JB&JS OPEN ACCESS

Cannabidiol Perceptions and Use in the Orthopaedic Patient Population

Bradley Lambert, PhD, Karen L. Hernandez, BS, Haley Goble, MHA, Erin Orozco, MD, and Patrick C. McCulloch, MD

Investigation performed at Houston Methodist Hospital, Houston, TX

Background: Although explored in other medical fields, cannabidiol (CBD) use for pain management remains understudied in orthopaedics. The purpose of this study was to evaluate the frequency of CBD use and perceptions among an orthopaedic population. We hypothesized that most patients would be aware of CBD, that the prevalence of CBD use would at least be comparable with the general population (~15%), and that the overall perception of CBD use for pain relief would be favorable.

Methods: Five hundred adult orthopaedic patients (♂249/♀247; 4 = undisclosed, 54 ± 16 years, 18-86 years) seeking treatment for a wide range of conditions were recruited from a single hospital system before undergoing surgery. Patients were sent an email with a REDCap link for an anonymous survey that included questions about the following: demographics, procedure type, current pain levels, previous knowledge of and/or use of CBD, and indication of favorability regarding CBD use for pain management.

Results: Among all patients, >80% reported having heard of CBD and 41.8% reported having used CBD. Among patients reporting previous CBD use, "pain management" (79.43%) and "seeking alternative pain treatment" (58.81%) were the most common reasons. Among patients reporting no use, the most common reasons were "unsure of how to obtain" (42.76%) or "lack of familiarity" (37.24%); although the same patients indicated they would consider using if prescription CBD was available (61.22%) along with more evidence regarding safety/efficacy (44.90%). Over 80% of the surveyed patients agreed that CBD might be effective for pain management ($p < 0.05$).

Conclusion: A large proportion of orthopaedic patients have used, or are aware of, CBD for pain management. Presently, barriers to use appear to be most associated with the need for more evidence regarding efficacy/safety and the availability of physician-prescribed pharmaceutical-grade CBD. These results highlight an important need for large-scale randomized trials that may support pharmaceutical-grade CBD use for pain management.

Level of Evidence: Level III, Descriptive Survey Study. See Instructions for Authors for a complete description of levels of evidence.

Introduction

The United States is amid an ongoing epidemic of opioid use with a 6-fold increase in opioid overdose deaths from 1999 to 2017 and a projected increase from 33,100 deaths in 2015 to 81,700 in 2025[1,2]. Importantly, orthopaedic clinicians rank 3rd in opioid medication prescription[3]. In the interest of combating this ongoing issue, a variety of alternative and/or multimodal pain management strategies have gained substantial interest for improving patient outcomes while also reducing opioid medication intake[4-8]. In particular, the use of over-the-counter and prescription-grade cannabidiol (CBD) has gained heightened interest as an adjunct for management of chronic, acute, and postoperative pain following recent observations supporting its therapeutic use for a range of neurological conditions and conditions such as anxiety[9-12]. However, evidence regarding efficacy for pain management remains lacking despite a general increase in public use[10]. In addition, perceptions regarding support, apprehension to use, and current or past usage remain underreported among orthopaedic patient populations.

Cannabis sativa plant extract has long been used in various herbal forms as a therapeutic adjunct for a variety of ailments including joint pain, muscle spasms, and various chronic

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSOA/A784).

conditions[13]. CBD has been observed to provide therapeutic benefits for patient populations suffering from chronic neurological disorders, cancer, and a range of psychiatric conditions[14]. Furthermore, data from recent animal investigations indicate that CBD use may provide anti-inflammatory benefits while also decreasing pain responses associated with arthritis[15]. Based on these findings, the anxiolytic, anti-inflammatory, and analgesic properties of CBD indicate that it may be a viable candidate for nonopioid pain management in operative and nonoperative orthopaedic patients[16-18]. However, access to prescription-grade CBD is limited, making randomized controlled trials difficult in the United States. Furthermore, what small-scale studies have been completed in humans was concluded by Porter et al.[10] to have yielded mixed results with poor levels of control. In addition, the only current CBD medication approved by the Food and Drug Administration (FDA), Epidiolex, is solely indicated for rare, severe forms of epilepsy[19,20]. Presently, there are no current FDA-approved CBD medications for pain management in the United States. Given the increasing number of orthopaedic procedures each year paired with a rise in those living with chronic orthopaedic conditions, it is likely that CBD and other forms of nonopioid treatments will be increasingly considered as an adjunct for pain among prescribers and patients[21,22]. However, the degree to which factors such as physician guidance, clinical evidence, availability of prescription grade drug, and stigma associated with marijuana use may influence patient perceptions or willingness to use CBD for pain management remains largely understudied[23]. Therefore, understanding patient perceptions, history of use, and potential apprehensions to the use of CBD for pain management is important for clinicians and policy makers alike as patient adherence is a critical factor in treatment efficacy. This information would also be highly valuable for future development of much-needed clinical trials and identification of initial target patient populations that may be most appropriate for therapeutic CBD interventions.

