# Manipulation and Injection After Total Knee Arthroplasty: Incidence and Outcomes

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*Following total knee arthroplasty (TKA), stiffness can lead to poor outcomes. Manipulation under anesthesia (MUA) is sometimes combined with corticosteroid injection (CSI). This study sought to describe the incidence of CSI with MUA after TKA, as well as the odds of prosthetic joint infection (PJI). A database was queried to identify 754,421 primary TKA patients. The incidences of MUA, injection, revision, and PJI were investigated, along with patient characteristics before and after matching. Overall, 22,015 (2.9%) underwent MUA alone, and 3,272 (14.9% of MUA procedures) underwent MUA with injection. The odds of all-cause revision (1.0, p = 1.0) and revision with PJI (1.1, p = 0.83) were not significantly higher following injection, even after matching (0.9, p = 0.29 and 0.9, p = 0.77, respectively). Overall, the incidence of MUA following TKA within 90 days of index surgery was low and one in seven underwent injection. Injection during MUA did not increase odds of PJI.* (Journal of Surgical Orthopaedic Advances 34(3):134-137, 2025)

Key words: manipulation under anesthesia, total knee arthroplasty, arthrofibrosis, prosthetic joint infection

Total knee arthroplasty (TKA) is a common procedure for the surgical treatment of end-stage knee osteoarthritis. Although the procedure is generally safe and effective, some patients will develop significant stiffness which can be challenging to treat. Stiffness secondary to infection or component malalignment might require surgical intervention; however, acquired idiopathic stiffness (AIS) or arthrofibrosis can be managed without an open procedure.[1] Manipulation under anesthesia (MUA) is a method for improving range of motion in select patient groups, but the procedure does not always lead to satisfactory outcomes.[1] Some surgeons, in addition to MUA, have utilized simultaneous corticosteroid injection to try and maximize the effectiveness of the procedure with a goal of targeting inflammation and post-manipulation pain allowing for ongoing physical therapy.[2]

Proponents of the idea suggest that CSI improves the success of manipulation without a significant risk for infection, one of the most devastating complications of TKA. However, given common practice to avoid primary total joint arthroplasty within three months of CSI in a native arthritic knee,[3] the practice is controversial. Further, the use of CSI in prior TKA knees has been associated with increased risk of infection.[4,5] It is unclear how frequently surgeons are using an injection with MUA and if certain patient characteristics are associated with its use. Further, it is unclear whether injection in addition to MUA impacts outcomes. We sought to use a large administrator claims database to determine the incidence of MUA following TKA with and without injection, as well as associated patient characteristics. Finally, this study sought to identify and compare rates of revision with and without diagnosis of PJI following these interventions.

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1548-825X/19/3403-0134$22.00/0
DOI: 10.3113/JSOA.2025.0134

## Materials and Methods

PearlDiver (PearlDiver Technologies), an administrative claims database, was used to identify 754,421 primary TKA patients aged 18 – 80 years old with at least one year of follow-up. To maximize the power of the study given the low incidence of PJI and revision following MUA with injection, the entire database was queried without restrictions on year of procedure. As the database is deidentified and Health Insurance Portability and Accountability Act compliant, the study was Institutional Review Board exempt.

TKA was defined using Current Procedural Terminology (CPT), International Classification of Diseases *Ninth* (ICD-9), and *Tenth* (ICD-10) *Revision* procedure codes. Patients with prior TKA procedures were excluded to attenuate concern for laterality of subsequent procedures. Manipulation of the knee under anesthesia, large joint injection or aspiration, culture analysis, and revision total TKA were defined using CPT codes alone given specificity of coding. Prosthetic joint infection was defined using ICD-9 and ICD-10 coding. Revision due to PJI was identified as a diagnosis of PJI within 30 days before or after revision given individual and institutional variation on documentation and coding. Diagnoses including obesity, tobacco use, and diabetes were defined using pre-defined ICD cohorts within the PearlDiver database. The CPT code for large joint injection or aspiration was included as a surrogate for same-day corticosteroid injection, and patients with same-day codes for culture analysis were excluded to mitigate the effect of aspirations rather than injections performed during MUA. Codes for procedure laterality and specific drugs such as corticosteroids were not included in the analysis given concern for coding accuracy and consistency.

