RESEARCH ARTICLE

# The Effect of Adding Corticosteroid to the Periarticular Injection Cocktail for Pain Control after Total Hip and Total Knee Arthroplasty: A Double-Blinded Randomized Clinical Trial

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## Abstract

**Background:** The impact of periarticular corticosteroid injection for pain control after total joint arthroplasty (TJA) is controversial. The present study aimed to investigate this controversy in patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA).

**Methods:** A total of 42 THA and 42 TKA patients were included in this study. The patients of each group were randomly allocated into group A (cocktail+Depo-Medrol) and group B (cocktail alone). The outcome measures were a Visual Analog Scale (VAS) for pain at five different time points for both THA and TKA, as well as the knee range of motion (ROM) and straight leg raise (SLR) for the TKA group only. Patients were followed for three months to observe infection, wound complications, and any venous thromboembolic event.

**Results:** In the THA group, the preoperative VAS, 12, 24, 48, and 72h postoperative VAS were not statistically different between groups A and B (*P=0.49*, *P=0.5*, *P=0.96*, *P=0.15*, and *P=0.11*, respectively). In the TKA group, the preoperative VAS, 12, 24 48h, and 72h postoperative VAS were not statistically different between groups A and B (*P=1.0*, *P=0.47*, *P=0.82*, *P=0.92*, *P=0.5*, respectively). The mean scores of knee range of motion and ability to perform SLR were not significantly different between TKA patients in the steroid and non-steroid groups (*P=0.18* and *P=0.58*, respectively). The only observed complication was one surgical site infection in the non-steroid group of the TKA.

**Conclusion:** The obtained results did not support the benefit of including a steroid (Depo-Medrol) in the periarticular injection cocktail for pain control after the THA and TKA.

**Level of evidence:** II

**Keywords:** Periarticular corticosteroid injection, Postoperative pain control, Total hip arthroplasty, Total knee arthroplasty

## Introduction

Osteoarthritis is an age-related disease and one of the most common underlying causes of physical disability among the elderly. As the population ages, the number of people living with symptomatic osteoarthritis increases.[1,2] Total joint arthroplasty (TJA) is considered a successful surgical procedure in patients for whom conservative therapy of osteoarthritis has failed. The number of TJA increases in parallel with the growing prevalence of symptomatic osteoarthritis.[3] This increased rate highlights the need for developing multidisciplinary approaches to enhance TJA outcomes while minimizing unnecessary expenditures and hospital readmission rates.[4]

Severe postoperative pain is a major complication in

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patients undergoing TJA. This pain directly impacts the postoperative rehabilitation process, resulting in stiffness and poor functional outcome. Consequently, "immediate postoperative pain" is a great concern for both TJA candidates and care providers.[5,6] Several modalities are recommended for the management of postoperative pain after TJA, including patient education, preemptive analgesics, epidural analgesia, femoral nerve block, periarticular injection, patient-controlled analgesia, and oral analgesics. Although the efficacy of many of these methods remains controversial,[5,7] multimodal pain management is widely accepted as the current gold standard with different protocols.[8–10]

Periarticular injection with corticosteroid has been introduced as an effective pain-reduction modality after TJA.[11–14] Although the analgesic effects of corticosteroids are well documented, there is no consensus regarding the safety and efficacy of periarticular injection of corticosteroids for managing early postoperative pain after TJA.[15,16] In light of the aforementioned issues, the present study aimed to evaluate the effect of periarticular corticosteroid injection on postoperative pain control in patients undergoing TJA. Moreover, it aimed to separately evaluate the effect of periarticular corticosteroid injection in total hip arthroplasty (THA) and total knee arthroplasty (TKA). To the best of our knowledge, no earlier study has evaluated the efficacy of periarticular corticosteroid injection in managing postoperative pain in THA patients.

## Materials and Methods

This study was approved by the Ethics Committee of the Iran University of Medical Sciences under the code of IR.IUMS.FMD.REC.1397.124. The study protocol was registered in the Iranian Registry of Clinical Trials under the code IRCT20161121031003N2. Patients provided written informed consent prior to their participation in the study. In a parallel-designed study, patients with osteoarthritic hip and knee who were candidates for the primary THA and TKA at Shafa Orthopedic Hospital, Iran University of Medical Sciences, were included. Patients with diabetes mellitus, immunodeficiency, renal failure, hypothyroidism, rheumatoid arthritis, allergic to the component of periarticular injection, and drug addiction were excluded from the study.

