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# Total Hip Arthroplasty Outcomes in Patients with Gout: A Retrospective Analysis of Matched Large Cohorts

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**Background:** Gout is the most prevalent form of inflammatory arthritis in the world. Total hip arthroplasty (THA) has emerged as a widely sought-after and highly effective surgical procedure for advanced hip diseases. However, there is a lack of research on the impact of gout on primary THA outcomes in large cohorts. This study aimed to address this gap by primarily investigating complications following THA in patients with or without gout.

**Methods:** Patients with records of gout in the 2 years leading up to their primary THA and who also have at least 2 years of follow-up were identified using a national insurance database and compared to a 5:1 matched control. A total of 32,466 patients with gout and 161,514 patients without gout undergoing THA were identified. Multivariable logistic regression analyses were done for medical complications up to 90 days and surgical complications up to 2 years. In addition, 90-day emergency department (ED) visits and inpatient readmission were also documented.

**Results:** Patients with gout demonstrated higher rates of medical complications including deep vein thrombosis, transfusion, acute kidney injury, and urinary tract infection than non-gout patients ($p < 0.001$). Gout patients also showed higher rates of pulmonary embolism ($p = 0.017$). Increased incidences of surgical complications were identified in gout patients, specifically wound complications and periprosthetic joint infection ($p < 0.001$). There was an increased risk of revision for gout patients up to 90 days ($p = 0.003$), 1 year ($p = 0.027$), and 2 years ($p = 0.039$). There was also an increased risk of dislocation for gout patients up to 90 days ($p = 0.022$) and 1 year ($p = 0.047$), but not at 2 years. No significant difference was observed in aseptic loosening or periprosthetic fracture. Additionally, gout patients also demonstrated a higher likelihood of 90-day ED visits and readmission ($p < 0.001$).

**Conclusions:** Primary THA in gout patients is associated with increased risks of multiple medical and surgical complications. Our findings provide insights into the planning and expectation of THA for patients with gout. These insights have the potential to benefit the decision-making process for gout patients considering THA.

**Keywords:** *Total hip arthroplasty, Gout, Hip, Prosthesis related infection, Treatment outcome*

Gout is the most prevalent form of inflammatory arthritis in the world, manifesting as intermittent episodes of severe joint pain known as gout flares.[1-3] The older population is particularly susceptible to it as the risk of gout increases with age. Given various study methods, it is estimated that gout has a prevalence of less than 1% up to 6.8% and an incidence of 0.58–2.89 per 1,000 person-years.[2] Studies have shown a greater incidence of gout among men than women at a ratio of 3:1 to 10:1.[1] Gout is also associated

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with multiple comorbidities, such as cardiovascular disease and renal disease.[2]

The terminal product of the purine degradation pathway, urate, underlies one of the key processes of gout pathophysiology. Urate is normally regulated and excreted via the kidney and intestine.[3] However, misregulation of urate excretion can lead to hyperuricemia, where 24% of asymptomatic individuals with hyperuricemia are found with monosodium (MSU) urate crystallization in early gout.[4] The presence of MSU crystals subsequently heightens innate immune pathways, particularly characterized by the activation of the NLRP3 inflammasome in macrophages and monocytes.[5] The recruited neutrophils to the site produce numerous pro-inflammatory substances and promote the local acute inflammatory response. The management of the gout flare consists of early anti-inflammatory treatment while long-term management of gout consists mainly of urate-lowering therapy (ULT).[3]

Given the inflammatory response associated with gout, it is of great importance and interest to identify the impact of gout on orthopedic surgical outcomes. Total hip arthroplasty (THA) has emerged as a widely sought-after and highly effective surgical procedure, witnessing a surge in demand within the United States.[6,7] However, there is presently a paucity of research on primary THA from post-surgical outlooks in patients with a history of gouts. Of the few pertinent studies, Chen et al.[8] found that gout patients (n = 237) who underwent primary THA experienced worse wound healing issues at 12.2% to 5.1% and more renal complications at 8.4% to 3.0% when compared to non-gout individuals. In another study utilizing the U.S. National Inpatient Sample database, following primary THA, gout was linked to a 9%–20% increase in healthcare use and a 6% increase in the risk of transfusion.[9] However, gout-associated comorbidities were not controlled in this study. Currently, to the best of our knowledge, available research on gout and post-primary THA outcomes was limited to either a relatively small patient sample size or carried out without controlling for comorbidities. This study aimed to address this gap by primarily investigating complications following THA in patients with or without gout.

