Journal of Hand Surgery Global Online 6 (2024) 16–20

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Original Research

Multimodal Pain Management After Outpatient Orthopedic Hand Surgery: A Prospective Randomized Trial

Asif M. Ilyas, MD, MBA, * Padmaja Sundaram, BA, * Kyle Plusch, BA, * Alexis Kasper, BS, * Christopher M. Jones, MD *

* Rothman Orthopaedic Institute at Thomas Jefferson University, Philadelphia, PA USA

ARTICLE INFO

Article history:
Received for publication December 8, 2022
Accepted in revised form July 29, 2023
Available online October 1, 2023

Key words:
Acetaminophen
Elbow
Hand
Multimodal pain management
Naproxen
Narcotics
Opioid crisis
Opioids
Orthopedic
Oxycodone
Postoperative Pain
Surgery
Wrist

Purpose: Opioid stewardship ensures effective pain management while avoiding overprescribing of opioids after surgery. This prospective randomized study investigates the efficacy of a multimodal postoperative pain regimen compared to a traditional opioid-only pain regimen following elective outpatient orthopedic hand surgery. We hypothesized that patients receiving multimodal pain management would consume fewer opioids and report greater satisfaction than patients receiving only opioids.

Methods: Consecutive patients undergoing outpatient hand and upper extremity surgery performed by two board-certified fellowship-trained orthopedic hand surgeons at one institution were recruited and randomized into either a study or control group. The study group received a standing multimodal postoperative regimen consisting of scheduled oral acetaminophen and naproxen as well as oxycodone to be taken as needed. The control group received only oxycodone to be taken as needed. Postoperatively, daily pain levels, medication usage, refills, satisfaction, and adverse events were recorded. Descriptive statistics were performed.

Results: Of the 112 patients enrolled, 54 were randomized to the control group, and 58 were randomized to the study group. Study and control group patients did not differ significantly based on daily average pain scores or daily worst pain scores. However, study group patients reported fewer average daily oxycodone intake and total oxycodone pill count (7.0 vs 2.4 total pills, $P < .005$). In addition, the study group patients were more likely to report satisfaction with their postoperative pain control than control regimen patient's and were more likely to use the same pain regimen again if required.

Conclusion: A multimodal postoperative pain regimen reduces opioid usage and has higher patient satisfaction rates in comparison to traditional opioid-only regimens. Use of multimodal pain regimens that use nonopioids, such as acetaminophen and naproxen, over an opioid should be considered for postoperative pain after orthopedic hand surgery.

Level of Evidence: Therapeutic II

The ongoing opioid crisis warrants effective opioid stewardship by surgeons to effectively manage patients' postoperative pain experience while avoiding inadvertent overprescribing of opioids that can potentially lead to diversion, addiction, abuse, and overdose. Several studies in the Orthopedics and Hand Surgery literature have identified that overprescribing remains common.[1–3] Multimodal pain management strategies have been used in various surgical specialties with the goal of providing effective postoperative pain management by emphasizing nonopioid analgesics and anti-inflammatory and neuromodulating agents as first-line agents for pain while reserving opioids for severe or breakthrough pain.[4]

This prospective, randomized study investigates the efficacy of a multimodal postoperative pain regimen compared to a traditional opioid-only pain regimen following patients undergoing elective

Declaration of interests: The study was funded through a grant from the Rothman Institute Foundation for Opioid Research & Education.

Corresponding author: Alexis Kasper, BS, Rothman Orthopaedic Institute, 925 Chestnut St, 5th Floor, Philadelphia, PA 19107.
E-mail address: alexis.kasper@rothmanortho.com (A. Kasper).

https://doi.org/10.1016/j.jhsg.2023.07.021

outpatient orthopedic hand surgery. We hypothesized that patients receiving multimodal pain management would consume fewer opioids and report greater satisfaction than patients receiving only opioids.

Materials and Methods

Institutional review board approval was obtained, and a prospective, randomized controlled study was conducted with two hand and upper extremity surgery fellowship-trained, board-certified orthopedic surgeons. All protocols were performed according to Consolidated Standards of Reporting Trials guidelines. Consecutive patients undergoing hand and upper extremity surgery at a single outpatient surgical center were recruited. Exclusion criteria included surgeries using local anesthesia only (ie, wide-awake local anesthesia no tourniquet [WALANT] surgeries), patients with known allergies to prescribed medications, a history of chronic pain requiring current opioid use, pregnant patients, non-English speaking patients, and patients under 18 years of age. Current opioid use was assessed at the preoperative clinic visit as well as verified when approaching patients for consent in the preoperative holding area. Patients undergoing surgery with local anesthesia only were excluded based on previously published data from Ilyas et al[5] demonstrating no difference in postoperative pain control following carpal tunnel release under local anesthesia between oxycodone, ibuprofen, and acetaminophen monotherapies, suggesting a lack of need for opioids following these procedures. Patients were randomized into either a study or control group using a randomizing computer application.