The incidences of MUA with and without injection or aspiration performed during the same encounter excluding same-day culture analysis were determined. Excluding same-day aspiration codes, 28 patients were excluded within the MUA plus injection cohort. The incidences of all-cause revision and revision with coexisting diagnosis of PJI were identified among all included TKA patients. Patient characteristics including age, gender, and comorbid diagnoses including diabetes, tobacco use, and obesity were determined for those undergoing MUA with and without injection. Patient characteristics were not significantly different when comparing

those undergoing MUA with or without injection; however, groups tended to be women, non-smokers, and non-diabetics (Table 1). TKA patients undergoing MUA with and without injection were then matched 2:1 on patient characteristics including age, gender, and Elixhauser comorbidity index, as well as comorbidities such as obesity, tobacco use, and diabetes.

Chi-squared tests were performed on clinical characteristics. An alpha of 0.005 was chosen to determine significance. However, given the large numbers obtained from the database, *p*-values should be interpreted with caution given the potential for insignificant associations to reach the threshold of significance.[6] Rates of all-cause revision as well as revision with coexisting diagnosis of PJI were then determined for matched and unmatched patients undergoing MUA with or without injection within one year of index procedure. Odds ratios were calculated, and Kaplan-Meier survival curves were used to evaluate for a spike in revision rates following intervention, comparing these groups for survival until all-cause revision as well as revision with PJI.

**TABLE 1. Patient characteristics**

| | +MUA* n = 22,015 (2.92%) | +MUA with injection/ aspiration** n = 3,272 (0.43%) | *p*-Value |
|---|---|---|---|
| Characteristic | n (%) | n (%) | |
| Gender | | | |
| Women | 14,091 (64.0) | 2,135 (65.3) | |
| Men | 7,924 (36.0) | 1,137 (34.8) | 0.17 |
| Age | | | |
| 40 – 49 | 1,789 (8.1) | 301 (9.2) | |
| 50 – 59 | 6,644 (30.2) | 1,004 (30.7) | |
| 60 – 69 | 8,374 (38.0) | 1,169 (35.7) | |
| 70 –79 | 4,867 (22.1) | 750 (22.9) | 0.03 |
| Obesity | | | |
| Yes | 11,119 (50.5) | 1,638 (50.1) | |
| No | 10,896 (49.5) | 1,634 (49.9) | 0.63 |
| Tobacco use | | | |
| Yes | 6,920 (31.4) | 1,035 (31.6) | |
| No | 15,095 (68.6) | 2,237 (68.4) | 0.82 |
| Diabetes | | | |
| Yes | 9,714 (44.1) | 1,516 (46.3) | |
| No | 12,301 (55.9) | 1,756 (53.7) | 0.02 |

*Manipulation under anesthesia performed within 90 days of index surgery

**Manipulation under anesthesia with claimed injection within same encounter

## Results

Rates of MUA within 90 days of index TKA were low, with an overall rate of 2.92% of included TKA patients. Of these patients, one in seven (14.9%) underwent injection during the MUA procedure (see Table 1).

The incidence of all-cause revision following MUA alone (646, 2.9%) was not significantly different than rates of all-cause revision following MUA with injection (96, 2.9%). Similarly, the incidence of revision with diagnosis of PJI following MUA alone (141, 0.6%) was not significantly different than rates following MUA with injection (22, 0.7%). Even after matching for confounding variables including age, gender, and Elixhauser comorbidity index, as well as comorbidities such as obesity, tobacco use, and diabetes, there were no significant differences in incidences of all-cause revision or revision with diagnosis of PJI between those undergoing MUA alone or with injection (Table 2 and 3). Kaplan-Meier analyses demonstrated no apparent differences in survival until all-cause revision or revision with PJI diagnosis between MUA alone or MUA, with no apparent spike in revision post-procedure (Figs. 1 and 2).