Considering the rising interest in nonopioid pain management, the purpose of this study was to assess patient frequency of CBD use (past and present), perceptions of use for pain management, and rationale for or against CBD use for pain management among patients undergoing a wide range of orthopaedic procedures that also encompass a wide age range. We hypothesized that the majority of the patient population among all surgery types/subspecialties would be aware of CBD, that the prevalence of CBD use would at least be comparable with the prevalence within the general population (~15%), and that the overall perception of CBD use for pain relief would be favorable. We also hypothesized that those with more chronic conditions such as osteoarthritis who require more long-term pain management would be more favorable toward CBD use compared with those with acute injuries requiring surgery. As secondary aims, we sought to determine if sex or age affected patient perceptions of CBD.

Methods

All procedures to follow were reviewed and approved by the institutional review board for research involving humans (IRB Protocol#: PRO00030559), and all patients provided informed consent before participating.

Patients

A sample of 500 adult orthopaedic patients (m = 249, f = 247; 4 = undisclosed, 54 ± 16 years, 18-86 years) were recruited from a single hospital system performing both outpatient and inpatient surgeries in a major metropolitan area. All patients were recruited before surgery within all orthopaedic subspecialties, which included sports medicine; total joint arthroplasty; hand, foot, and ankle; spine; and general orthopaedics. Patients who met inclusion criteria were screened before surgery by the research team and recruited through REDCap e-consent and survey. Because of the supplement/drug-related nature of the study, completion of the surveys was anonymous through instruction of the institutional review board. Inclusion criteria included patients undergoing orthopaedic surgery above the age of 18 years. Patient demographics and procedure distributions are presented in Table I.

Study Protocol

All orthopaedic patients were sent an email with a REDCap link for an anonymous survey. The survey included questions about the following: demographic information, reason for seeking orthopaedic treatment (subspecialty), pain level on the day of survey completion as well as over the past week and month prior to survey completion (Visual Analog Scale [VAS] 0-100), previous knowledge of and/or use of CBD, and indication of whether the patient is supportive of CBD use for perioperative pain management. Those in support of CBD use were also asked about their reasoning for support of CBD use and their openness to the use of CBD for pain management. Those not in support of CBD use were asked about their reasoning for being apprehensive of CBD use for pain management. A copy of the survey can be found in the data supplement (see Appendix).

Statistical Analysis

All statistical analyses were performed using SPSS Statistics Software (v.26; IMB). Independent sample *t*-tests and an ANOVA followed by a Bonferroni post hoc test for individual pairwise comparisons were used to compare continuous/parametric survey data among sex (male vs female) and age (18-40 years, 41-60 years, 61+ years) for all patients. The same test was used to compare survey responses between patients seeking treatment for acute vs. chronic conditions. Next, among all included procedure types, a one-sample *t*-test was used to determine perceptions of "efficacy" and "openness to use" (quantified using a VAS scale of 0 [no favorability] to 100 [max favorability]) with scores significantly above 50 considered to be "more favorable" and those below 50 to be "less favorable". Next, chi-square analysis was used for frequency-based data comparisons between subcategories of respondents. Type-I error was set at $\alpha = 0.05$ for all analyses.

Last, descriptive statistics for the frequency of the following was recorded: perceptions of what CBD is commonly used for, rational for use by those who reported previously using CBD, reason for first being interested in using CBD

JBJS Open Access • 2025:e24.00141. openaccess.jbjs.org

TABLE I Patient Demographics and Orthopaedic Procedure Distribution*

Procedure Type	Age Mean ± SD	Sex	
		Male	Female
Knee arthroscopy (n = 81)	43.0 ± 15.0	40.5%	59.5%
	12.35%		
Hip arthroscopy (n = 27)	40.0 ± 14.1	63.0%	37.0%
	14.81%		
Shoulder arthroscopy (n = 80)	51.5 ± 14.5	28.8%	71.2%
	8.75%		
Joint replacement (hip, knee, shoulder) (n = 123)	65.6 ± 9.4	58.2%	41.8%
	6.56%		
Carpal tunnel release (n = 26)	55.1 ± 13.3	44.0%	56.0%
	3.85%		
Fracture repair (n = 16)	51.3 ± 17.2	50.0%	50.0%
	18.75%		
Spinal disc removal/decompression (n = 29)	60.5 ± 14.3	27.6%	72.4%
	3.45%		
Other/not disclosed (n = 118)	52.3 ± 15.1	65.3%	34.7%

*Data are presented for patient recruitment, sex frequencies (M, F), and orthopaedic procedure distribution with age (years ± SD) and sex distribution within each. ACL = anterior cruciate ligament, CBD = cannabidiol, MCL = medial collateral ligament, and PCL = posterior cruciate ligament.

among those who reported previous use, reason for not using CBD among patients who reported no previous use, and factors required for patients to consider using CBD among patients who reported no previous use.