The study group patients were prescribed postoperatively a multimodal postoperative prescription regimen consisting of the following: (1) 30 pills of 500 mg of acetaminophen to be taken every 4 hours until pain had resolved or the pills were completed, (2) 30 pills of 500 mg of naproxen to be taken every 12 hours until pain had resolved or the pills were completed, and (3) five pills of 5 mg of oxycodone to be taken every 4 hours as needed for severe pain. Control group patients were prescribed 10 pills of 5 mg of oxycodone to be taken every 4 hours or as needed for pain.

Patients were given a pain diary logging daily average and worst pain scores as well as any adverse reactions experienced. Patient's demographic information, contact details, surgical details, and group status were entered into a secure, Health Insurance Portability and Accountability Act (HIPAA) compliant research database that was organized and maintained by a nonblinded research coordinator. Postoperative study medications were prepared and distributed at the patient's personal pharmacy.

After surgery, all patients were asked to adhere strictly to their prescribed postoperative regimens. In the case of an adverse reaction or if a different medication or a refill of a current medication was desired, patients were instructed to contact their respective surgeon, and these events were also recorded.

By 14 days postoperatively, patients were contacted by the research coordinator to collect their pain diaries and to receive a Qualtrics electronic questionnaire assessing their patient satisfaction with their pain management regimen. The patient's pain diary recorded the daily number of respective medication pills taken and worst pain experienced as measured using an evidence based 10-point numeric rating scale. The questionnaire assessed pain satisfaction using the following nine items: (1) How satisfied are you with pain control after surgery? (2) What is your opinion of the amount of pain medication (s) you were provided for your surgery? (3) What is your opinion of the strength of the pain medication you were provided for your surgery? (4) Did you need any refills of the prescribed medication(s) after surgery? (5) Did you take any other pain medication(s) other than the prescribed ones after surgery? (7) Did you use any methods outside of the prescribed medications to relieve your pain after surgery? (8) Would you use the same pain regimen again if required? (9) Would you recommend the same pain regiment to your family/friends if they had a similar surgery?

Descriptive statistics were performed on all demographic data. An independent two-tailed t-test was used to determine differences in continuous variables (number of opioid pills consumed daily and daily average and worst pain scores) between medication groups. Categorical variables (differences in satisfaction between medication groups) were assessed using Chi-Square or Fisher's Exact tests. Statistical significance was set at $P < .05$. Power analysis based on previously published studies regarding postoperative pain control in hand surgery determined that a minimum of 50 patients would be required in each study group to detect a 1-point difference in average visual analog scale pain scores and an one pill/day difference in consumption with an alpha of 0.05 and power of 0.8.

Table 1
Distribution of Surgeries Performed

Surgery Type	Number of Respondents
Wrist fracture ORIF	38
Carpal or cubital tunnel release	15
Medial or lateral epicondylitis repair	12
Thumb basal joint arthroplasty	8
Hand fracture repair	7
Dupuytren's contracture release	4
Wrist arthroscopy	4
Thumb collateral ligament repair	4
Trigger finger release	3
Wrist mass excision	3
Elbow fracture repair	3
Thumb arthrodesis	2
Tendon repair, hand	1
Dequervain's tenosynovitis release	1
Forearm skin grafting	1
Wrist arthroplasty	1
Hand mass excision	1
Nerve repair, wrist	1
Humerus fracture ORIF	1
Distal biceps tendon repair	1

ORIF, open reduction and internal fixation.

Results

Total patients enrolled were 112, with 58 (52%) patients being randomized into the study group, and 54 (48%) patients being randomized into the control group. No patients that were approached for enrollment declined participation in the study. The study cohort consisted of 55 females (49%) and 57 males (51%). The average age of participants was 58 (range 19–75). There was no statistical difference between groups relative to gender and age. The surgeries undergone by the patients are listed in Table 1 separated by study and control groups. The most common procedure undergone by participants in this study was distal radius fracture open reduction and internal fixation (n = 43, 39.8%), followed by carpal tunnel release (n = 19, 17.6%) and medial or lateral epicondylitis debridement (n = 11, 10.2%).