The patients were randomized into two study groups using a simple numerical randomization table (even and odd): group A (periarticular injection of cocktail plus Depo-Medrol) and group B (periarticular injection of a cocktail without Depo-Medrol). The cocktail consisted of bupivacaine (20 mg), epinephrine (1/125000), ketorolac (60 mg), and morphine (10 mg) diluted in 50 CC normal saline. Depo-Medrol (40 mg, Pfizer) was added to the cocktail of group A as the corticosteroid of choice. In THA patients, the periarticular injection sites included the joint capsule, synovium, iliopsoas tendon, abductors, external rotators, and fascia lata. All THAs were performed by one senior surgeon using a standard lateral approach. In TKA patients, the periarticular injection sites were the joint capsule, patellar tendon, suprapatellar tendon, and medial collateral ligament. All the surgeries were performed by either of the three senior surgeons under general anesthesia.

Pre-and postoperative multimodal pain management was used for all patients, including preoperative acetaminophen (1000 mg) and gabapentin (100 mg) administered the night before the surgery and postoperative celecoxib (200 mg BID), gabapentin (100 mg TID), and acetaminophen (2-3 grams based on the patient's weight). No other analgesic medication, especially the narcotic compound, was used.

The sample size was calculated based on the study of Kelley et al. who assessed the effect of periarticular corticosteroid injection on postoperative pain in patients undergoing TKA using the visual analog scale (VAS).[17] With an effect size of 0.6 obtained from the difference in mean VAS between the two study groups, at a power of 80% and a significance level of 5%, a sample size of 42 patients in each group was regarded to be sufficient to detect a clinically important difference between the outcome measures of the study groups, using an independent t-test of the difference between means. It was assumed that the outcome measures are normally distributed.

The outcome measure included a five-step evaluation of VAS (preoperative, 12 hours, 24 hours, 48 hours, and 72 hours after the operation). In the TKA group, the range of motion (ROM) of the knee and ability to perform straight leg raise (SLR) test were also assessed 12 hs and five days after the surgery, respectively, to compare the function of the knee in steroid and non-steroid group. Surgical complications, including infection, venous thromboembolic event, and tendon rapture, were recorded. Outcome evaluations were performed by one physiotherapist and senior residents who were blinded to the treatment allocation. The patients were blinded to the type of the pain management protocol as well.

### *Statistical analysis*

The data were analyzed in SPSS software (version 16). Descriptive measures were presented as mean±standard deviation (SD) of number and percentage. The normal distribution of variables was assessed using the Kolmogorov-Smirnov normality test. Between-group comparison of the outcome measures was made using the independent t-test test for parametric variables and the Mann-Whitney U test for non-parametric variables. A *P-value* of less than 0.05 was considered statistically significant.

## Results

The study population included 84 patients consisting of 42 patients who underwent TKA and 42 cases who underwent THA surgery. The patients' assignment is demonstrated in the flowchart of the study [Figure 1]. A number of 42 patients underwent THA, 18 of whom received cocktail+Depo-Medrol treatment (group A), and 24 cases received cocktail alone (group B). The demographic characteristics of the patients were not significantly different between the two study groups [Table 1]. The mean preoperative VAS was 9.9±0.5 in group A and 9.7±1.0 in group B. This difference was not

