

The Effect of Arthroscopic Removal of Monosodium Urate Crystals in the Knee Joint on Patients with Gout

Jiangnan Sun^{1,3}, Shanshan Li², Haifeng Huang^{3,*}

¹Zunyi Medical University, Zunyi, Guizhou, China

²Department of Anesthesiology, Guizhou Provincial People's Hospital, Guiyang, Guizhou, China

³Department of Orthopaedics, Guizhou Provincial People's Hospital, Guiyang, Guizhou, China

*Correspondence Author, yixuedawang@163.com

Abstract: ***Objective:** To explore whether arthroscopic removal of monosodium urate crystals in the knee can reduce the frequency of acute gout attacks and improve knee function compared to medication alone. **Methods:** The study included 38 male patients with hyperuricemia (serum uric acid >7.0 mg/dL) who also had recurrent knee gouty arthritis. Among them, 17 patients (Group 1) underwent arthroscopic surgery to remove monosodium urate crystals from the knee, followed by staged rehabilitation exercises to help restore knee function; the remaining 21 patients (Group 2) served as the control group and received medication treatment (Combined use of uric acid-lowering and anti-inflammatory drugs). In both groups, treatment aimed to reduce and maintain serum uric acid levels between 5 and 6 mg/dL. The arthroscopic surgery group (Group 1) had a follow-up of 21.24 ± 6.92 months, while the medication group (Group 2) had 17.05 ± 6.36 months. **Results:** After arthroscopic surgery and medication treatment, both groups showed varying degrees of improvement in knee Lysholm scores and the frequency of acute recurrent knee gout attacks. In both indicators, Group 1 showed better outcomes than Group 2 (arthroscopic removal of knee monosodium urate crystals was more effective than medication alone). The average reduction in acute gout attacks was significantly greater in Group 1 than in Group 2 (Comparison of the number of acute gouty arthritis attacks before and after surgery in Group 1: $5.59 \pm 1.37/0.29 \pm 0.59$; $P < 0.001$, Group 2: $6.52 \pm 1.54/4.24 \pm 1.58$; $P < 0.001$), and the mean increase in Lysholm scores was also significantly higher in Group 1 than in Group 2 (Comparison of preoperative/postoperative Lysholm scores in Group 1: $68.65 \pm 3.87/85.24 \pm 4.96$; $P < 0.001$, Group 2: $68.67 \pm 4.66/73.57 \pm 5.35$; $P < 0.001$). Final serum uric acid levels were as follows (Group 1 preoperative/postoperative comparison $9.90 \pm 1.70/7.39 \pm 1.28$; $P < 0.001$; Group 2: $10.0 \pm 1.62/8.5 \pm 1.24$; $P < 0.001$). **Conclusion:** Simple uric acid-lowering and anti-inflammatory drug treatment can also improve patients' uric acid levels, the frequency of acute gout attacks, and Lysholm Scale scores. However, when pharmacotherapy is combined with arthroscopic removal of monosodium urate crystals from the knee joint, patients show more significant improvements in uric acid levels, the frequency of acute gout attacks, and Lysholm Scale scores postoperatively. This also demonstrates that arthroscopic removal of monosodium urate crystals from the knee joint is more effective for patients with knee gout.*

Keywords: Knee arthroscopy, Hyperuricemia, Gouty arthritis.

1. Introduction

Gout is a chronic joint disease caused by the deposition of monosodium urate crystals in the joint tissues and surrounding areas [1, 2]. In recent decades, the prevalence of gout has been continuously rising, and the associated medical burden has also been increasing, with this trend expected to continue [3, 4]. In China, gout has become increasingly common as living standards improve, and the prevalence of the disease has also risen significantly, making it another common metabolic disease after diabetes [5]. Across the United States, the prevalence of gout is 5.1%, affecting no fewer than 12.1 million adults [6]. In 2020, there will be 55.8 million people with gout worldwide. Among these 55.8 million people, the majority will be men, as the global prevalence of gout in men is 3.26 times that of women. In China, men are more likely to develop gout than women [7]. Of course, the prevalence of gout also increases with age, so the prevalence among the elderly is relatively high [8]. Regarding the root cause of gout pain, some believe that it is caused by hyperuricemia, which leads to the deposition of monosodium urate crystals around the joints, thereby causing gout pain [9]. Gout not only causes joint pain, but may also be accompanied by flare-ups of inflammatory arthritis, which can lead to loss of joint function. If gout is not properly managed, it can even result in the formation of tophi, causing joint damage [10]. The article by Satti, Lakshmana Reddy,

