demonstrate a subtle role for cannabis in acute injury rehabilitation, demonstrating superior analgesic efficacy compared to placebo, although with considerable variability across injury subtypes. Musculoskeletal and neuropathic conditions demonstrate the most consistent benefit, likely due to the interaction of cannabinoids with peripheral and central pain pathways, as evidenced by reduced inflammation and hyperalgesia in clinical cohorts [21]. In contrast, its utility in soft tissue injuries such as ligament or tendon injuries remains less clear, due to differences in injury-specific pathophysiology or the density of localized endocannabinoid receptors [21]. The results regarding functional recovery show a dual benefit. Sleep quality is improved, especially in athletes recovering from high-severity injuries. Physical recovery parameters are also improved, with reduced pain problems at night [22]. In summary, the benefits of their use are offset by side effects. Delayed reaction time and impaired decision-making may compromise sport-specific rehabilitation protocols or readiness to return to play [23]. These discrepancies suggest a need for personalized dosing strategies. This would balance symptom relief with functional demands.

Cannabis has a dual analgesic mechanism. THC, by acting on CB1 receptors, reduces pain perception in the brain. CBD acts on CB2 receptors and reduces inflammation. These mechanisms are also responsible for the presence of side effects, e.g. cognitive impairment [24,25]. Modulation of the endocannabinoid system (ECS) reduces the expression of pro-

inflammatory cytokines (e.g. TNF-α, IL-6) - accelerates tissue repair. In addition, it promotes angiogenesis in damaged musculoskeletal tissues [25]. Due to the side effects of THC, it is not commonly used in rehabilitation [23].

Cannabis can be part of an adjunctive therapy for patients with opioid-resistant pain. It can also be useful for people taking NSAIDs chronically because it is not associated with gastrointestinal side effects [28]. Before including it in therapy, the risk should be assessed. Adolescents are more susceptible to addiction. The incidence of cannabis use disorders in chronically used cannabis is 17% [27,28]. In order to introduce the use of cannabis in treatment, the public must be educated. The public must be made aware that cannabis should not be used as a mild therapeutic agent. Normalization of its recreational use is also undesirable [29]. According to research, in states with laws allowing the use of medicinal marijuana, the number of visits to emergency departments increased by 23%. Visits were mainly related to marijuana use by young adults [29]. Taking into account these data, guidelines for monitoring treatment should be refined.

It is currently difficult to compare studies due to their heterogeneity. These differences include routes of administration (inhalation vs. oral), dosing protocols, cannabis formulations (e.g. THC:CBD ratios), which make it difficult to establish treatment standards [26]. Short-term studies also predominate over long-term studies (median follow-up: 12 weeks), which makes it difficult to determine the risk of chronic use. These risks have been associated with the development of tolerance, cardiovascular effects, or the impact of THC exposure on neurocognitive performance in athletes [26,29]. Future studies should use randomized controlled trials with extended follow-up periods, stratified by injury type and patient demographics. These efforts will help define therapeutic windows and minimize iatrogenic harm.

Future Directions

Further research is needed on the safety and use of cannabis during rehabilitation after acute injuries. Guidelines should be developed that present the dosage of cannabis preparations. This is necessary to optimize therapy and minimize adverse effects. Currently, studies differ in, among others, the proportions of cannabinoids used, the method of delivery and the

diversity of the patient group [14]. Systematic reviews conducted by Ware et al. (2018) and Millar et al. (2019) also reported the need to develop standards for cannabis dosage in athletes.According to these studies, balancing pain relief with rapid recovery remains a contentious issue [8,14]. In addition, long-term studies are needed to clarify the risk of addiction and the impact on cognitive functions of the brain, especially given concerns that long-term use impairs motor skills, decision-making and psychological well-being. These factors are crucial for sports performance [19]. Data suggest that cannabis may serve as an opioid-sparing agent. Its potential for misuse and interaction with rehabilitation protocols remains unexplored [23]. Comparative studies evaluating synthetic cannabinoids, such as dronabinol, versus whole plant extracts may elucidate the role of the "entourage effect" in modulating pain and inflammation [16]. Preclinical models suggest that synthetic derivatives may offer targeted benefits. However, whole plant products are often preferred because of their synergistic phytochemical profiles [25]. Addressing these priorities will require rigorous research and multidisciplinary collaboration. These efforts will establish an evidence-based framework that balances efficacy with athlete safety [14,26].

Conclusion

Cannabis shows promise in treating musculoskeletal and neuropathic pain during rehabilitation. However, its role remains controversial. While some athletes report improved pain tolerance, clinicians must weigh these benefits against the risks. There is a risk of addiction and impaired coordination, which can impair the recovery process [5,6]. Clinical studies indicate the possibility of reducing opioid dependence and improving adherence to rehabilitation protocols. Pain management and psychological support should be improved, which will result in, for example, reducing anxiety and improving sleep quality [9]. These benefits must be carefully balanced against the risk of cannabis use disorder (CUD). CUD affects 10–15% of users. Impaired cognitive function and fine motor skills, especially with long-term or high-dose THC use, are specific risks for athletes [17]. The heterogeneity of dosing regimens, cannabinoid ratios, and routes of administration underscores the urgent need for standardized, evidence-based guidelines. These should take into account athlete-specific risk profiles and injury subtypes [14,26]. A multidisciplinary approach- integrating pain specialists, sports physicians, and mental health professional- is essential to optimize therapeutic outcomes. It will simultaneously mitigate addiction and reduce performance-

related side effects [18,19]. Future research should focus on long-term studies and head-to-head comparisons of synthetic and whole-plant cannabis to clarify their therapeutic potential in sports medicine rehabilitation.

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