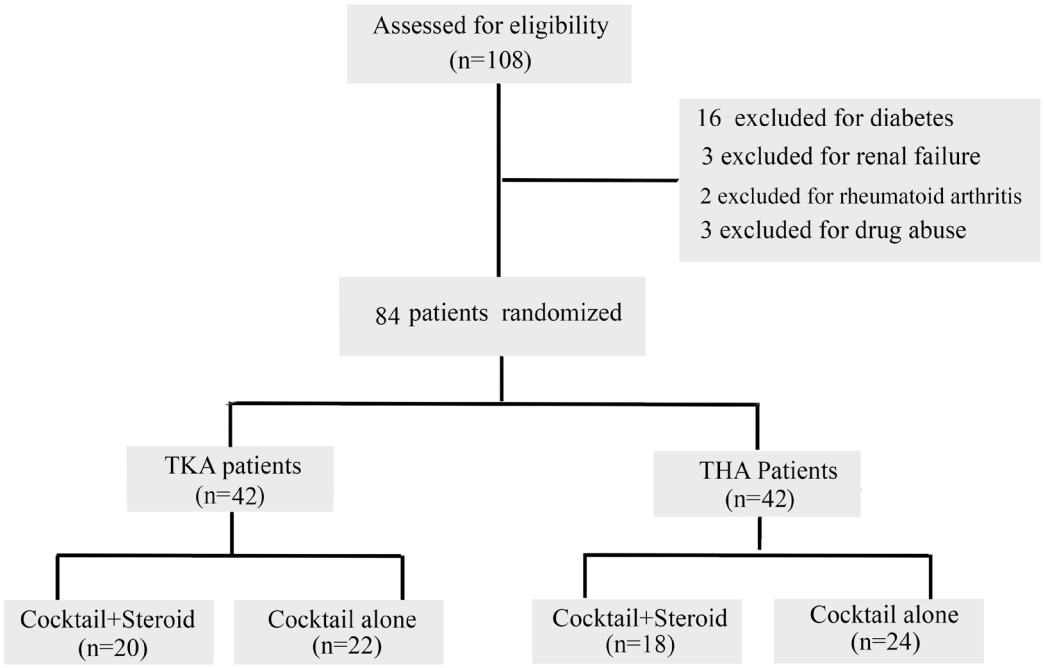


**Figure 1. Flowchart of the study population.**

statistically significant (*P*= 0.49).

Moreover, 12 h after the surgery, the mean VAS was 5.3±3.7 in group A and 5.9±2.9 in group B (*P = 0.5*); 24 h after the surgery, the mean VAS was 4.2±2.7 in group A and 4.2±2.4 in group B (*P*= 0.96); 48 h after the surgery, the mean VAS was 3.0±1.9 in group A and 3.8±1.8 in group B (*P= 0.15*); and 72 h after the surgery, the mean VAS was 2.4±1.5 in group A and 3.1±1.5 in group B (*P=0.11*). Accordingly, the mean VAS scores were not significantly different between the two study groups at any time. The trend of VAS changes over time in the two groups of patients who underwent THA surgery is demonstrated in Figure 2.

A total of 42 patients underwent TKA, 20 of whom received cocktail+Depo-Medrol treatment (group A), and 22 cases received cocktail alone (group B). The demographic characteristics of patients were not significantly different between the two study groups [Table 2]. The mean preoperative VAS was 10 in both study groups. Based on the results, 12 h after the surgery, the mean VAS was 4.9±2.0 in group A and 4.4±2.3 in group B (*P=0.47*); 24 h after the surgery, the mean VAS was 6.4±1.3 in group A and 6.3±2.2 in group B (*P=0.82*); 48 h after the surgery, the mean VAS was 4.85±1.8 in group A and 4.9±2.1 in group B (*P= 0.92*); and 72 h after the surgery, the mean VAS was 3.8±1.4 in group A and 3.55±1.3 in group B (*P=0.5*). Accordingly, the mean VAS scores were not significantly different between the two study groups at any time. The trend of VAS changes over time in the two groups of patients who underwent TKA surgery is demonstrated in Figure 2**.** The mean knee range of motion was 73±21.7 in group A and 63.6±23.2

**Table 1. Comparison of the demographic characteristics and preoperative VAS between the two groups of the THA patients**

| Variable | Group A (Cocktail+Steroid) (n=18) | Group B (Cocktail alone) (n=24) | *P-value* |
|---|---|---|---|
| Age (years) | 69.7±10.1 | 71.3±9.8 | 0.59 |
| Gender<br>Male<br>Female | <br>8 (44.4)<br>10 (55.6) | <br>11 (45.8)<br>13 (54.2) | 0.72 |
| BMI (kg/m$^2$) | 28.1±5.5 | 27.9±6 | 0.48 |
| Preoperative VAS | 9.9±0.5 | 9.7±1 | 0.49 |

VAS: Visual Analog Scale. Data are presented as mean ± SD or number (%). P<0.05 is considered significant.