and others also demonstrates that gout-induced inflammatory arthritis not only causes persistent severe joint pain but can also lead to serious complications such as joint stiffness [11]. Hyperuricemia that leads to gout essentially involves elevated levels of serum uric acid, and the diseases it causes are not limited to gout. Hyperuricemia is also associated with a variety of conditions, including cardiovascular diseases, kidney diseases, metabolic syndrome, and diabetes [12, 13]. Drug treatment for joint gout is common, while cases of treating knee joint gout with arthroscopy are relatively rare. However, some literature has already shown that the use of arthroscopy in the ankle joint has improved both the incidence of chronic gout and the function of the ankle joint [14]. The purpose of this article is to explore whether arthroscopy can reduce the frequency of knee gout attacks by removing monosodium urate deposits in the knee joint and improve knee joint function.

2. Methods

This study included 38 male patients, all of whom had hyperuricemia (serum uric acid level >7.0 mg/dL) accompanied by recurrent gouty knee arthritis. Among them, 17 patients (Group 1) did not achieve relief after half a year of medical gout treatment and ultimately chose to undergo arthroscopic surgery (Table 1). The remaining 21 male patients (Group 2) declined arthroscopic knee surgery but

were willing to continue long-term gout medication (Table 2) [15]. Exclusion criteria for arthroscopic knee surgery include acute attacks of gouty knee arthritis with nodule rupture, wound infection, or the formation of multiple large nodules that are difficult to surgically remove. The average age of patients undergoing arthroscopic knee surgery (Group 1) was 32.53 years (range 21 to 47 years). The average age of patients receiving medication treatment (Group 2) was 37.05 years (range 20 to 52 years). Arthroscopic surgery (Group 1) had a duration of gout symptoms of 7.82 years (range 4 to 15 years)

before surgery, and the duration of knee joint symptoms was 18.0 ± 8.40 months (range 7 to 35 months). In the drug treatment group (Group 2), the duration of gout history before medication was 7.26 years (ranging from 3 to 12 years), and the duration of knee joint symptoms was 19.24 ± 6.62 months (ranging from 8 to 33 months). In the recent follow-up, changes in uric acid, the frequency of acute gout attacks in the knee, and the Lysholm scale score were assessed by independent observers.

Table 1: Details and Clinical Data of Group 1

Case	Gender	Age (yr)	Side	Duration of Preoperative Symptoms (mo)	Follow-up (mo)	Preoperative/Postoperative Uric Acid Level (mg/dL)	Preoperative/Postoperative Number of Acute Attacks of Gouty Arthritis	Preoperative/Postoperative Lysholm Scale Score
1	M	35	R	8	24	8.6/7.0	4/0	73/82
2	M	21	R	22	37	11.3/5.9	7/0	63/86
3	M	26	L	25	25	10.9/8.3	7/0	65/88
4	M	36	R	13	26	8.1/6.4	6/0	67/84
5	M	42	L	9	31	9.9/7.2	5/1	72/88
6	M	28	R	7	15	12.6/9.4	8/1	69/86
7	M	31	R	33	17	10.1/7.5	6/0	69/89
8	M	47	R	26	20	12.2/9.8	7/2	65/80
9	M	29	L	18	22	10.7/7.5	5/0	68/90
10	M	21	L	15	18	9.7/8.1	6/0	66/84
11	M	26	L	19	16	7.5/6.0	4/0	64/88
12	M	45	L	23	11	7.9/6.4	5/0	73/88
13	M	35	R	11	9	12.7/8.7	7/1	77/82
14	M	38	R	15	21	8.3/5.3	4/0	67/82
15	M	27	L	10	23	10.6/7.8	6/0	73/92
16	M	29	L	35	26	7.8/6.1	3/0	70/89
17	M	37	L	17	20	9.4/8.2	5/0	66/71
Summary (mean $\pm$ SD unless indicated)	17M	32.53 $\pm$ 7.74	8R/9L	18.0 $\pm$ 8.40	21.24 $\pm$ 6.92	9.90 $\pm$ 1.70/7.39 $\pm$ 1.28 (P<.001)	5.59 $\pm$ 1.37/0.29 $\pm$ 0.59 (P<.001)	68.65 $\pm$ 3.87/85.24 $\pm$ 4.96 (P<.001)