## METHODS

### Ethical Statements

This retrospective research study utilized the PearlDiver Patient Records Database, a national private payer insurance database that contains indexed and de-identified data. The database consists of procedural volumes and patient demographics for patients with International Classification of Diseases, 9th Revision diagnoses (ICD-9), 10th Revision diagnoses (ICD-10), and procedures or Current Procedural Terminology (CPT) codes. Our Institutional Review Board deemed this study exempt, including the need for participants' consent to participate and publish the results.

### Data Source

This study utilized the PearlDiver database, which is a fee-based repository of patient records available at www.pearldiverinc.com in Colorado Springs, Colorado. The database is insurance-based and comprises patient demographics, charge data, and procedural records for individuals diagnosed with ICD-9 or ICD-10 conditions, and CPT codes from various insurers, including Medicare and Humana (private insurer). The study utilized the M161 dataset, which consisted of around 161 million patient records from 2010 to 2022 at the time of data collection and analysis. The database was password-protected and accessed from PearlDiver Technologies for academic research purposes. As the patient data was de-identified and publicly available, it was exempt from institutional review board approval.

### Study Population

The database was queried for patients aged greater than 35 years with records of any gout arthritis in the 2-year window before undergoing primary THA using a combination of ICD-9, ICD-10, and CPT codes from 2010 to 2022. To isolate primary THA, we excluded patients with a record of prior hip arthroplasty, revision surgery, or diagnosis codes reflecting the presence of an artificial hip joint. Patients with pathologic hip fractures, hip infectious processes, or conversion from prior hip surgery at the time of the primary THA were also excluded. Codes used to define gout are provided in the Supplementary Material 1.

The control cohort was matched using randomized allocation with a 1:5 ratio to the respective gout group by age, sex, obesity (body mass index > 30 kg/m$^2$), chronic kidney disease, chronic obstructive pulmonary disease, diabetes mellitus, coronary artery disease, tobacco use, congestive heart failure, hyperlipidemia, peripheral vascular disease, hypertension, depression, and osteoporosis with exact match methodology. Only patients with records of gout within the 2 years leading up to their THA were included. Additionally, patients had a minimum of 2 years of follow-up following THA. A total of 193,980 patients undergoing THA were identified, of whom 32,466 patients had gout and the others did not. Approximately 70% of patients fell within the age range of 55–75 years in both

cohorts. About 29% of the cohorts were women. There were no statistical differences in terms of age, sex, and relevant comorbidities after matching (Table 1).

### Outcomes of Interest

The following events within 90 days were chosen as relevant medical complications after THA: pneumonia, pulmonary embolism (PE), cerebrovascular accident, deep vein thrombosis (DVT), transfusion, acute kidney injury (AKI), urinary tract infection (UTI), sepsis, and myocardial infarction. Surgical complications include wound complications within 90 days, periprosthetic joint infection (PJI) with or without sinus tracts, dislocation, aseptic loosening, periprosthetic fracture, and revision within 90 days, 1 year, and 2 years postoperatively. In addition, emergency department (ED) visits and hospital readmission within 90 days were determined.

### Statistical Analysis

Pearson chi-square tests were used to assess differences in demographics and preexisting comorbidities (including smoking status). Multivariate logistic regressions comparing gout patients and non-gout patients were used to determine the independent effect of gout on the postoperative outcomes after adjusting for demographic factors and comorbidities. R software embedded within the PearlDiver database (R Foundation for Statistical Computing) was used for all statistical analyses. Factors were considered significant at $p < 0.05$.