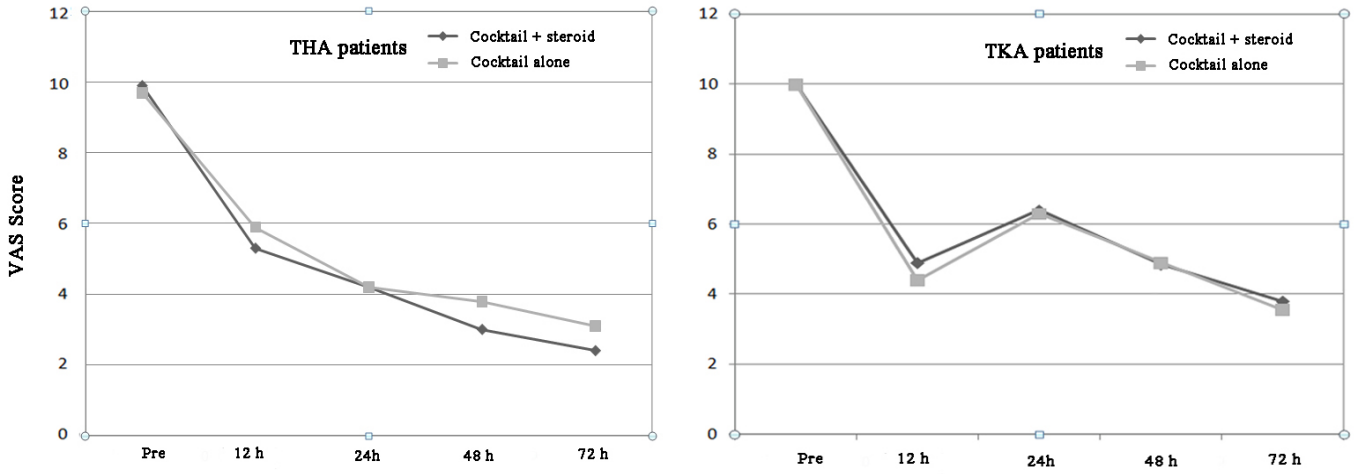


**Figure 2. Comparison of VAS scores of different time-points between the group who received cocktail+Depo-Medrol and the group who received cocktail alone.**

**Table 2. Comparison of the demographic characteristics and preoperative VAS between the two groups of TKA patients**

| Variable | Group A (Cocktail+Steroid) (n=20) | Group B (Cocktail alone) (n=22) | *P Value* |
|---|---|---|---|
| Age (years) | 69.3±9.5 | 69.8±9.9 | 0.61 |
| Gender<br>Male<br>Female | <br>12 (60)<br>8 (40) | <br>12 (54.5)<br>10 (45.5) | 0.57 |
| BMI (kg/m$^2$) | 28.3±5.1 | 28±6.3 | 0.66 |
| Preoperative VAS | 10 | 10 | - |

VAS: Visual Analog Scale. Data are presented as mean±SD or number (%). P<0.05 is considered significant.

in group B (*P=0.18*). Moreover, 14 (70%) patients of group A and 15 (68.2%) patients of group B were able to perform SLR (*P= 0.58*). In total, a surgical site infection (suture abscess) occurred in one patient in group B and was treated with an antibiotic. No other complications were observed in any patients in this study.

## Discussion

Corticosteroids are known as pain relief adjuvants[18]; nonetheless, the role of periarticular corticosteroid injection to control pain after the TJA remains controversial since corticosteroid injection to an already vulnerable patient might increase the risk of infection and other side-effects attributed to the corticosteroids.[19] Therefore, complementary studies are needed to assess the risk and benefits of periarticular corticosteroid injection in detail before it can be recommended as a routine adjutant for managing pain after TJA.

The current study evaluated the effect of including Depo-Medrol (methylprednisolone) in a periarticular injection cocktail to control pain after the TJA. Based on the obtained results, the pain level was not statistically different in patients who received cocktail+Depo-Medrol compared to those who received the cocktail alone. The same results were observed when the patients were categorized based on the type of surgery into the THA and TKA groups. Moreover, in the TKA group, there was no significant difference in the knee range of motion and SLR of the patients who received a periarticular steroid injection in comparison with those who did not.