Results

Familiarity and Prevalence of Use

The frequency of previous use and those who have heard of CBD among each surgery type is presented in Table II, with over 80% of patients having previously heard of CBD. Of all patients surveyed, 41.8% indicated they have used CBD before (range: 19%-63%) with the highest frequency of use reported among hip arthroscopy patients (62.96%).

Among patients reporting previous use of CBD, rationale frequencies for use are presented in Figure 1. Among those who reported previously using CBD, the majority reported primarily using CBD for pain management (79.43%) (Fig. 1-A). In addition, 17.22% reporting using CBD for management of anxiety/depression, 30.14% for stress, 20.10% for recreational purposes, 7.18% as a sleep aid, and 1.91% have used CBD during cancer treatment. Among the patients who have used CBD, 58.81% stated they were first interested in CBD because they were seeking an alternative treatment (Fig. 1-B). In addition, 49.76% were interested because they were not experiencing relief on current treatment regimens and 44.02% were interested because it was recommended by others (Fig. 1-B).

Among patients reporting no previous use of CBD, rationale frequencies for no previous use are presented in Figure 2. The most common reasons for subjects to have not used CBD before included being unsure of how to obtain CBD (42.76%) or a lack of familiarity with CBD (37.24%) (Fig. 2-A). Most patients who have not used CBD did endorse they would consider using it if a prescription CBD was available (61.22%), there was more available evidence on its safety and efficacy (44.90), or if there were better regulations on its use (28.16%) (Fig. 2-B).

Over 80% of the patients interviewed undergoing each procedure type agreed with the statement that CBD may be effective for controlling pain and that they would be open to using CBD to manage pain (Fig. 3-A). All procedure types except for fracture repair had a statistically significant percentage of subjects who agreed CBD may be effective for controlling pain. All procedure types had a statistically significant percentage of subjects who would be open to using CBD for pain management (Fig. 3-B). When comparing patient-reported pain scores across the past week and month, those who reported prior use of CBD were observed to have higher pain scores across the past month before taking the survey (Fig. 4, $p = 0.023$).

Last, no effect of sex or age was observed with regard to frequency of CBD use or patient perceptions of CBD (usage or apprehension towards usage).

Discussion

In this study, we sought to determine the past frequency of CBD use among orthopaedic patients, as well as their perceptions of CBD. We hypothesized that most patients would be aware of CBD, that prevalence of CBD use would be comparable with the general population, that overall perception of

JBJS Open Access • 2025:e24.00141. **openaccess.jbjs.org**

TABLE II Frequency of Orthopaedic Patients of Have "Heard of" or "Previously Used" CBD by Procedure Type*

	Previously Heard of CBD		Previously Used CBD	
Procedure Type	Yes	No	Yes	No
Knee arthroscopy	87.65%	12.35%	40.74%	59.26%
Hip arthroscopy	85.19%	14.81%	62.96%	37.04%
Shoulder arthroscopy	91.25%	8.75%	41.25%	57.50%
Joint replacement (hip, knee, shoulder)	93.44%	6.56%	41.46%	58.54%
Carpal tunnel release	96.15%	3.85%	30.77%	69.23%
Fracture repair	81.25%	18.75%	37.50%	62.50%
Spinal disc removal/decompression	96.55%	3.45%	37.93%	62.07%

*Knee arthroscopy includes knee scope and repair of ACL, MCL, and PCL. Shoulder arthroscopy includes shoulder scope and rotator cuff repairs. Joint replacement includes all total hip, knee, and shoulder replacement procedures. ACL = anterior cruciate ligament, CBD = cannabidiol, MCL = medial collateral ligament, and PCL = posterior cruciate ligament.