## Discussion

The current study demonstrated that the incidences of MUA (2.92% following TKA) and simultaneous injection (0.4% following TKA; 13% of MUA procedures following TKA) were infrequent within the studied population (see Table 1). The rate of MUA determined by the current study was similar to literature reported rates of 2.6%.[1] Patients undergoing MUA alone and MUA with injection did not differ significantly in terms of patient characteristics; however, groups tended to be women, non-smokers, and non-diabetics. For patients un-

**TABLE 2. All-cause revision within one year of TKA and MUA +/- injection**

| Procedure | All-cause revision | | Revision with PJI diagnosis | |
|---|---|---|---|---|
| | No revision n (%) | Revision n (%) | No revision n (%) | Revision n (%) |
| MUA* | 21,369 (97.1) | 646 (2.9) | 21,874 (99.4) | 141 (0.6) |
| MUA +Injection* | 3,176(97.1) | 96(2.9) | 3,250 (99.3) | 22 (0.7) |
| Odds ratio and 95% CI: | 1.0 (8.0 to 1.2) | | 1.1 (0.7 to 1.7) | |
| Significance (*p*) | 1.0 | | 0.8 | |

*MUA with or without injection during same encounter performed within 90 days of index surgery

TKA, total knee arthroplasty; MUA, manipulation under anesthesia; PJI, periprosthetic joint infection

**TABLE 3. All-cause revision within one year of TKA and MUA +/- injection following 2:1 matching**

| Procedure | All-cause revision | | Revision with PJI diagnosis | |
|---|---|---|---|---|
| | No revision n (%) | Revision n (%) | No revision n (%) | Revision n (%) |
| MUA* | 6,250 (96.7) | 216 (3.34) | 6,419 (99.3) | 47 (0.7) |
| MUA + Injection* | 3,167 (97.1) | 96 (2.94) | 3,241 (99.3) | 22 (0.7) |
| Odds ratio and 95% CI: | 0.8771 (0.7 to 1.1) | | 0.9 (0.6 to 1.5) | |
| Significance (*p*) | 0.3 | | 0.8 | |

*MUA with or without injection during same encounter performed within 90 days of index surgery

TKA, total knee arthroplasty; MUA, manipulation under anesthesia; PJI, periprosthetic joint infection