Several earlier studies have also evaluated the role of periarticular steroid injection in the management of pain following the TKA. Some of them have reported periarticular steroid injection as an efficacious approach in the reduction of pain following the TKA, whereas others have not reported a significant role for periradicular steroid injection in pain management in these surgeries.

Christensen et al., in a double-blind, randomized trial, aimed to compare the clinical efficacy of periarticular injections of a cocktail consisting of bupivacaine, morphine, epinephrine, clonidine, and cefuroxime and methylprednisolone acetate (39 TKA patients) with the efficacy of periarticular injections of the same cocktail without corticosteroid (37 TKA patients). No significant differences were detected between the two groups regarding pain, narcotic consumption, outcome scores, or motion. Three complications were recorded in the steroid group, including one knee joint infection leading

to numerous complications and, ultimately, death. Yet, the hospital stay was significantly shorter in patients in the steroid group.[20]

Chia et al. performed a double-blinded, randomized controlled trial to evaluate the efficacy of two different doses of triamcinolone acetate (42 patients in each group) added to the local anesthetic in TKA patients. They found no significant differences in pain scores or range of movements between the control and corticosteroid groups. Secondary outcomes were also not significantly different. They concluded that periarticular corticosteroid injections do not appear efficacious in the management of postoperative pain in TKA.[21]

Ikeuchi et al. studied the efficacy of adding steroids to local anesthetics during TKA. A total of 40 patients were randomized into the steroid or control group. The steroid group received a periarticular injection of ropivacaine, dexamethasone, and isepamicin, while the control group received the same analgesic mixture without dexamethasone. The pain severity was significantly lower in the steroid group on days 1 and 3 after the surgery. The patients who were able to perform SLR within postoperative day 2 were also significantly more in the steroid group. Consequently, they concluded that the addition of a steroid to local anesthetics results in significant early pain relief and rapid recovery in TKA[22].

Kwon et al. performed a prospective, double-blind, randomized trial to assess the efficacy and safety of periarticular corticosteroid injection in patients undergoing TKA. A total of 76 female patients undergoing bilateral staged TKA were randomly allocated to receive steroid or non-steroid periarticular injection. The steroid group received a periarticular injection of a mixture containing triamcinolone acetonide (40 mg), while the non-steroid group received the same mixture without a corticosteroid. The pain level was significantly lower in the steroid group on the night of the surgery. Moreover, the steroid group could perform SLR earlier than the control group. The complication rates were similar between the two groups.[23]

Tsukada et al. assessed the efficacy of corticosteroids in a periarticular cocktail injection to control pain after TKA (40 patients in the corticosteroid group and 37 patients in the control group). During the first 24 h after the surgery, the corticosteroid group had a significantly lower cumulative pain score than the non-corticosteroid group. The rate of complications was not significantly different between the two groups up to one year after the operation.[24]

Other investigations have also assessed the role of periarticular steroid injection in controlling postoperative pain in TKA.[13,25] Yet, to the best of our knowledge, the role of periarticular steroid injection in the control of postoperative pain has not been studied earlier in THA, and this research is by far the first study in this regard. The results of the present study demonstrated no significant difference between the steroid and non-steroid THA groups in postoperative pain. It could be concluded that the role of periarticular steroid injection in controlling postoperative pain is the same in THA and TKA patients.

Based on the present evidence, no clear consensus can be achieved regarding the role of steroid addition to the periarticular cocktail injection. This discrepancy in results can be ascribed to differences in the periarticular injection mixture used in various studies. The type of steroid used in different investigations is also a source of heterogeneity. Furthermore, although spinal anesthesia is preferred in TKA due to the low rate of complications, it might mask the pain level in the early postoperative period; therefore, the type of anesthesia also might impair pain evaluation.[26]

The heterogeneity of surgical techniques may also be responsible for the conflicting results of previous studies.[27,28] Therefore, further standardized studies are needed to fully unwrap the efficacy of periarticular corticosteroid injection in the management of pain after TJA. The main limitation of this study was the inability to statistically compare the ratio of complications, including surgical site infection and wound complication, between the study groups owing to their low frequency. Moreover, the sample size of this study was underpowered to perform a multivariate analysis of the data.