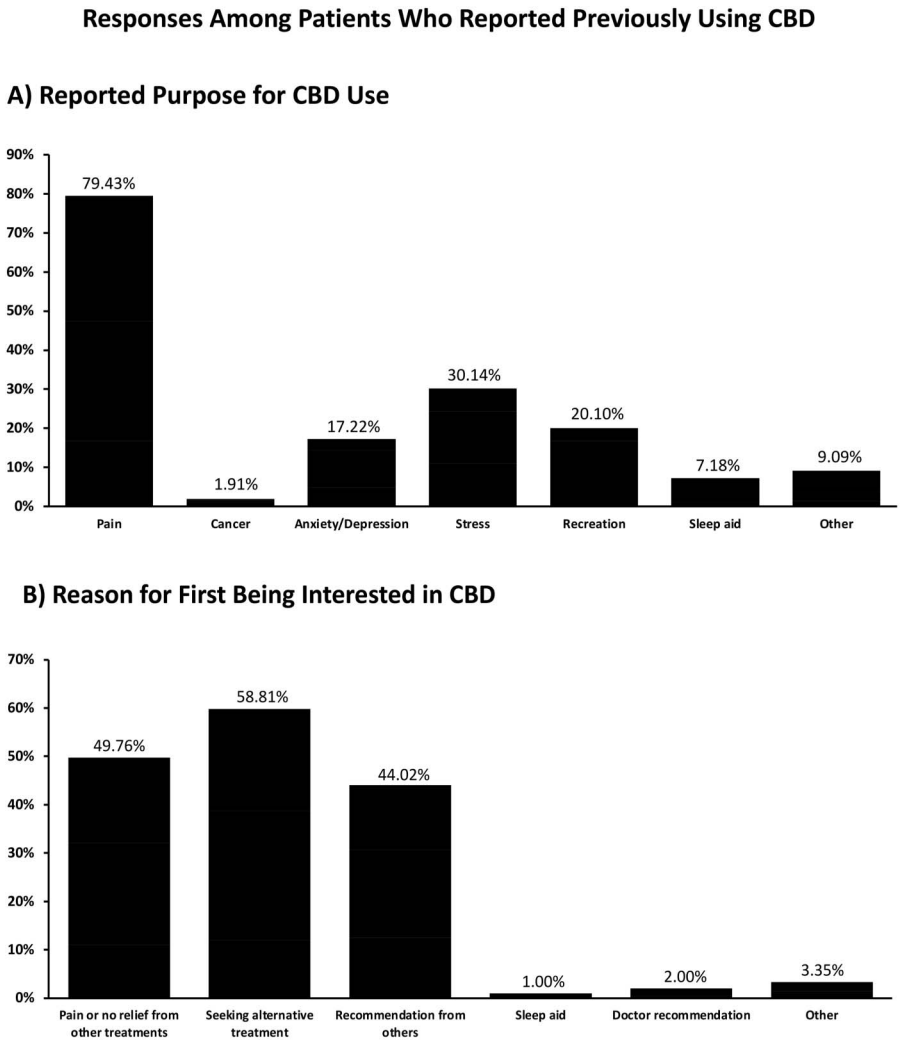

Fig. 1

Responses among patients who reported previously using CBD. Data are presented as response frequencies among patients reporting to have previously used CBD. Both reason for reported use (**Fig. 1-A**) and reason for first being interested in CBD (**Fig. 1-B**) are reported here. CBD = cannabidiol.