Postoperative opioid consumption differed significantly between study and control groups. The average number of oxycodone pills consumed per day from the date of surgery through postoperative day 13 was 0.79 for the control group, which was significantly more than the 0.24 pills consumed by the study group ($P = .0035$, Fig. 3). The control group consumed an average of 6.96 pills in total, significantly more than the average of 2.41 pills consumed by the study group ($P = .007$). Throughout the study period, the control group reported an average daily pain score of 3.42 (0–10 scale) over the postoperative period; the study group

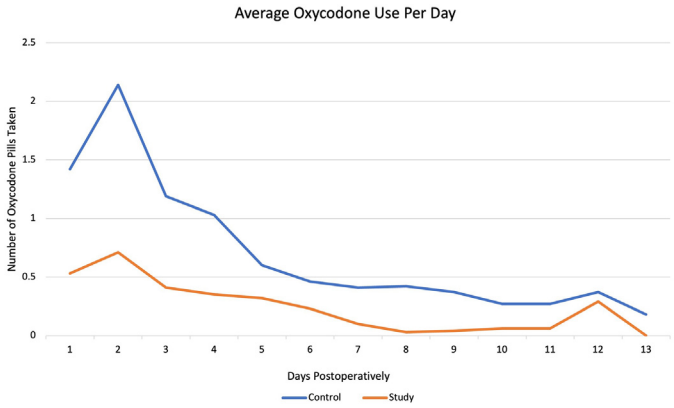

Figure 1. Average oxycodone use per day. The number of oxycodone pills taken on each postoperative day was recorded for both the control group and the study group. Error bars represent SD.

reported an average daily pain score of 3.72 (0–10 scale). The difference was not statistically significant ($P = .43$). Average worst daily pain scores for the control and study groups were 4.45 and 4.40, respectively, which is not statistically different ($P = .75$). Detailed results are shown in Figures 1, 2, and 3. The study group consumed on average a total of 17 acetaminophen pills (range 0–30) and 15 naproxen pills (range 0–30).

No patients were lost to follow-up, and 96% (n = 108) completed the satisfaction survey. The postoperative patient satisfaction results are listed in Table 2**.** A majority in both the study and control pain groups reported being very or somewhat satisfied with their postoperative pain regimen. However, study group participants were statistically significantly more satisfied with their pain control than control group participants (study = 66%, control = 42%, $P = .044$). A majority of both groups felt the number of medications provided postoperatively was the proper amount and had little difference in distribution of opinion between groups (control = 46%, study = 54%, $P = .921$). A majority of patients of both groups found that the strength of medication was the proper amount and had a similar distribution of opinion (control = 76%, study = 86%, $P = .373$). However, those in the study group reported significantly fewer refills than those in the control group (21.4% vs 10.7%, $P = .019$). Overall, 23 individuals experienced side effects. Experiences were reported at the first postoperative visit via the questionnaire, including 11 study group participants and 12 control group participants (Table 3), with the difference not being statistically different ($P = .814$) and all being classified as minor. Control group participants reported requiring other pain alleviating therapies or medications in addition to their prescribed medication more often than study group participants (control = 0.59, study = 22, $P < .001$). Lastly, a majority of both groups equally reported they would recommend their respective postoperative pain regimen to friends and family (control = 0.82, study = 0.96, $P = .257$).

Discussion

Given that a large proportion of opioid abusers begin their cycle of dependence after an initial prescription by a medical provider after surgery, there is a need for opioid stewardship and thoughtful postoperative pain management not exclusively reliant on opioids.[6] This study's findings present a potential multimodal pain management model for hand surgery to deliver effective pain management while decreasing opioid use.

In terms of postoperative pain management satisfaction, the study's findings suggest that a multimodal pain regimen leads to reduced opioid intake while providing equal pain scores. Most importantly, study group participants were more likely to report pain control satisfaction than control group participants. Nota et al[7] echoes this sentiment when tracking opioid use and patient satisfaction during the postoperative period; their multivariable model suggested that with each morphine equivalent increase in a regimen, the satisfaction odds with pain relief decreased by 20% (odds ratio 1.2; 95 confidence interval [CI] 1.0–1.4). In contrast, in an analogous study looking at a patient's postarthroscopic meniscectomy, Pham et al[8] found no significant difference in satisfaction between the two groups. This could be due to a difference in procedure or a smaller sample size; their study only had 30 in each study arm. Furthermore, although opioids typically are regarded as a much higher strength of pain medication, both groups were equally satisfied with the amount and strength of their respective medications. This, in conjunction with statistically higher levels of overall satisfaction among study patients, makes this multimodal pain regimen a potential replacement of traditional regimens from a patient perspective.