## RESULTS

### Medical Complications

Multivariate regression analysis on primary THA patients demonstrated that gout was not associated with an in-

**Table 1.** Patients Demographics

| Variable | Gout (n = 32,466) | MC (n = 161,514) | *p*-value |
|---|---|---|---|
| Age (yr) | 573 (1.76) | 2,827 (1.75) | 1.000 |
| 35–44 | 573 (1.76) | 2,827 (1.75) | 1.000 |
| 45–54 | 3,345 (10.30) | 16,603 (10.28) | 1.000 |
| 55–64 | 9,125 (28.11) | 45,406 (28.11) | 1.000 |
| 65–75 | 13,479 (41.52) | 67,126 (41.56) | 1.000 |
| > 75 | 5,944 (18.31) | 29,552 (18.30) | 1.000 |
| Sex (female) | 9,483 (29.21) | 47,117 (29.17) | 0.899 |
| Comorbidity | | | |
| Obesity (BMI > 30 kg/m$^2$) | 4,496 (13.85) | 22,072 (13.67) | 0.387 |
| Chronic kidney disease | 5,441 (16.76) | 26,680 (16.52) | 0.291 |
| Chronic obstructive pulmonary disease | 6,075 (18.71) | 29,957 (18.55) | 0.492 |
| Diabetes mellitus | 9,527 (29.34) | 47,219 (29.24) | 0.697 |
| Coronary artery disease | 9,091 (28.00) | 45,033 (27.88) | 0.665 |
| Tobacco abuse | 5,102 (15.71) | 25,192 (15.60) | 0.594 |
| Congestive heart failure | 2,549 (7.85) | 12,417 (7.69) | 0.319 |
| Hyperlipidemia | 23,382 (72.02) | 116,280 (71.99) | 0.929 |
| Peripheral vascular disease | 3,596 (11.08) | 17,637 (10.92) | 0.415 |
| Hypertension | 26,712 (82.28) | 132,842 (82.25) | 0.907 |
| Depression | 4,912 (15.13) | 24,218 (14.99) | 0.539 |
| Osteoporosis | 2,153 (6.63) | 10,456 (6.47) | 0.298 |

Values are presented as number (%).
MC: matched control, BMI: body mass index.

creased risk of pneumonia within 90 days postoperatively (1.17% vs. 1.14%; odds ratio [OR], 1.01; $p = 0.785$). However, gout patients were at a marginally higher risk for PE (0.59% vs. 0.49%; OR, 1.21; $p = 0.017$) and DVT (2.01% vs. 1.61%; OR, 1.25; $p < 0.001$). The likelihood of cerebrovascular accidents did not differ significantly (0.73% vs. 0.67%; OR, 1.08; $p = 0.266$), nor did myocardial infarction rates (0.56% vs. 0.55%; OR, 1.00; $p = 0.905$). The necessity for transfusion was higher in the gout cohort (2.68% vs. 2.00%; OR, 1.35; $p < 0.001$), as was the rate of AKI (2.93% vs. 1.95%; OR, 1.52; $p < 0.001$) and UTIs (4.08% vs. 3.52%; OR, 1.16; $p < 0.001$). Sepsis incidence showed no significant difference (0.75% vs. 0.67%; OR, 1.10; $p = 0.162$) (Table 2).

### Surgical Complications

Gout patients experienced higher rates of wound complications (2.73% vs. 2.07%; OR, 1.32; $p < 0.001$) and PJIs