JBJS Open Access • 2025:e24.00141. openaccess.jbjs.org

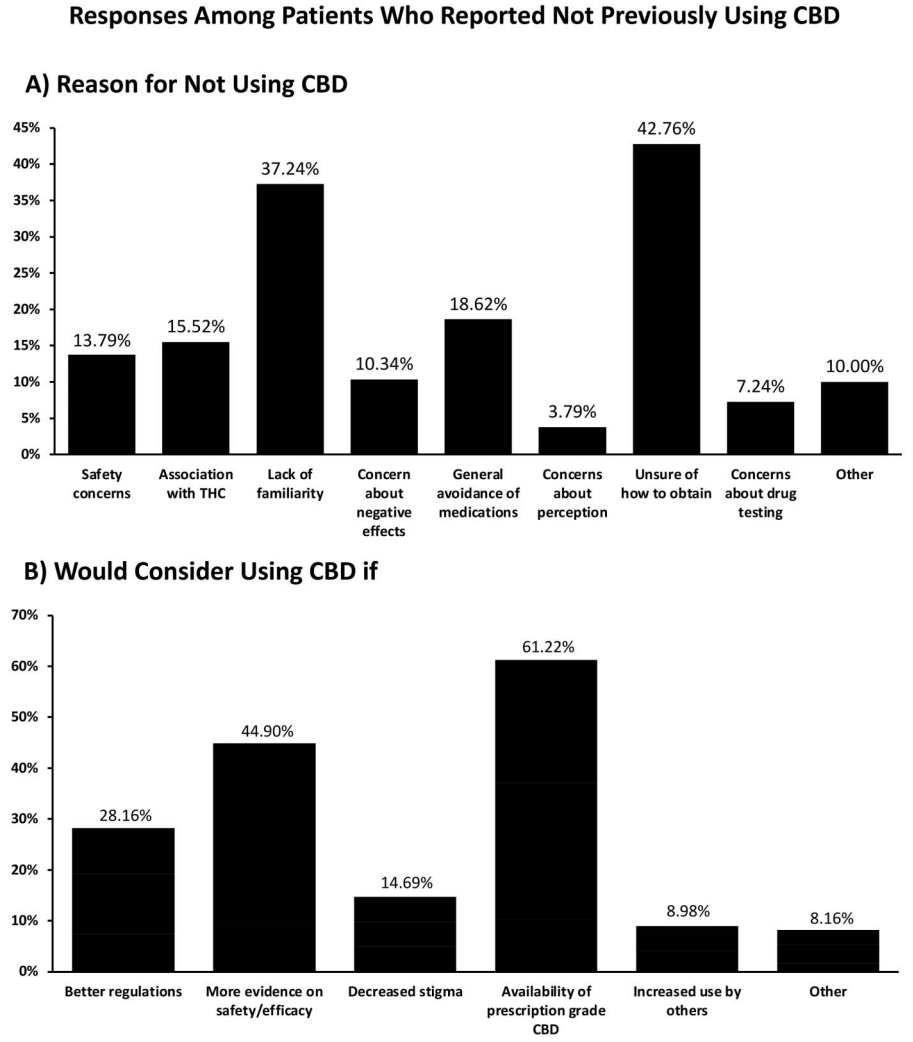

Fig. 2

Responses among patients who reported not previously using CBD. Data are presented as response frequencies among patients reporting to have not previously used CBD. Both reason for not using (**Fig. 2-A**) and conditions under which patients might consider using CBD (**Fig. 2-B**) are reported here. CBD = cannabidiol.

CBD use would be favorable, and that chronic pain patients would have more favorable views of CBD than those with acute injuries. As anticipated, most patients surveyed had heard of CBD before (70%), and over 80% of patients surveyed supported its use for pain control. These findings are clinically relevant, as they help further inform clinicians regarding the perspectives of their patients in relation to pain control methods. In addition, these findings provide further support for performing high quality placebo-controlled randomized controlled trials among a wide range of subspecialties, as a large subset of orthopaedic patients and the general population have already used this compound at least once.

Prevalence of Use Among Orthopaedic Patient Populations

As of 2019, the Substance Abuse and Mental Health Services Administration reported that approximately 14% of the population aged older than 18 years has used or is currently using CBD[24]. Subsequently, this frequency rose to nearly 1 in 3 adults in 2020 despite mixed evidence regarding efficacy and a lack of FDA-approved sources designated for the treatment of pain[24]. In the orthopaedic population surveyed here with over 500 patients among several subspecialties, 41.8% of patients reported having used CBD. This result is somewhat expected considering the primary reason for reported use was pain management, and pain is a common component of why patients seek orthopaedic treatment to begin with. Cumulatively, these findings indicate that even amidst a growing frequency of use among general population adults, use of CBD in the form of nonprescription grade over the counter is even further elevated among orthopaedic patients, regardless of age.

Compared with those who have not used CBD, the pain population that has used or is using CBD was the population

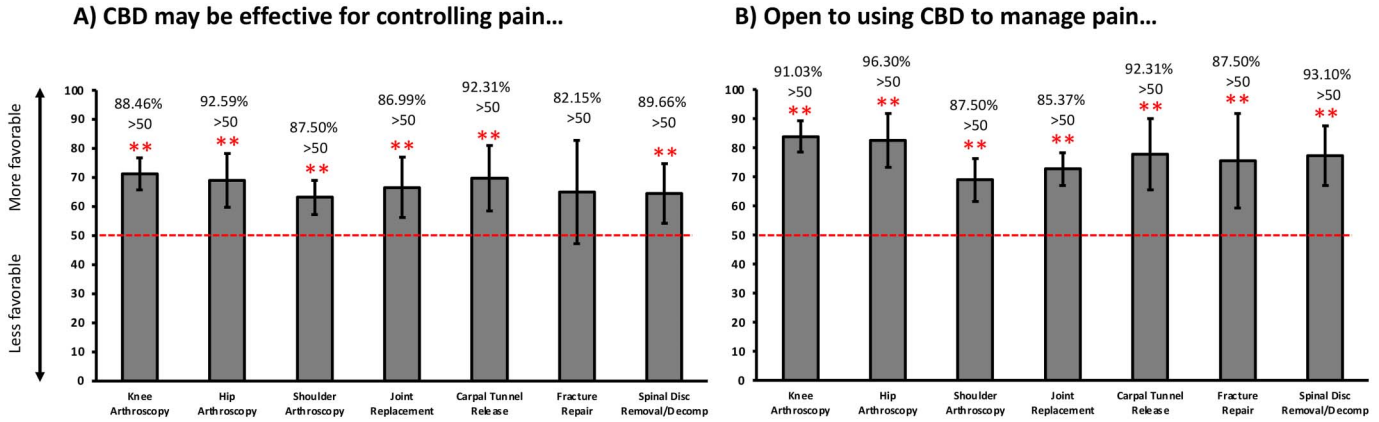

Fig. 3

Patient favorability toward CBD use for managing pain (all patients surveyed). Data are presented as means ± 95% CI for patient favorability scores assessed suing a visual analog scale (VAS, 0-100) with lower scores indicating lower favorability and higher scores indicating higher favorability. *, ** = Significantly higher than a score of 50 (>50 = more favorable) at $p < 0.05$ and $p < 0.01$, respectively. CBD = cannabidiol.