Abbreviations: M, male; R, right; SD, standard deviation.

Table 2: Details and Clinical Data of Group 2

Case	Gender	Age (yr)	Side	Premedical Treatment Duration of Symptoms (mo)	Follow-up (mo)	Premedical Treatment/Postmedication Uric Acid Level (mg/dL)	Premedical Treatment/Postmedication Number of Acute Attacks of Gouty Arthritis	Premedical Treatment/Postmedication Lysholm Scale Score
1	M	22	L	25	15	8.9/8.0	6/2	72/77
2	M	25	L	33	17	7.8/6.8	4/2	70/74
3	M	36	L	24	22	12.3/10.1	7/6	64/68
4	M	49	R	10	23	9.2/8.5	5/4	78/82
5	M	29	R	16	32	11.2/9.4	6/4	63/68
6	M	43	L	8	30	10.4/9.1	7/5	64/67
7	M	36	R	13	15	9.6/8.2	4/3	65/69
8	M	39	L	20	21	10.4/7.9	8/5	71/74
9	M	48	R	19	15	9.9/8.4	7/4	75/78
10	M	37	R	16	10	13.0/11.2	9/7	63/65
11	M	34	L	22	12	10.8/9.5	8/4	70/73
12	M	40	R	13	18	7.6/6.4	4/3	74/80
13	M	28	L	32	13	10.9/8.5	6/3	68/70
14	M	31	L	15	20	8.4/7.9	6/4	71/82
15	M	43	R	18	19	7.8/7.0	5/2	76/77
16	M	52	L	21	8	9.4/7.8	7/3	75/79
17	M	44	R	11	21	12.0/10.2	8/5	66/69
18	M	33	R	20	11	11.3/8.8	9/7	69/73
19	M	39	R	26	9	12.1/9.8	8/7	64/66
20	M	29	R	23	13	8.4/6.9	6/4	72/76
21	M	41	R	19	14	8.7/8.1	7/5	73/78
Summary (mean $\pm$ SD unless indicated)	21M	37.05 $\pm$ 8.02	12R/9L	19.24 $\pm$ 6.62	17.05 $\pm$ 6.36	10.0 $\pm$ 1.62/8.5 $\pm$ 1.24 (P<.001)	6.52 $\pm$ 1.54/4.24 $\pm$ 1.58 (P<.001)	69.67 $\pm$ 4.66/73.57 $\pm$ 5.35 (P<.001)

Abbreviations: L, left; M, male; R, right; SD, standard deviation.

3. Surgical Technique

All arthroscopic surgeries are performed by the same surgeon (to avoid unnecessary errors). Patients undergoing arthroscopic surgery will receive arthroscopy, lavage, and

surgical debridement. All the monosodium urate deposition on the cartilage surface were removed with shaver or curette. Drainage tube was used for all the patients immediately and removed one day after operation. The rehabilitation program after knee arthroscopy involves weight-bearing exercises

immediately after surgery according to the patient's tolerance. In the first two weeks after knee arthroscopy, the initial exercises for patients include knee flexion and extension, as well as quadriceps stretching exercises. After two weeks of basic training, patients will gradually transition to partial weight-bearing walking and fitness training. Following four weeks of partial weight-bearing walking exercises, patients will proceed to full weight-bearing walking and sports

activities. During this period, patients also need to undergo adequate postoperative medication therapy [15] and reduce serum uric acid levels to below 5 to 6 mg/dL.