In terms of overall medication consumption, our findings suggest that a multimodal pain regimen reduced opioid consumption among patients without compromising postoperative pain control. Study group participants consumed significantly fewer opioid medications. Thompson et al's[9] findings support this conclusion through a similar prospective randomized control trial looking at patients after arthroscopic shoulder Bankart repair surgeries; they found the opioid-only group consistently showed a higher usage of oxycodone throughout the postoperative period ($P < .05$). Similar findings were reported among patients undergoing arthroscopic partial meniscectomy, with opioid group patients having significantly higher average opioid consumption (1.1 vs 0.5, $P < .03$)[7]. In contrast, Harrison et al[10], in a prospective randomized control trial within ambulatory hand surgery, found no difference between the total numbers of oxycodone tablets consumed between groups. However, this finding may be related to the less painful nature of the study's surgeries.

In terms of the overall patient experience, despite fewer opioid medications consumed by study group participants, there was no significant difference in average daily and worst pain scores. Likewise, analogous studies done among patients after arthroscopic meniscectomy and arthroscopic Bankart repair found that multimodal pain regimens yielded similar pain scores to that of opioid-only regimen.[8,9] Hence, our study contributes to the growing evidence that multimodal postoperative regimens can reduce the number of opioid prescriptions patients take while providing comparable pain control as traditional regimen. This finding has benefits beyond reducing a patient's risk of addiction; studies have shown that opioid consumption reduction improves postoperative outcomes and reduces a patient's risk of opioid-associated respiratory depression, ileus, urinary retention, and dehydration.[11] The presence of increased satisfaction, decreased side effects, and fewer opioids used among our study group suggests the immense benefits a multimodal regimen has for orthopedic patients undergoing hand and wrist procedures.

However, multimodal regimens need not be limited to the addition of acetaminophen and naproxen. Other studies have denoted the success of other nonopioid oral medications in relieving pain. Bali et al[12] suggests that in comparison to naproxen sodium, a combination of naproxen sodium-codeine phosphate was more effective in relieving pain after arthroscopic meniscus surgery. Gimbel et al[11] found over a subset of orthopedic surgeries that celecoxib may prove to be a better postoperative pain regimen than hydrocodone/acetaminophen. Similar prospective cohort studies have suggested transdermal buprenorphine or

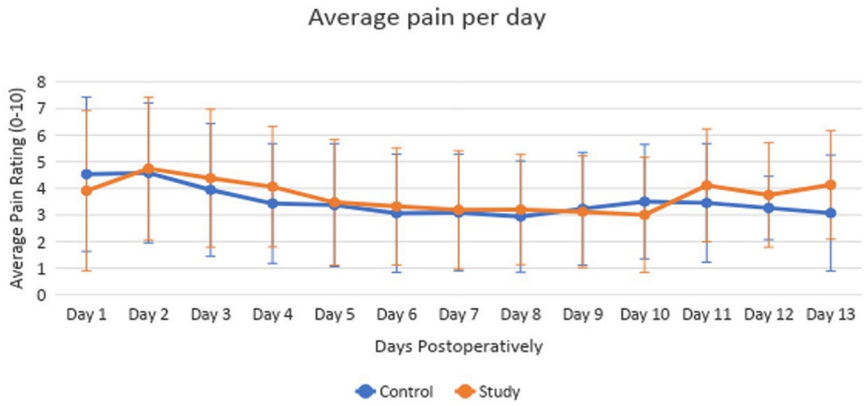

Figure 2. Average pain per day. The average pain rating (on a scale of 1–10) on each postoperative day was recorded for both the control and the study group. Error bars represent SD.