that had higher pain levels over longer periods of time (>1 month). Furthermore, arthroscopic procedures of the hip, knee, and shoulder as well as total joint arthroplasty were observed to be among the most frequent users when examining across subspecialty (Table II). However, further study will be required to determine if orthopaedic populations suffering from more chronic conditions may be more likely to seek out alternative pain management strategies before being surgically treated (compared with those with more acute trauma).

Rational for or Against CBD Use Among Orthopaedic Patients

As previously mentioned, pain was the primary factor for patient-reported CBD use. Other reasons for use included treatment of stress and anxiety, or for recreational purposes. This is consistent with data from a survey of individuals who used CBD for medicinal purposes, in which chronic pain was the most common reason for reported use, followed by arthritis or joint pain, then anxiety[25]. Briefly, the mechanisms of the often reported analgesic effect of CBD includes inhibition of the release of neurotransmitters and neuropeptides from presynaptic nerve endings, modulation of postsynaptic neuron excitability, activation of descending inhibitory pain pathways, and reduction of neural inflammation[12]. However, data from human clinical trials remains lacking with previous studies involving only short durations, low sample sizes, blends of different nonpure CBD sources, and a wide range of dosing strategies[12]. Therefore, substantial need remains for further evidence on efficacy, dosing, and long-term clinical outcomes.

Despite the current lack of evidence, use of CBD for pain management in the general population continues to rise. Multiple survey-based outcome studies have reported that chronic use of CBD by various clinical populations resulted in a marked reduction in the use of other pain medications. For instance, one study that surveyed chronic pain patients, Schilling et al.[26] reported that 59% of patients indicated that CBD helped alleviate their pain, with as many as 67.6% decreasing their pain medication use after initiation of CBD. Another study demonstrated similar findings in patients with fibromyalgia, where patients surveyed endorsed a decreased reliance on pain medication when using CBD[27]. These

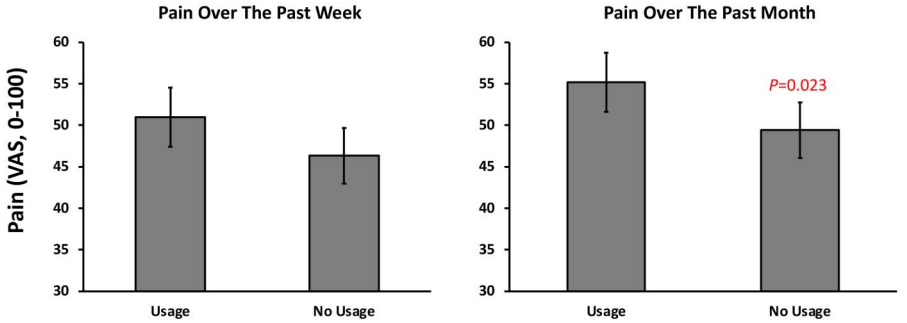

Fig. 4

Patient-reported pain comparison between those reporting prior use vs. no use of CBD. Data are presented as means ± 95% CI for pain recorded using a visual analog scale (VAS, 0-100), whereby patients rated their pain over the past week and month before taking the survey. p-value indicates a significant difference between patients who reported previously using CBD (usage) and those who reported not previously using CBD (No Usage). CBD = cannabidiol.

reports paired with the findings presented here add further support to warrant large-scale randomized controlled trials and improved availability of pharmaceutical-grade CBD for therapeutic use.

Regarding our orthopaedic patients who had not previously used CBD, the most common reasons for hesitancy of use were lack of access to prescription grade CBD (61%), limited evidence on efficacy (45%), and a lack of regulations on CBD products (28%) (Fig. 2). This further illuminates a need for investigation into the efficacy and safety profile of CBD for treatment of specific medical conditions outside of its current list of FDA-approved conditions. Notably, these reasons were provided in markedly higher frequency compared with the commonly reported stigma of CBD in association with marijuana use[28].