In patients with severe monosodium urate deposition in the right knee joint (Figure 1), after surgically removing the monosodium urate crystal deposits, an uneven cartilage surface can be observed.

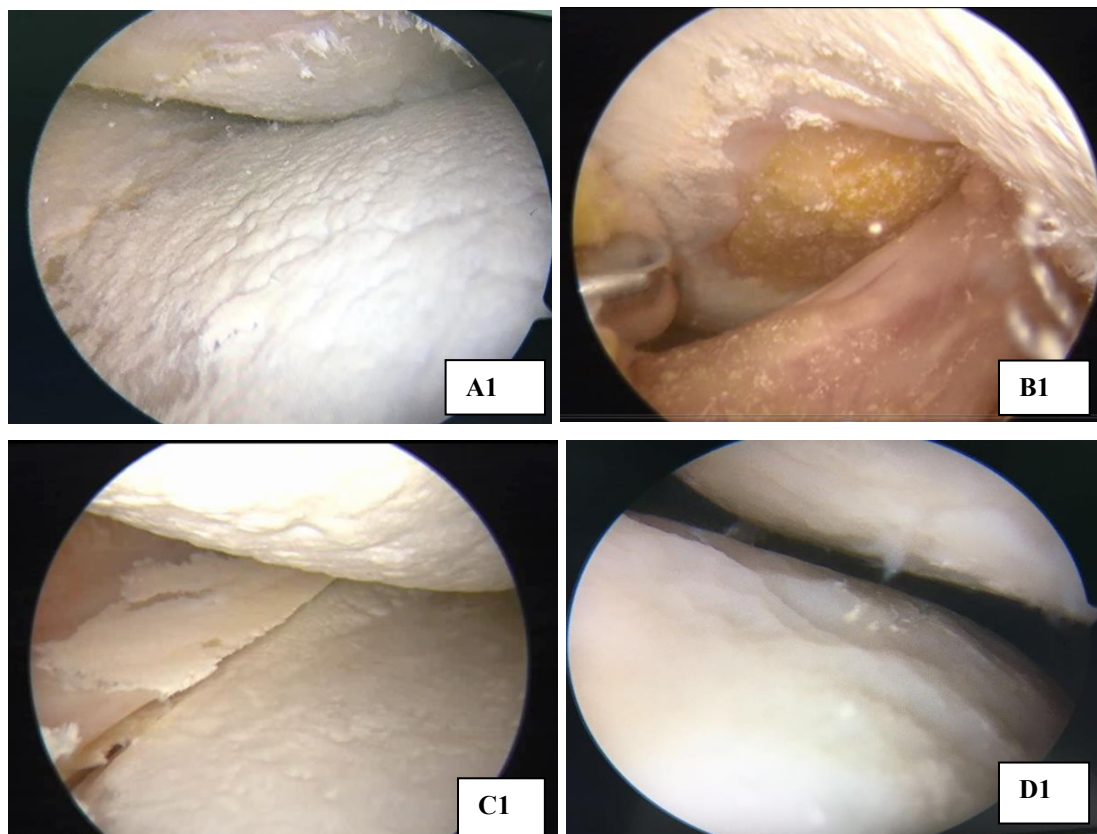


Figure 1: (A1, B1, C1) Where the red arrow points, lots of white crystalline material on the articular surface within the knee joint noted under arthroscopy. Arthroscopic examination of joints affected by gout reveals a white, nodular, chalky appearance. Gout stones adhere to ligaments and synovial tissues, meniscal surfaces. (D1) The articular cartilage surface was eroded by urate crystallizes and after removing, it can be found that the cartilage surface was uneven.

4. Function Evaluation and Data Analysis

When continuous variable data are normally distributed, they are represented by the mean. The frequency of acute knee gout attacks and the Lysholm scale scores were assessed by independent observers, and the outcomes were analyzed by personnel not involved in the study. A parametric paired-sample t-test was used to compare uric acid levels, the frequency of acute gout attacks, and Lysholm scale scores before and after treatment. The independent sample t-test was used to analyze differences in posttreatment number of acute attacks and Lysholm scale scores between the two patient groups. Statistical analysis was performed with the SPSS software package (version 30.0; SPSS, Chicago, IL, USA). $P < 0.05$ was considered statistically significant.