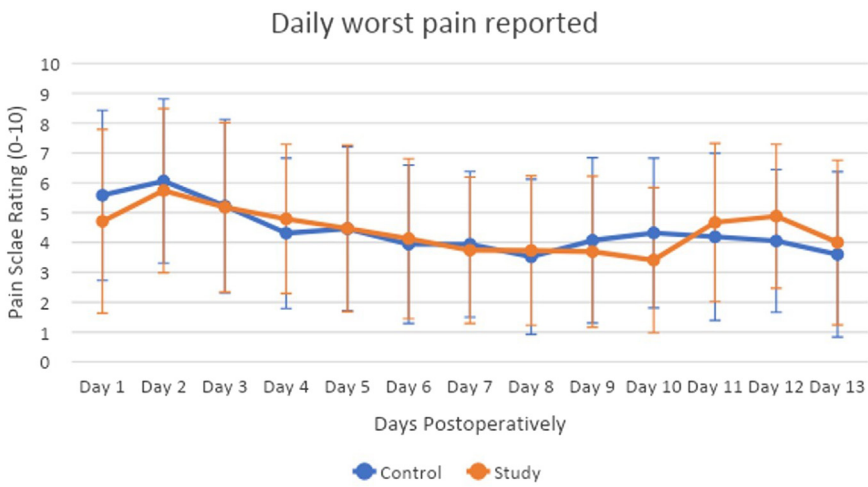

Figure 3. Daily worst pain reported. The daily worst pain rating (on a scale of 1–10) on each postoperative day was recorded for both the control group and the study group.

Table 2
Patient Satisfaction Data

Question	Answer Choice	Group		*P* Value
		Control	Study	
Satisfaction with overall postoperative regimen	Very or somewhat satisfied	34	47	.044
	Very or somewhat dissatisfied	18	9	
Satisfaction with amount of medication prescribed	Too much	11	10	.921
	Proper amount	36	43	
	Not enough	5	3	
Satisfaction with strength of medication prescribed	Too much	5	5	.373
	Proper amount	39	48	
	Not enough	7	3	
Required a refill	Yes	12	6	.019
	No	39	50	
Presence of a side effect	Yes	12	11	.814
	No	39	44	
Use of additional alternate therapies/medications	Yes	30	12	<.001
	No	21	43	
Would recommend this regimen to family/friends	Yes	42	49	.257
	No	9	5	

cannabinoids as possible additions to nonopioid pain regimens for effective pain management after various orthopedic surgeries.[13] This, in conjunction with increasing evidence that non-narcotic medications improve postoperative outcomes, makes a strong argument for multimodal pain regimens.[14]

However, potential adverse effects of using a multimodal regimen must be acknowledged. Though, in comparison to most opioids, acetaminophen and naproxen have a much safer profile, long-term use is associated with affecting liver, kidney, and gastrointestinal function.[11] Systematic reviews of nonsteroidal anti-

Table 3
Adverse Reactions

Symptoms	Control	Study	Total (n = 23)
Nausea/vomiting	4	0	4
Reflux/heartburn	0	1	1
Constipation	5	8	13
Lightheadedness/dizziness	3	2	5
Itchiness	1	1	1
Other	Anxiety	Swelling Stomach pain Headache Anxiety	4

inflammatory drug (NSAID) use on bone healing suggests that long-term use may increase the likelihood of delayed union or nonunion, which is concerning in the setting of hand or wrist surgery.[15] However, these findings are dose dependent, and the low-dose and short exposure of multi modal regimens like in this study were found to not affect union rates. Additionally, pre-existing medical conditions represent a potentially confounding variable that may impact patients' individual response to medications or their adverse effects. The slightly increased rate of constipation reported by the study group is surprising given their reduced opioid consumption but may be attributable to patients' existing medical conditions. In the setting of increased prescription of multimodal regimens, patients should be screened for contraindications and increased risk for these reactions.

Study strengths include a randomized control design, multiple measures of patient satisfaction, pain medication intake, and pain scores, and close follow-up. We included a large variety of hand and wrist surgeries, making findings more generalizable, but also were sure to address other confounders, such as local anesthesia use, to make findings more accurate. To improve accuracy, patient characteristics between study and control groups were similar to one another.

Limitations

This study contained several limitations. Being a single-center study limited the study's generalizability, as the population from which our patients could be selected from was limited to the center. Patients were not fully blinded to the medication groups due to the need to screen for allergies to any potentially prescribed medications. Anesthesiologists' preoperative use of a regional nerve block and intraoperative choice of anesthetic agents were not controlled and may have impacted each patient's postoperative pain experience. However, the effect of all perioperative modalities would unlikely impact a patient's postoperative pain experience and subsequent pain medication use beyond a day or so. Also, though patients were requested to record daily medication intake, they may have underreported their opioid intake. Though our pain diary submission rate was analogous to other studies, a small subset (4%) of consented patients forgot to record their medication or bring in their pain diaries, which may expose the study to selection bias. Lastly, we were unable to compare patients who elected to enroll in this study with ones who did not, placing a possible volunteer effect.