Clinical Considerations

Based on a systematic review of multiple randomized controlled trials, CBD is generally well tolerated[29]. However, its most common side effects include dry mouth, euphoria, hunger, red eyes, and sedation or fatigue. Diarrhea has been reported as an additional side effect. Furthermore, it may interact with the hepatic metabolism of certain medications. Therefore, it is reasonable to conclude that CBD is generally well tolerated and can be safely prescribed as long as a proper review of potential medication interactions is conducted[29]. Nevertheless, lack of pharmaceutical-grade CBD for therapeutic or recreational use remains a substantial concern and barrier for care providers seeking alternative methods for multimodal pain management. Therefore, providing physicians with data for both efficacy and the ability to safely prescribe CBD holds important clinical value. Furthermore, to our knowledge, no current publications exist that have compared CBD with opioids for postoperative pain management. As previously mentioned, biochemical and subjective evidence exists to support the exploration of CBD as a potential modality for pain management. Obtaining robust evidence for the use of CBD to control pain may help to initiate more widespread use of CBD in the medical field, consequently decreasing the number of written opioid prescriptions.

Limitations and Considerations

As is particularly the case with any survey-based investigation, this study is not without limitations. As with any study surveying perception among patients, there is a risk of bias affecting results. Both recall and response bias can play a factor in the responses received in the study, though the use of electronic surveys may decrease the effect of response by delivering the study resources to the patients in a convenient manner. Furthermore, the survey was completed in a home setting using electronic survey software and not in the clinic which likely influenced the low response rate and may have resulted in selection biases. In addition, since this study took place in a state that has not legalized recreational marijuana, we cannot discount that this may affect the generalizable nature of the present findings[30]. Expanding this survey across multiple states and comparing perceptions between nonlegalized and legalized states could be a useful next step to better evaluate patient perceptions of CBD. Next, although this survey involved a relatively large sample size of 500 patients, sample size was not matched across subspecialties or age ranges, thus limiting some of the potential comparisons across subspecialty that may have been of interest.

Conclusion

The use of CBD in orthopaedic patients among various subspecialties for the primary purpose of alternative pain management occurs at a frequency that is outpacing an already rising incidence of use in the general population. Among those who report not using CBD, barriers to use appear to be most associated with the need for more evidence regarding efficacy and safety as well as the availability of pharmaceutical-grade drug that can be prescribed by a patient's physician. Given the present findings, it may be possible that if those issues can be addressed, therapeutic use will continue to rise. Regardless, the results of this study point to an important clinical need for large-scale randomized controlled trials in a clinical setting that may help to drive the development of pharmaceutical-grade CBD approved for pain management.

Appendix

eA Supporting material provided by the author is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSOA/A785). This content has not been copyedited or verified. ■

Bradley Lambert, PhD[1]
Karen L. Hernandez, BS[1]
Haley Goble, MHA[1]
Erin Orozco, MD[1]
Patrick C. McCulloch, MD[1]

[1]Department of Orthopedics & Sports Medicine, Houston Methodist Hospital, Houston, Texas

E-mail address for Bradley Lambert: bslambert@houstonmethodist.org

References

1. Mattson CL, Tanz LJ, Quinn K, Kariisa M, Patel P, Davis NL. Trends and geographic patterns in drug and synthetic opioid overdose deaths–United States, 2013-2019. MMWR Morb Mortal Wkly Rep. 2021;70(6):202-7.

2. VanHouten JP, Rudd RA, Ballesteros MF, Mack KA. Drug overdose deaths among women aged 30-64 years–United States, 1999-2017. MMWR Morb Mortal Wkly Rep. 2019;68(1):1-5.

3. Morris BJ, Mir HR. The opioid epidemic: impact on orthopaedic surgery. J Am Acad Orthop Surg. 2015;23(5):267-71.

4. Brozovich AA, Incavo SJ, Lambert BS, Sullivan TC, Wininger AE, Clyburn TA, Taraballi F, Park KJ. Intraosseous morphine decreases postoperative pain and pain medication use in total knee arthroplasty: a double-blind, randomized controlled trial. J Arthroplasty. 2022;37(6s):S139-S146.

5. Morehouse H, Goble HM, Lambert BS, Cole J, Holderread BM, Le JT, Siff T, McCulloch PC, Liberman SR. Limb occlusion pressure versus standard pneumatic tourniquet pressure in open carpal tunnel surgery–a randomized trial. Cureus. 2021;13(12):e20110.