Pain severity was not statistically different in TJA patients who received Depo-Medrol in their periarticular cocktail injection compared to those who did not. A separate evaluation of TKA and THA patients also revealed that the inclusion of Depo-Medrol in the periarticular cocktail injection did not improve pain control in any group. The ability to perform SLR and knee range of movement was not different between TKA patients who received a periarticular Depo-Medrol injection and those who did not. Accordingly, the results of this study demonstrated no benefit of including steroids, such as Depo-Medrol, in the periarticular injection cocktail for pain control after the TJA.

***Patient consent:*** Informed consent was obtained from the patients to use their medical data for publication.

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## References

1. Anderson AS, Loeser RF. Why is osteoarthritis an age-related disease? Best Pract Res Clin Rheumatol. 2010;24(1):15-26. doi: 10.1016/j.berh.2009.08.006.
2. Bagherifard A, Jabalameli M, Mirzaei A, Khodabandeh A, Abedi M, Yahyazadeh H. Retaining the medial collateral ligament in high tibial medial open-wedge osteotomy mostly results in postoperative intra-articular gap reduction. Knee Surg Sports Traumatol Arthrosc. 2020;28(5):1388-1393. doi: 10.1007/s00167-019-05473-8.
3. Kremers HM, Larson DR, Crowson CS, et al. Prevalence of total hip and knee replacement in the United States. J Bone Joint Surg Am. 2015;97(17):1386. doi: 10.2106/JBJS.N.01141.
4. Feng JE, Novikov D, Anoushiravani AA, Schwarzkopf R. Total knee arthroplasty: improving outcomes with a multidisciplinary approach. J Multidiscip Healthc. 2018;11:63. doi: 10.2147/JMDH.S140550.
5. Society KK. Guidelines for the management of postoperative pain after total knee arthroplasty. Knee Surg Relat Res. 2012;24(4):201. doi: 10.5792/ksrr.2012.24.4.201.
6. Lee RM, Tey JBL, Chua NHL. Postoperative pain control for total knee arthroplasty: continuous femoral nerve block versus intravenous patient controlled analgesia. Anesth Pain Med. 2012;1(4):239. doi: 10.5812/aapm.3404.
7. Ilfeld BM, McCartney CJL. Searching for the optimal pain management technique after knee arthroplasty: analgesia is just the tip of the iceberg. Anesthesiology. 2017;126(5):768-770. doi: 10.1097/ALN.0000000000001608.
8. Jiang J, Teng Y, Fan Z, Khan MS, Cui Z, Xia Y. The efficacy of periarticular multimodal drug injection for postoperative pain management in total knee or hip arthroplasty. J Arthroplasty. 2013;28(10):1882-1887. doi: 10.1016/j.arth.2013.06.031.
9. Peters CL, Shirley B, Erickson J. The effect of a new multimodal perioperative anesthetic regimen on postoperative pain, side effects, rehabilitation, and length of hospital stay after total joint arthroplasty. J Arthroplasty. 2006;21(6):132-138. doi: 10.1016/j.arth.2006.04.017.
10. Parvataneni HK, Shah VP, Howard H, Cole N, Ranawat AS, Ranawat CS. Controlling pain after total hip and knee arthroplasty using a multimodal protocol with local periarticular injections: a prospective randomized study. J Arthroplasty. 2007;22(6):33-38. doi: 10.1016/j.arth.2007.03.034.
11. Kurosaka K, Tsukada S, Ogawa H, et al. Addition of corticosteroid to periarticular injections reduces postoperative pain following total hip arthroplasty under general anaesthesia: a double-blind randomized controlled trial. Bone Joint J. 2020;102(10):1297-1302. doi 10.1302/0301-620X.102B10.BJJ-2020-0428.R1.
12. Reddy AVG, Thayi C, Natarajan N, et al. Validating the role of steroid in analgesic cocktail preparation for local infiltration in total knee arthroplasty: a comparative study. Anesth Essays Res. 2018;12(4):903. doi: 10.4103/aer.AER_138_18.
13. Zhao X, Qin J, Tan Y, Mohanan R, Hu D, Chen L. Efficacy of steroid addition to multimodal cocktail periarticular injection in total knee arthroplasty: a meta-analysis. J Orthop Surg Res. 2015;10(1):1-12. doi: 10.1186/s13018-015-0214-8.
14. Li Q, Mu G, Liu X, Chen M. Efficacy of additional corticosteroids to multimodal cocktail periarticular injection in total knee arthroplasty: a meta-analysis of randomized controlled trials. J Orthop Surg Res. 2021;16(1):1-14. doi: 10.1186/s13018-020-02144-0.
15. Tran J, Schwarzkopf R. Local infiltration anesthesia with steroids in total knee arthroplasty: a systematic review of randomized control trials. J Orthop. 2015;12:S44-S50. doi: 10.1016/j.jor.2015.01.017.
16. Summers S, Mohile N, McNamara C, Osman B, Gebhard R, Hernandez VH. Analgesia in total knee arthroplasty: current pain control modalities and outcomes. J Bone Joint Surg Am. 2020;102(8):719-727. doi: 10.2106/JBJS.19.01035.
17. Kelley TC, Adams MJ, Mulliken BD, Dalury DF. Efficacy of multimodal perioperative analgesia protocol with periarticular medication injection in total knee arthroplasty: a randomized, double-blinded study. J Arthroplasty. 2013;28(8):1274-1277. doi: 10.1016/j.arth.2013.03.008.
18. Vyvey M. Steroids as pain relief adjuvants. Can Fam Physician. 2010;56(12):1295-1297.
19. Rostaing L, Malvezzi P. Steroid-based therapy and risk of infectious complications. PLoS Med. 2016;13(5):e1002025. doi: 10.1371/journal.pmed.1002025.
20. Christensen CP, Jacobs CA, Jennings HR. Effect of periarticular corticosteroid injections during total knee arthroplasty: a double-blind randomized trial. J Bone Joint Surg Am. 2009;91(11):2550-2555. doi: 10.2106/JBJS.H.01501.
21. Chia SK, Wernecke GC, Harris IA, Bohm MT, Chen DB, MacDessi SJ. Peri-articular steroid injection in total knee arthroplasty: a prospective, double blinded, randomized controlled trial. J Arthroplasty. 2013;28(4):620-623. doi: 10.1016/j.arth.2012.07.034.
22. Ikeuchi M, Kamimoto Y, Izumi M, et al. Effects of dexamethasone on local infiltration analgesia in total knee arthroplasty: a randomized controlled trial. Knee Surg Sports Traumatol Arthrosc. 2014;22(7):1638-1643. doi: 10.1007/s00167-013-2367-5.
23. Kwon SK, Yang IH, Bai SJ, Han CD. Periarticular injection with corticosteroid has an additional