**Table 2.** Patient Postoperative Outcomes

| Variable | Gout (n = 32,466) | MC (n = 161,514) | Adjusted OR (95% CI) | Adjusted *p*-value |
|---|---|---|---|---|
| Pneumonia (90 days) | 379 (1.17) | 1,848 (1.14) | 1.01 (0.90–1.13) | 0.785 |
| Pulmonary embolism (90 days) | 193 (0.59) | 793 (0.49) | 1.21 (1.03–1.41) | 0.017* |
| Cerebrovascular accident (90 days) | 237 (0.73) | 1,086 (0.67) | 1.08 (0.93–1.24) | 0.266 |
| Deep vein thrombosis (90 days) | 654 (2.01) | 2,594 (1.61) | 1.25 (1.14–1.36) | < 0.001* |
| Transfusion (90 days) | 870 (2.68) | 3,228 (2.00) | 1.35 (1.25–1.45) | < 0.001* |
| Acute kidney injury (90 days) | 952 (2.93) | 3,144 (1.95) | 1.52 (1.41–1.63) | < 0.001* |
| Urinary tract infection (90 days) | 1,325 (4.08) | 5,680 (3.52) | 1.16 (1.09–1.24) | < 0.001* |
| Sepsis (90 days) | 243 (0.75) | 1,089 (0.67) | 1.10 (0.95–1.26) | 0.162 |
| Myocardial infarction (90 days) | 182 (0.56) | 893 (0.55) | 1.00 (0.85–1.18) | 0.905 |
| Wound complications (90 days) | 885 (2.73) | 3,350 (2.07) | 1.32 (1.22–1.42) | < 0.001* |
| Periprosthetic joint infection (90 days) | 412 (1.27) | 1,695 (1.05) | 1.20 (1.08–1.34) | < 0.001* |
| Periprosthetic joint infection (1 year) | 568 (1.75) | 2,415 (1.50) | 1.16 (1.06–1.28) | < 0.001* |
| Periprosthetic joint infection (2 year) | 696 (2.14) | 2,880 (1.78) | 1.20 (1.10–1.30) | < 0.001* |
| Dislocation (90 days) | 408 (1.26) | 1,787 (1.11) | 1.13 (1.01–1.26) | 0.022* |
| Dislocation (1 year) | 539 (1.66) | 2,435 (1.51) | 1.09 (1.00–1.20) | 0.047* |
| Dislocation (2 year) | 607 (1.87) | 2,867 (1.78) | 1.05 (0.96–1.14) | 0.266 |
| Aseptic loosening (90 days) | 65 (0.20) | 314 (0.19) | 1.02 (0.78–1.33) | 0.839 |
| Aseptic loosening (1 year) | 166 (0.51) | 817 (0.51) | 1.00 (0.85–1.19) | 0.908 |
| Aseptic loosening (2 year) | 269 (0.83) | 1,329 (0.82) | 1.00 (0.88–1.14) | 0.930 |
| Periprosthetic fracture (90 days) | 152 (0.47) | 786 (0.49) | 0.95 (0.80–1.13) | 0.641 |
| Periprosthetic fracture (1 year) | 214 (0.66) | 1,054 (0.65) | 1.00 (0.86–1.16) | 0.917 |
| Periprosthetic fracture (2 year) | 260 (0.80) | 1,299 (0.80) | 0.99 (0.86–1.13) | 0.922 |
| Revision (90 days) | 426 (1.31) | 1,810 (1.12) | 1.17 (1.05–1.30) | 0.003* |
| Revision (1 year) | 654 (2.01) | 2,956 (1.83) | 1.10 (1.00–1.19) | 0.027* |
| Revision (2 year) | 808 (2.49) | 3,710 (2.30) | 1.08 (1.00–1.17) | 0.039* |
| ED visit (90 days) | 3,923 (12.08) | 16,401 (10.15) | 1.21 (1.17–1.26) | < 0.001* |

Values are presented as number (%).
MC: matched control, OR: odds ratio, CI: confidence interval, ED: emergency department.
*Statistical significance with $p < 0.05$.