Patients were retrospectively followed up from the time of entry in the case records at first visit till the time of discharge from clinic. Case records were traced to check for two key outcomes in the patient: the occurrence of similar symptoms after discharge and the need for further surgery subsequent to this knee surgery. Study participants then received an assessment at the conclusion of their follow-up.

5. Results

The average uric acid level in the surgical treatment group (Group 1) decreased significantly (9.90 ± 1.70 mg/dL vs. 7.39 ± 1.28 mg/dL; $P < 0.001$), and the same was observed in the medication treatment group (Group 2) (10.0 ± 1.62 mg/dL vs. 8.5 ± 1.24 mg/dL; $P < 0.001$). After treatment, the average number of acute gouty arthritis attacks in the surgical treatment group (Group 1) decreased significantly (5.59 ± 1.37 vs. 0.29 ± 0.59 ; $P < 0.001$), and the medication treatment group (Group 2) also showed a significant decrease (6.52 ± 1.54 vs. 4.24 ± 1.58 ; $P < 0.001$). The average Lysholm scale score in the surgical treatment group (Group 1) increased significantly (68.65 ± 3.87 vs. 85.24 ± 4.96 ; $P < 0.001$), and the medication treatment group (Group 2) also showed a significant improvement (69.67 ± 4.66 vs. 73.57 ± 5.35 ; $P < 0.001$). All patients' Lysholm scale scores were improved in group 1 at the final follow-up. However, in the short term after surgery, there are also symptoms appearing worse: two patients had no improved for pain and had to take dexamethasone for one week after surgery; one patient felt more pain and knee restriction, second-look arthroscopy examination found

cartilage lesion (Fig 2), this patient continued to undergo microfracture surgery and had a good postoperative recovery.

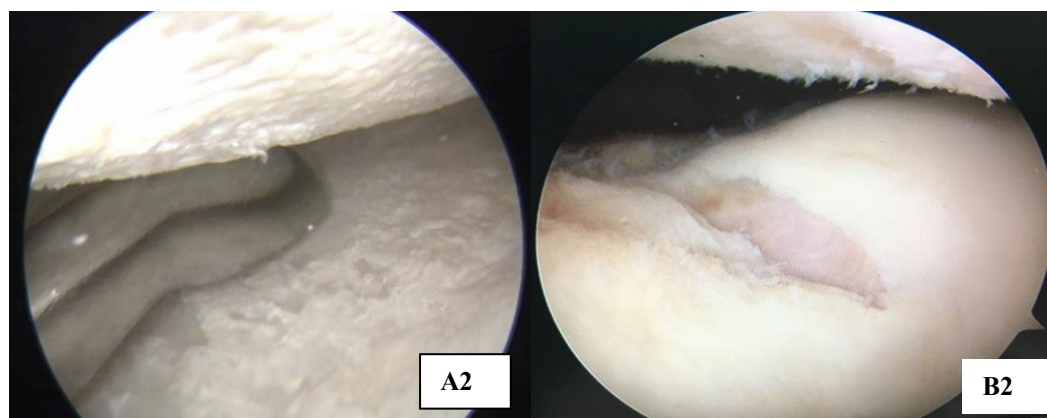


Figure 2: (A2) A large number of gout stones on the surface of the articular surface are visible before arthroscopic surgery. (B2) Secondary arthroscopic exploration found articular cartilage surface was partially exfoliated

Intergroup comparison showed that the mean reduction in the frequency of acute attacks of gouty arthritis in the surgical treatment group (Group 1) was significantly greater than that in the medication treatment group (Group 2) (5.29 ± 1.21 vs. 2.29 ± 1.01 ; $P < 0.001$). Similarly, the mean increase in Lysholm scale scores in the surgical treatment group (Group 1) was also significantly higher than that in the medication treatment group (Group 2) (16.59 ± 5.73 vs. 3.90 ± 2.02 ; $P < 0.001$).