pain management effect in total knee arthroplasty. Yonsei Med J. 2014;55(2):493-498. doi: 10.3349/ymj.2014.55.2.493.
24. Tsukada S, Wakui M, Hoshino A. The impact of including corticosteroid in a periarticular injection for pain control after total knee arthroplasty: a double-blind randomised controlled trial. Bone Joint J. 2016;98(2):194-200. doi: 10.1302/0301-620X.98B2.36596.
25. Yue D bo, Wang B liang, Liu K peng, Guo W shou. Efficacy of multimodal cocktail periarticular injection with or without steroid in total knee arthroplasty. Chin Med J (Engl). 2013;126(20):3851-3855.
26. Pugely AJ, Martin CT, Gao Y, Mendoza-Lattes S, Callaghan JJ. Differences in short-term complications between spinal and general anesthesia for primary total knee arthroplasty. J Bone Joint Surg Am. 2013;95(3):193-199. doi: 10.2106/JBJS.K.01682.
27. Matsueda M, Gustilo RB. Subvastus and medial parapatellar approaches in total knee arthroplasty. Clin Orthop Relat Res. (1976-2007). 2000;371:161-168. doi: 10.1097/00003086-200002000-00020.
28. Ejaz A, Laursen AC, Kappel A, et al. Faster recovery without the use of a tourniquet in total knee arthroplasty: A randomized study of 70 patients. Acta Orthop. 2014;85(4):422-426. doi: 10.3109/17453674.2014.931197.