within 90 days (1.27% vs. 1.05%; OR, 1.20; $p < 0.001$), with this trend extending to 1 year (1.75% vs. 1.50%; OR, 1.16; $p < 0.001$) and 2 years (2.14% vs. 1.78%; OR, 1.20; $p < 0.001$). Dislocation occurrences in gout patients were slightly higher within 90 days (1.26% vs. 1.11%; OR, 1.13; $p = 0.022$) and marginally higher at 1 year (1.66% vs. 1.51%; OR, 1.09; $p = 0.047$), but no significant difference was noted at the 2-year mark. No significant increases were seen in aseptic loosening or periprosthetic fractures across all time frames. Gout patients had a higher revision rate within 90 days (1.31% vs. 1.12%; OR, 1.17; $p = 0.003$), and the trend persisted albeit with reduced significance at 1 year (2.01% vs. 1.83%; OR, 1.10; $p = 0.027$) and at 2 years (2.49% vs. 2.30%; OR, 1.08; $p = 0.039$). Notably, gout patients had a higher incidence of ED visits within 90 days (12.08% vs. 10.15%; OR, 1.21; $p < 0.001$) and hospital readmissions (7.24% vs. 5.90%; OR, 1.24; $p < 0.001$) (Table 2).

## DISCUSSION

Gout is the most common form of inflammatory arthritis in the world. Given the inflammatory response associated with gout, it is of great importance and interest to identify the impact of gout on orthopedic surgical outcomes. However, there is presently a paucity of research on primary THA outcomes in patients with gout from a post-surgical perspective. To the best of our knowledge, available research on gout and post-primary THA outcomes has been limited, either involving a relatively small patient sample or conducted without controlling for comorbidities. This study utilized an expansive database, including a large gout population (n = 32,466) and a 1:5 matched control group (n = 161,514). It investigated medical complications within 90 days and surgical complications within 2 years following THA in patients with or without gout.

Our study has its limitations. Given the nature of our study, we are unable to obtain the urate acid levels of patients or identify the joints involved with gout, either ipsilateral or contralateral. Furthermore, we are also unable to discern patient compliance in their gout management. We also do not know if the patients had a flare before or after their THA. These biological effects that gout may potentiate in THA patients warrant further research as we are unable to evaluate the presence of MSU crystals at the site of THA. It is unclear whether the studied patients are undergoing ULT or taking other medication that could impact gout management. However, while there is evidence suggesting that long-term adherence to ULT suppresses gout flare, promotes tophi regression, and protects against joint damage, Kuo et al.[10] found that ULT is unable to reduce the elevated risk of TJR conferred by gout in Taiwan and UK patient populations.[3] While the PearlDiver database enables us to control for certain comorbidities, it is possible that there are variables not coded by the database, such as operative time and types of prostheses, that impact outcomes and contribute to bias. Additionally, we were unable to determine the indications of the THA, which could be another variable influencing surgery outcome. Nevertheless, the study has its strengths. The large national database allowed us to investigate outcomes with much higher statistical power with a studied gout population of 32,466 patients and a match-controlled population of 161,514 patients. This approach overcomes numerous limitations stemming from a limited sample size from the currently available studies on the topic. PearlDiver database also allows for comprehensive matching with multivariate logistic regression analysis and longitudinal study as it encompasses outcomes at any time during enrollment, enabling short- to intermediate-length data. These advantages position our study as a unique approach to investigating THA outcomes in gout patients from available known studies to our knowledge.

### Medical Complications

Gout patients who underwent primary THA demonstrated significantly higher rates ($p < 0.001$) of DVT, transfusion, AKI, and UTI. Additionally, gout patients were found with higher rates of PE ($p = 0.017$) than non-gout patients. The same complications, except transfusion, were also assessed in a study by Chen et al.,[8] where only AKI was found at a higher complication rate with statistical significance (8.4% gout vs. 3.0% non-gout, $p = 0.01$) following THA. It is known that hyperuricemia is an independent risk factor associated with AKI.[11] Additionally, the incidence of AKI ranges from 0.3% to 16.2% in patients undergoing total joint arthroplasty (TJA), and it remains one of the most common medical causes of readmission after TJA.[12,13] AKI may be a problem for gout patients who undergo TJA, especially as patients frequently get dehydrated and may receive insufficient resuscitation.[8] In a study by Su et al.,[14] they proposed AKI could be induced by hyperuricemia by the following mechanisms, such as MSU crystal deposition-induced renal damage as well as hyperuricemia-induced oxidative stress, endothelial dysfunction, renal fibrosis, and renal inflammation. Regarding transfusion risk, gout has been indicated to have an additional 6% risk of transfusion following primary THA.[9]