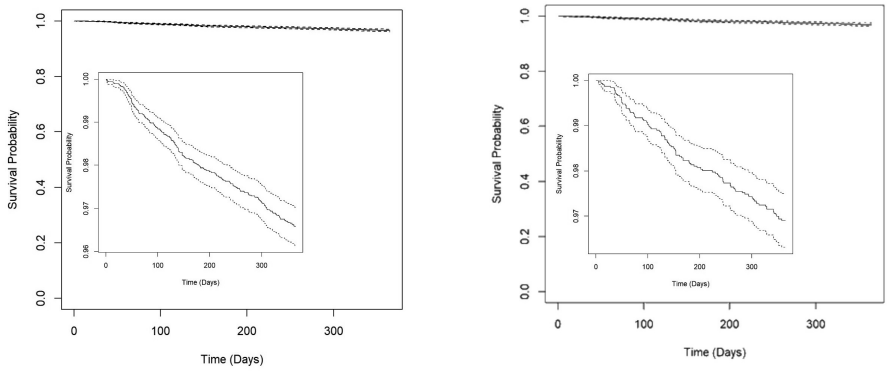


**FIGURE 1.** Kaplan-Meier survival to all-cause revision in unmatched cohorts.

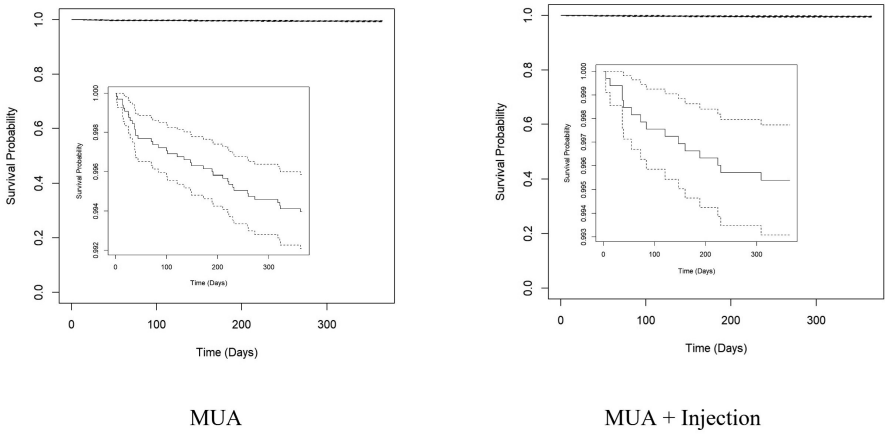


**FIGURE 2.** Kaplan-Meier survival total joint arthroplasty and prosthetic joint infection in matched cohorts.

dergoing MUA within one year of primary TKA, the addition of injection during MUA within 90 days was not associated with increased risk of all cause revision or revision with a coexisting diagnosis of PJI. These findings remained similar after controlling for known confounders.

Total knee arthroplasty is generally a safe and effective procedure for the treatment of end-stage osteoarthritis refractory to conservative measures; however, complications such as postoperative infection, instability, pain, aseptic loosening, and stiffness can be detrimental for both patients and providers. Pathologic idiopathic stiffness following TKA is termed acquired idiopathic stiffness (AIS), a broad term including the subcategory of arthrofibrosis and defined as less than 90 degrees range of motion for greater than twelve weeks postoperatively without an alternative diagnosis.[7] Flexion to at least 125 degrees allows for unhindered activity, with even a ten-degree deficit causing measurable decrease in athletic performance such as running speed.[8] Historical literature has cited 63 degrees of knee flexion required for normal gait, 83 degrees of flexion for climbing stairs, 90 degrees of flexion to descend stairs, and 93 degrees to rise from a chair.[9] Knee stiffness is cited as an important predictor of overall patient satisfaction following TKA[10] with an odds of satisfaction 1.03 times greater for each degree increase in flexion at three months.[11]

The incidence of AIS following TKA has routinely been cited around 4%.[7] Notably, however, the distinction between AIS and arthrofibrosis is relatively recent and less clearly defined in prior literature with possible overlap in utilization. Arthrofibrosis describes the development of excessive scar tissue leading to decreased range of motion commonly secondary to trauma or surgery.[1,7,12] Despite current knowledge, optimal prevention and treatment of AIS or arthrofibrosis following TKA remains controversial.

The exact etiology is unclear. Arthrofibrosis is thought to be an inflammatory process caused by an exaggerated immune response leading to contraction of the joint capsule secondary to extracellular matrix deposition. Myofibroblast proliferation, downregulation of proteolytic enzyme production, and subsequent collagen formation within the joint capsule secondary to stress stimulated immune cells and inflammatory signaling, including overexpression of TGF-beta and platelet derived growth factor, have been associated with the stiffness clinically observed.[12,13] Systemic biomarkers such as inflammatory cytokines are elevated in the days following TKA, correlating with development of AIS at six weeks postoperatively.[13] Possibly, AIS and arthrofibrosis represent systemic illnesses with an underlying genetic disposition. For instance, adhesive capsulitis of the shoulder has been associated with postoperative knee stiffness following TKA.[14] Notable risk factors include younger age, increased tourniquet time, general anesthesia, and diabetes, although confounding factors remain debated.

Manual manipulation of the knee under anesthesia has been accepted as a treatment for decades and has recently been investigated in a multi-center trial showing promising results with a mean improvement of 46 degrees of range of motion.[15] Unsatisfactory stiffness following TKA refractory to MUA forces providers to consider more invasive measures such as arthroscopic or open lysis of adhesions and even revision arthroplasty. Revision due to arthrofibrosis is common and has been shown to account for up to 10.8% of all TKA revi-

sions.[10] Given the morbidity of revision TKA, there is enthusiasm for less invasive treatment modalities.