6. Discussion

Gout is primarily caused by the deposition of monosodium urate crystals around the joints, which leads to severe pain and affects the patient's quality of life. However, the underlying mechanisms behind gout-related pain remain unclear [16]. From a biochemical perspective, the saturation of urate in the extracellular fluid causes gout, a condition that usually ultimately manifests as hyperuricemia. Hyperuricemia is characterized by urate concentrations in plasma or serum exceeding 6.8 mg/dL, which is approximately 400 $\mu\text{mol/L}$ [17]. Gout is caused by hyperuricemia, which is why it can occur in many organs. For instance, 17% of patients experience gout in the spine [18]. Of course, most cases of gout still involve the distal joints of the lower limbs [19]. The characteristic of gouty arthritis is the deposition of monosodium urate crystals in the synovial fluid and joint areas, which are what needs to be removed during arthroscopy [20]. Up to now, the clinical use of medicinal agents usually led to undesirable side effects [21]. In *Pakorn Chawanpaiboon* et al.'s [22] study, A patient with knee gout underwent arthroscopic removal of a bony nodule in the intercondylar notch and a large central bony protrusion that prevented full knee extension. One year later, the patient showed significant improvement, and joint function was greatly restored.

Gout is relatively complex. In itself, gout often causes acute attacks in a single joint, leading to heat, redness, swelling, and tenderness around the joint [23, 24]. Besides gout, hyperuricemia is also closely associated with hypertension, diabetes, and dyslipidemia, and it also affects the increased mortality risk in the general population and patients with cardiovascular diseases [25, 26]. In addition, the data from *Yujie Shi* and others also demonstrate that hyperuricemia is closely related to insulin resistance [27]. Among the common

complications of obesity in children and adolescents, hyperuricemia is also included. Patients with obesity and type 2 diabetes also have a close relationship with gout [28]. Therefore, for adolescents and children, losing weight is an essential step in controlling hyperuricemia [29–31]. The occurrence of gout is not only related to hyperuricemia, but is also influenced by various factors such as genetics, environment, and lifestyle, among which elevated serum monosodium urate levels are an important risk factor for gout attacks [32]. Gout is not only characterized by acute pain attacks; more seriously, prolonged hyperuricemia can lead to the formation of tophi, which often indicates that gout has entered a more prolonged chronic phase. Tophi are also an important manifestation of chronic gout [23]. The formation of gout stones further worsens the damage caused by gout to the joint areas, leading to impaired joint function in patients.

In our research, diet control was included in the treatment. For the urinary acid crystal on the surface of the cruciate ligament and meniscus needs to be completely removed during surgery. However, for the uric acid crystals within the parenchymal, it does not need to be completely removed, because it will damage the normal structure, only need to properly clean. Simultaneous removal of inflammatory synovial tissue Before the end of surgery, the joint cavity needs to be flushed with a large amount of physiological saline so that free urate crystals can be discharged as much as possible.

In this study, one patient had pain and increased mobility restriction after knee arthroscopy and drug treatment was invalid. We performed a second surgical exploration and found that the cartilage of the articular surface was damaged and considered to be iatrogenic. Although the patient recovered well after microfracture surgery, this complication needs to be noticed by the operator. We also found that the health education of patients was beneficial to the recovery of patients' postoperative knee function.

Studies have shown that surgical removal of gouty tophi in the wrist joint can not only improve the joint's functionality and enhance local aesthetics, but also reduce the occurrence of complications and the recurrence of gout [33]. Arthroscopy to remove urate deposits can effectively reduce patients' uric acid levels, improve joint function, and relieve pain. Combined with diet and medication, arthroscopy can effectively control the recurrence of gouty arthritis, making it

a viable option for treating gouty arthritis [34]. The above literature is consistent with our findings. Although drugs for gouty knee arthritis are effective in this study. But our data further shows that the removal of urate crystals directly leads to a further reduction in the number of gout attacks and further improvement of knee function.

7. Conclusions

Arthroscopic removal of gout crystals in the knee joint, compared with simply using uric acid-lowering and anti-inflammatory drugs, can significantly reduce the frequency of acute gout attacks and improve knee joint function. Removing monosodium urate deposits in the knee joint through arthroscopy can reduce the recurrence of gout. Of course, we should also be aware of iatrogenic cartilage damage and place greater emphasis on patient health education.