Other medical complications with statistically significantly elevated risk in our study–PE, DVT, and UTI–

were also found at a higher rate in gout THA patients than the non-gout THA group in a prior study.[8] Nevertheless, none of these complications demonstrated a statistically significant difference in the prior study, which can be attributed to the relatively small sample size that was improved in the current approach. Gout is associated with risk of PE, DVT, and venous thromboembolism.[15,16] Additionally, regardless of exposure to urate-lowering treatment, gout was linked to a greater risk of venous thromboembolism, especially when the patient was not receiving hospital care.[17] Additionally, within 30 days of a primary-care consultation or hospitalization for a gout flare, a brief increase in the rate of venous thromboembolism was found.[18] With regard to the risk of pneumonia, a cohort study from the U.K. has demonstrated a higher risk of pneumonia although the same study did not show an elevated risk of UTI.[19] It is worth noting that post-surgical UTI has been linked to an increased revision rate following THA.[20] While the higher cerebrovascular accident rate in our gout patient group did not achieve statistical significance, it is worth noting that a higher serum uric acid level is associated with an elevated risk of ischemic stroke.[21] Additionally, hyperuricemia and gout have been indicated as risk factors for myocardial infarctions.[22] With regard to sepsis, the incidence of AKI and the likelihood of 90-day all-cause mortality were both strongly correlated with hyperuricemia in sepsis patients in the intensive care unit.[23]

**Surgical Complications**

Wound complications in gout patients are at a significantly higher rate at 2.73% than in non-gout patients at 2.07%. Chen et al.[8] also found statistically significantly higher wound healing problems in patients with gout at 12.2% than in non-gout patients at 5.1% following THA. It is worth noting that wound complications remain elevated in gout patients after controlling for numerous gout-associated comorbidities, such as obesity and peripheral arterial disease, which are associated with interrupted tissue healing.[2,24] Additionally, in an animal study, rats with an artificially induced gouty ulcer, when compared with the control group, demonstrated delayed wound healing with associated signs of chronic MSU crystal deposition, tophi ulceration, and chronic inflammatory responses.[25]

Furthermore, our study identified higher dislocation rates up to 1 year and higher revision rates as well as PJI up to the 2-year time frame following primary THA in gout patients. The poor healing of tissue around the hip joint might also contribute to the higher rate of dislocation in the early postoperative period. It is possible that the increased PJI rate in gout patients in our study also contributed to their increased revision rate. In a prior 2-center retrospective study, PJI has been identified as the third most common indication for THA revisions after aseptic loosening and instability.[26] A recent database study investigating the effect of gout following total knee arthroplasty found that patients with gout had a considerably higher average 1-year risk of revision surgeries and PJIs than their match control. Patients with gout also had a higher chance of prosthesis loosening, PJI, revision, and incision and debridement procedures at an average of 2 years.[27] Interestingly, in another study on post-total knee arthroplasty outcome, gout was associated with a higher risk of PJI and revision at 1 year, which however was no longer associated with gout after controlling for confounding factors.[28]

Regarding other surgical complications in this study, gout patients did not demonstrate a higher rate of aseptic loosening or periprosthetic fracture following primary THA. Regarding fracture risk, while a study in 2016 found elevated overall bony fracture risk with gout, especially in female patients with fractures in the lower legs or spine, a later meta-analysis found no association with increased fracture risk.[29,30]

In conclusion, the results demonstrate that primary THA in gout patients is associated with an elevated risk of multiple medical complications. In addition, gout patients exhibited higher surgical complications encompassing wound complications, PJI, dislocation, and revision. However, no increased risk of aseptic loosening or periprosthetic fracture was observed in gout patients following primary THA. The findings provide insights into the planning and expectation of orthopedic surgery for patients with gout.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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## SUPPLEMENTARY MATERIAL

Supplementary material is available in the electronic version of this paper at the CiOS website, www.ecios.org.

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