Studies have demonstrated that the use of perioperative nonsteroidal anti-inflammatory medication might have a preventative effect on the rates of AIS requiring subsequent MUA.[16] More recent studies suggest systemic anti-inflammatory medications, such as IV dexamethasone and celecoxib, demonstrated no significant effect when used in tandem with MUA.[15] Multiple studies have investigated the effect of perioperative angiotensin receptor blockers, which revealed a decreased need for MUA, and suggest a multifactorial approach may be warranted.[17,18] Some surgeons utilize intra-articular steroid injections to improve results of MUA, despite a perceived risk for infection.

The use of CSI following TKA has previously been investigated, with concern for increased risk of subsequent prosthetic joint infection,[4,5,19-21] with one retrospective study demonstrating an infection rate of 0.16% per injection.[4] In the context of simultaneous MUA, the current authors were only able to identify one retrospective study investigating the topic with 499 patients (578 TKAs) included, concluding that patients receiving CSI lost less gained motion than those without.[22] The study, however, was likely underpowered to detect differences in rates of complications such as prosthetic joint infection following intervention.

This study has limitations. Reliance on accurate coding within the dataset introduces the risk of missed or inaccurately coded diagnoses. Corticosteroid injection during manipulation under anesthesia was limited by the definition of the CPT code for large joint injection, which includes aspiration and is not specific to the knee. This was mitigated by excluding same-day codes for laboratory culture analysis; however, some patients might have undergone aspiration or injection of drugs other than steroids during the time of MUA. Further, although the coding does not specify the knee as the location for the procedure, the risk of patients receiving an injection or aspiration of a separate large joint at the time of knee MUA is unlikely. Although codes for laterality and specific drugs are included within the database, given concern for coding accuracy and reliability, these were not included in the current study. Although patients with prior TKA were excluded to mitigate this concern, it is possible that subsequent TKA procedures leading to laterality inaccuracies could limit the accuracy of the results. Codes for patient characteristics do not capture the severity or presence of the comorbidities present during the acute perioperative period, rather only a history of the comorbidity. While requiring patients to have a one-year follow up limits attrition it is not possible to determine whether patients had follow up for their TKA at institutions not captured by the dataset. The strengths of this study include the use of a large database that is useful when determining the incidence of rare outcomes such as PJI following infrequently used interventions, especially as prior literature has reported a low rate of infection following intra-articular steroid injection, such as a paper citing a number needed to harm of 448 investigating infection following intra-articular steroid injection at the time of knee arthroscopy.

## Conclusion

MUA following TKA is relatively infrequently performed; however, one in eight undergo simultaneous injection. Patient characteristics do not appear to be associated with the use of MUA with or without injection. Despite concern, there appears to be no significantly increased incidence of PJI when comparing MUA with or without injection following TKA. This data suggests that CSI can be utilized during MUA when faced with knee stiffness following arthroplasty, although further investigation into the comparative outcomes is warranted.