Declarations

Competing interests All other authors declare that there are no competing interest.

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Authors' contributions Jiangnan Sun participated in the writing of the paper and data analysis, Shanshan Li was involved in data collection and analysis, and Haifeng Huang took part in the study design and data analysis.

Ethics Approval and Patient Consent All information was obtained with the patient's informed consent.

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References

- [1] Punzi L, Galozzi P, Luisetto R, Scanu A, Ramonda R, Oliviero F (2024) Gout: one year in review 2023. *Clin Exp Rheumatol* 42:1–9
- [2] Yuan W, Liu T, Wang Y-Y, He S, Zhang F, Wang X-B, Deng S-H, Zhang T, Wu D-M, Xu Y (2023) Autophagy induced by PP121 alleviates MSU crystal-induced acute gouty arthritis via inhibition of the NLRP3 inflammasome. *Int Immunopharmacol* 123:110756
- [3] Timsans J, Palomäki A, Kauppi M (2024) Gout and Hyperuricemia: A Narrative Review of Their Comorbidities and Clinical Implications. *J Clin Med* 13:7616
- [4] Zou F, Li X, Yang R, Zhang R, Zhao X (2022) Effects and underlying mechanisms of food polyphenols in treating gouty arthritis: A review on nutritional intake and joint health. *J Food Biochem* 46:e14072
- [5] Zhou X, Liu K, Shi C, Zhang M, Liu S, Hou C, Di B (2024) Estimation of the spatial pattern of gout prevalence across China by wastewater-based epidemiology. *Sci Total Environ* 924:171565
- [6] FitzGerald JD (2025) Gout. *Ann Intern Med* 178: ITC33–ITC48
- [7] Ren J, Yan X, Zeng S, Wu J, Cao S, Luo Y, Zhang W, Hu W, Huang X, Zhou Y (2025) Multiple comorbidities and economic burden of hospitalized gout patients in Guangdong Province. *Clin Rheumatol* 44:4637–4645
- [8] GBD 2021 Gout Collaborators (2024) Global, regional, and national burden of gout, 1990–2020, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. *Lancet Rheumatol* 6:e507–e517
- [9] Terkeltaub R (2023) Emerging Urate-Lowering Drugs and Pharmacologic Treatment Strategies for Gout: A Narrative Review. *Drugs* 83:1501–1521
- [10] Ahn EY, So MW (2025) The pathogenesis of gout. *J Rheum Dis* 32:8–16
- [11] Satti LR, Mootha AK, Bajjangi US, Gundu G (2023) Atypical Presentation of Gouty Tophus as Posterior Cruciate Ligament Cyst: A Case Report. *J Orthop Case Rep* 13:89–92
- [12] Du L, Zong Y, Li H, Wang Q, Xie L, Yang B, Pang Y, Zhang C, Zhong Z, Gao J (2024) Hyperuricemia and its related diseases: mechanisms and advances in therapy. *Signal Transduct Target Ther* 9:212
- [13] Liu S, Sun H, Yang S, Liang N, Gao Y, Qu S, Chen H (2024) Clustering of gout-related comorbidities and their relationship with gout flares: a data-driven cluster analysis of eight comorbidities. *J Endocrinol Invest* 47:1119–1128
- [14] Boedijono DR, Nugroho A, Handidwiono R, Prasetyo J (2024) Gout arthritis of the ankle successfully treated with arthroscopic debridement: A case report. *Int J Surg Case Rep* 122:110066
- [15] Dalbeth N, Te Karu L, Stamp LK (2024) Gout and its management. *Intern Med J* 54:716–723
- [16] Yin C, Liu B, Li Y, et al (2020) IL-33/ST2 induces neutrophil-dependent reactive oxygen species production and mediates gout pain. *Theranostics* 10:12189–12203
- [17] Afzal M, Rednam M, Gujarathi R, Widrich J (2025) Gout. *StatPearls*
- [18] Mercken K, Valgaeren B, Noppe N (2025) Spinal gout in gouty polyarthropathy. *Skeletal Radiol*. <https://doi.org/10.1007/s00256-025-04983-6>
- [19] Coulibaly AK, Henchiri I, Meunier M, Saint-Marcoux B (2024) Inaugural cervical spinal location of gout: A case report. *Radiol Case Rep* 19:5238–5240
- [20] Iyer SS, Seo S-H, Iyer S (2025) Serendipitous Manifestation of Intra-abdominal Mass Leading to Primary Gout Diagnosis: A Case Report. *Cureus* 17:e89735
- [21] Ren S, Meng F, Liu Y, Meng Y, Tao N, Liu R, Zhang J (2020) Effects of external application of compound Qingbi granules on acute gouty arthritis with dampness-heat syndrome: a randomized controlled trial. *Chin Med* 15:117
- [22] Chawanpaiboon P, Voravitvet S, Juntharamussakarn C, Ganokroj P (2025) Arthroscopic Treatment of Extension Block in the Knee Caused by Gouty Tophi: A Case Report. *JBJS Case Connect*. <https://doi.org/10.2106/JBJS.CC.25.00231>
- [23] Udongwo NE, Odak M, AlBayati A, Zheng M, Tang X (2021) Unusual Subacute Interphalangeal Tophaceous Gouty Arthritis. *Cureus* 13:e13732
- [24] Zeng D, Yin C, Wei H, et al (2024) Activation of Nrf2 antioxidant signaling alleviates gout arthritis pain and