Conclusion

In conclusion, this prospective, randomized trial found that a multimodal pain regimen after hand and wrist surgery performed under general or regional anesthesia reduces opioid usage postoperatively and leads to higher patient satisfaction without sacrificing pain control in comparison to traditional opioid-only regimens. While this finding has been previously demonstrated in the context of local anesthesia soft tissue procedures, this study extends the benefits of multimodal regimens to fracture repair and more extensive soft tissue procedures throughout the hand, wrist, and forearm. These findings suggest a potential alternative to opioid-only regimens for postoperative pain management in orthopedic surgery patients.

References

1. Rodgers J, Cunningham K, Fitzgerald K, et al. Opioid consumption following outpatient upper extremity surgery. *J Hand Surg Am*. 2012;37(4):645–650.
2. Kim JY, Chung SW, Kim JH, et al. A randomized trial among compression plus nonsteroidal antiinflammatory drugs, aspiration, and aspiration with steroid injection for nonseptic olecranon bursitis. *Clin Orthop Relat Res*. 2016;474(3):776–783.
3. Trasolini NA, McKnight BM, Dorr LD. The opioid crisis and the orthopedic surgeon. *J Arthroplasty*. 2018;33(11):3379–3382.e1.
4. Labrum JT, Ilyas AM. The opioid epidemic: postoperative pain management strategies in orthopaedics. *JBJS Rev*. 2017;5(8):e14.
5. Ilyas AM, Miller AJ, Graham JG, et al. Pain management after carpal tunnel release surgery: a prospective randomized double-blinded trial comparing acetaminophen, ibuprofen, and oxycodone. *J Hand Surg Am*. 2018;43(10):913–919.
6. Schoenfeld AJ, Jiang W, Chaudhary MA, et al. Sustained prescription opioid use among previously opioid-naive patients insured through TRICARE (2006-2014). *JAMA Surg*. 2017;152(12):1175.
7. Nota SPFT, Spit SA, Voskuyl T, et al. Opioid use, satisfaction, and pain intensity after orthopedic surgery. *Psychosomatics*. 2015;56(5):479–485.
8. Pham H, Pickell M, Yagnatovsky M, et al. The utility of oral nonsteroidal anti-inflammatory drugs compared with standard opioids following arthroscopic meniscectomy: a prospective observational study. *Arthroscopy*. 2019;35(3):864–870.e1.
9. Thompson KA, Klein D, Alaia MJ, et al. Opioid use is reduced in patients treated with NSAIDs after arthroscopic Bankart repair: a randomized controlled study. *Arthrosc Sports Med Rehabil*. 2021;3(1):e15–e22.
10. Harrison RK, DiMeo T, Klinefelter RD, et al. Multi-modal pain control in ambulatory hand surgery. *Am J Orthop (Belle Mead NJ)*. 2018;47(6).
11. Gimbel JS, Brugger A, Zhao W, et al. Efficacy and tolerability of celecoxib versus hydrocodone/acetaminophen in the treatment of pain after ambulatory orthopedic surgery in adults. *Clin Ther*. 2001;23(2):228–241.
12. Bali C, Ergenoglu P, Ozmete O, et al. Comparison of the postoperative analgesic effects of naproxen sodium and naproxen sodium-codeine phosphate for arthroscopic meniscus surgery. *Brazilian Journal of Anesthesiology (English Edition)*. 2016;66(2):151–156.
13. Luo P, Lou J, Yang S. Pain management during rehabilitation after distal radius fracture stabilized with volar locking plate: a prospective cohort study. *BioMed Res Int*. 2018;2018:1–6.
14. Wu Y, Lu X, Ma Y, et al. Perioperative multiple low-dose DEXAMETHASONES improves postoperative clinical outcomes after total Knee Arthroplasty. *BMC Musculoskeletal Disorders*. 2018;19(1):428.
15. Wheatley BM, Nappo KE, Christensen DL, et al. Effect of NSAIDs on bone healing rates. *J Am Acad Orthop Surg*. 2019;27(7):e330–e336.