## References


1. Owen AR, Tibbo ME, Van Wijnen AJ, et al. Acquired idiopathic stiffness after contemporary total knee arthroplasty: incidence, risk factors, and results over 25 years. J Arthroplasty. 2021;36(8):2980-2985.
2. Bartlett LE, Henry JP, Lygrisse KA, et al. The risk of acute infection following intra-articular corticosteroid injection during total knee manipulation under anesthesia. J Arthroplasty. 2023;38(7):1373-1377.
3. Werner BC, Cancienne JM, Browne JA. The timing of total hip arthroplasty after intraarticular hip injection affects postoperative infection risk. J Arthroplasty. 2016;31(4):820-823.
4. Mills ES, Elman MB, Foran JRH. The risk of acute infection following intra-articular corticosteroid injection into a pre-existing total knee arthroplasty. J Arthroplasty. 2018;33(1):216-219.
5. Muffly BT, Ayeni AM, Jones CA, et al. Periprosthetic joint infection risk after primary total knee arthroplasty: are all preoperative corticosteroid injections the same? J Arthroplasty. 2024;39(5):1312-1316.e7.
6. Landy DC, Utset-Ward TJ, Lee MJ. What are the implications of alternative alpha thresholds for hypothesis testing in orthopaedics? Clin Orthop. 2019;477(10):2358-2363.
7. Tibbo ME, Limberg AK, Salib CG, et al. Acquired idiopathic stiffness after total knee arthroplasty: a Systematic review and meta-analysis. J Bone Joint Surg. 2019;101(14):1320-1330.
8. Magit D, Wolff A, Sutton K, et al. Arthrofibrosis of the knee. J Am Acad Orthop Surg. 2007;15(11):682-694.
9. Daluga D, Lombardi AV, Mallory TH, et al. Knee manipulation following total knee arthroplasty. J Arthroplasty. 1991;6(2):119-128.
10. Paxton EW, Furnes O, Namba RS, et al. Comparison of the Norwegian Knee Arthroplasty Register and a United States Arthroplasty Registry. J Bone Joint Surg. 2011;93(Supplement_3):20-30.
11. Williams DP, O'Brien S, Doran E, et al. Early postoperative predictors of satisfaction following total knee arthroplasty. Knee. 2013;20(6):442-446.
12. Usher KM, Zhu S, Mavropalias G, et al. Pathological mechanisms and therapeutic outlooks for arthrofibrosis. Bone Res. 2019;7(1):9.
13. Malahias MA, Birch GA, Zhong H, et al. Postoperative serum cytokine levels are associated with early stiffness after total knee arthroplasty: a prospective cohort study. J Arthroplasty. 2020;35(6):S336-S347.
14. Laperche JM, Chang K, Albright JA, et al. Shoulder adhesive capsulitis prior to total knee arthroplasty is associated with increased rates of postoperative stiffness requiring manipulation under anesthesia and arthroscopic lysis of adhesions. J Arthroplasty. 2024;39(4):960-965.
15. Abdel MP, Salmons HI, Larson DR, et al. The Chitranjan S. Ranawat Award: manipulation under anesthesia to treat postoperative stiffness after total knee arthroplasty: a multicenter randomized clinical trial. J Arthroplasty. 2024;39(8S1):S9-S14.e1.
16. Salmons HI, Payne AN, Taunton MJ, et al. Nonsteroidal anti-inflammatory drugs and oral corticosteroids mitigated the risk of arthrofibrosis after total knee arthroplasty. J Arthroplasty. 2023;38(6):S350-S354.
17. Premkumar A, Anatone A, Illescas A, et al. Perioperative use of antifibrotic medications associated with lower rate of manipulation after primary TKA: an analysis of 101,366 patients. J Arthroplasty. 2022;37(8):S1010-S1015.e1.
18. Albright JA, Testa EJ, Ibrahim Z, et al. Postoperative angiotensin receptor blocker use is associated with decreased rates of manipulation under anesthesia, arthroscopic lysis of adhesions, and prosthesis-related complications in patients undergoing total knee arthroplasty. J Arthroplasty. 2024;39(4):954-959.e1.
19. Roecker Z, Quinlan ND, Browne JA, et al. Risk of periprosthetic infection following intra-articular corticosteroid injections after total knee arthroplasty. J Arthroplasty. 2020;35(4):1090-1094.
20. Cheppalli N, Singanamala N, Choi TJ, et al. Intra-articular corticosteroid injection after total knee replacement: is it safe? Cureus. 2021;13(11)e19700.
21. Durst CR, Rezzadeh KT, Than JP, et al. Intra-articular corticosteroid injections into a preexisting total knee arthroplasty are associated with increased risk of periprosthetic joint infection and revision. Arthroplasty Today. 2023;24:101237.
22. Maheshwari A, Tsailas P, Ranawat A, et al. The results of knee manipulation for stiffness after total knee arthroplasty with or without an intra-articular steroid injection. Indian J Orthop. 2008;42(3):314.