- inflammation. *Biomed Pharmacother Biomedecine Pharmacother* 170:115957
- [25] Nakahashi T, Tada H, Sakata K, Takamura M (2025) Gout, Uric Acid, and Coronary Artery Disease. *J Atheroscler Thromb*. <https://doi.org/10.5551/jat.RV22043>
- [26] Dalbeth N, Mihov B, Stewart A, Gamble GD, Merriman TR, Mount D, Reid IR, Stamp LK, Horne A (2022) Effects of elevated serum urate on cardiometabolic and kidney function markers in a randomised clinical trial of inosine supplementation. *Sci Rep* 12:12887
- [27] Shi Y, Zhang Z, Yang J, Cui S (2025) The association between insulin resistance-related markers and ASCVD with hyperuricemia: results from the 2005 to 2018 National Health and Nutrition Examination Survey. *Front Cardiovasc Med* 12:1583944
- [28] Cai N, Chen M, Feng P, Zheng Q, Zhu X, Yang S, Zhang Z, Wang Y (2024) Relationships between obesity and prevalence of gout in patients with type 2 diabetes mellitus: a cross-sectional population-based study. *BMC Endocr Disord* 24:137
- [29] Niu Y, Zhang Y, Sheng J, Feng Y, Tang Q, Shen X (2025) Triponderal mass index can be used as a potential tool to predict the risk of hyperuricemia in children and adolescents with obesity: a population-based study. *Front Nutr* 12:1544209
- [30] Fritz J, Brozek W, Concin H, Nagel G, Kerschbaum J, Lhotta K, Ulmer H, Zitt E (2022) The Association of Excess Body Weight with Risk of ESKD Is Mediated Through Insulin Resistance, Hypertension, and Hyperuricemia. *J Am Soc Nephrol JASN* 33:1377–1389
- [31] Piché M-E, Tchernof A, Després J-P (2020) Obesity Phenotypes, Diabetes, and Cardiovascular Diseases. *Circ Res* 126:1477–1500
- [32] Tang D, Jiang Y, Ling G, Zhang J, Xie J (2025) Case report: Gouty renal abscess and gouty sacroiliitis associated with genetic variants of a young woman. *Front Med* 12:1509018
- [33] Doscher M, Beutel BG, Lovy A, Alba B, Melone C (2022) En Masse Excision and Curettage for Periarticular Gouty Tophi of the Hands. *Eplasty* 22:e25
- [34] Lv W, Li X, Chen J, Shen D (2025) Clinical observations on arthroscopic removal of urate deposits in the knee: a seven-case series. *Eur J Orthop Surg Traumatol Orthop Traumatol* 35:268