6. O'Neill A, Lirk P. Multimodal analgesia. Anesthesiol Clin. 2022;40(3):455-68.
7. Rawal N. Current issues in postoperative pain management. Eur J Anaesthesiol. 2016;33(3):160-71.
8. Rech MA, Griggs C, Lovett S, Motov S. Acute pain management in the Emergency Department: use of multimodal and non-opioid analgesic treatment strategies. Am J Emerg Med. 2022;58:57-65.
9. Boyaji S, Merkow J, Elman RNM, Kaye AD, Yong RJ, Urman RD. The role of cannabidiol (CBD) in chronic pain management: an assessment of current evidence. Curr Pain Headache Rep. 2020;24(2):4-6.
10. Porter B, Marie BS, Milavetz G, Herr K. Cannabidiol (CBD) use by older adults for acute and chronic pain. J Gerontol Nurs. 2021;47(7):6-15.
11. Vivace BJ, Sanders AN, Glassman SD, Carreon LY, Laratta JL, Gum JL. Cannabinoids and orthopedic surgery: a systematic review of therapeutic studies. J Orthop Surg Res. 2021;16(1):57-15.
12. Vučković S, Srebro D, Vujović KS, Vučetić Č, Prostran M. Cannabinoids and pain: new insights from old molecules. Front Pharmacol. 2018;9:1259.
13. Russo EB. History of cannabis and its preparations in saga, science, and sobriquet. Chem Biodivers. 2007;4(8):1614-48.
14. Scuderi C, Filippis DD, Iuvone T, Blasio A, Steardo A, Esposito G. Cannabidiol in medicine: a review of its therapeutic potential in CNS disorders. Phytother Res. 2009;23(5):597-602.
15. Gusho CA, Court T. Cannabidiol: a brief review of its therapeutic and pharmacologic efficacy in the management of joint disease. Cureus. 2020;12(3):e7375.
16. Atalay S, Jarocka-Karpowicz I, Skrzydlewska E. Antioxidative and anti-inflammatory properties of cannabidiol. Antioxidants. 2019;9(1):21.
17. Mlost J, Bryk M, Starowicz K. Cannabidiol for pain treatment: focus on pharmacology and mechanism of action. Int J Mol Sci. 2020;21(22):8870.
18. Peng J, Fan M, An C, Ni F, Huang W, Luo J. A narrative review of molecular mechanism and therapeutic effect of cannabidiol (CBD). Basic Clin Pharmacol Toxicol. 2022;130(4):439-56.
19. Golub V, Reddy DS. Cannabidiol therapy for refractory epilepsy and seizure disorders. Adv Exp Med Biol. 2021;1264:93-110.
20. Huestis MA, Solimini R, Pichini S, Pacifici R, Carlier J, Busardò FP. Cannabidiol adverse effects and toxicity. Curr Neuropharmacol. 2019;17(10):974-89.
21. El-Tallawy SN, Nalamasu R, Salem GI, LeQuang JAK, Pergolizzi JV, Christo PJ. Management of musculoskeletal pain: an update with emphasis on chronic musculoskeletal pain. Pain Ther. 2021;10(1):181-209.
22. Jarman MP, Weaver MJ, Haider AH, Salim A, Harris MB. The national burden of orthopedic injury: cross-sectional estimates for trauma system planning and optimization. J Surg Res. 2020;249:197-204.
23. Erridge S, Coomber R, Sodergren MH. Medical cannabis, CBD wellness products and public awareness of evolving regulations in the United Kingdom. J Cannabis Res. 2022;4(1):56.
24. Cannabidiol (CBD)–potential harms, side effects, and unknowns. Substance Abuse and Mental Health Services Administration; https://store.samhsa.gov/sites/default/files/pep22-06-04-003.pdf (2023, Accessed January, 2024).
25. Corroon J, Phillips JA. A cross-sectional study of cannabidiol users. Cannabis Cannabinoid Res. 2018;3(1):152-61.
26. Schilling JM, Hughes CG, Wallace MS, Sexton M, Backonja M, Moeller-Bertram T. Cannabidiol as a treatment for chronic pain: a survey of patients' perspectives and attitudes. J Pain Res. 2021;14:1241-50.
27. Boehnke KF, Gagnier JJ, Matallana L, Williams DA. Substituting cannabidiol for opioids and pain medications among individuals with fibromyalgia: a large online survey. J Pain. 2021;22(11):1418-28.
28. Zeng L, Lytvyn L, Wang X, Kithulegoda N, Agterberg S, Shergill Y, Esfahani MA, Heen AF, Agoritsas T, Guyatt GH, Busse JW. Values and preferences towards medical cannabis among people living with chronic pain: a mixed-methods systematic review. BMJ Open. 2021;11(9):e050831.
29. Chesney E, Oliver D, Green A, Sovi S, Wilson J, Englund A, Freeman TP, McGuire P. Adverse effects of cannabidiol: a systematic review and meta-analysis of randomized clinical trials. Neuropsychopharmacology. 2020;45(11):1799-806.
30. Steigerwald S, Cohen BE, Vali M, Hasin D, Cerda M, Keyhani S. Differences in opinions about marijuana use and prevalence of use by state legalization status. J Addict Med. 2020;14(4):337-44.