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Original Research Article

Comparative Effectiveness of Surgical versus Conservative Management of Knee Osteoarthritis

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Abstract

Background: Knee osteoarthritis (KOA) represents a leading cause of chronic musculoskeletal disability worldwide, with management strategies ranging from conservative approaches including pharmacotherapy and physical rehabilitation to surgical interventions such as arthroscopy and total knee arthroplasty (TKA). Despite extensive clinical experience with both modalities, comparative evidence regarding their long-term effectiveness across varying disease severities remains incomplete and frequently contested.

Methods: This prospective comparative cohort study enrolled 324 patients diagnosed with symptomatic KOA (Kellgren-Lawrence grades II–IV) at a university-affiliated orthopedic center. Patients were allocated to surgical management (n = 158; arthroscopic debridement or TKA) or conservative management (n = 166; structured physical therapy, pharmacological intervention, and intra-articular injections). Primary outcomes included changes in the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total score and visual analog scale (VAS) pain scores at 6 and 12 months. Secondary outcomes encompassed functional mobility assessed via the Timed Up and Go (TUG) test, patient satisfaction, and complication rates.

Results: At 12 months, the surgical group demonstrated significantly greater improvement in WOMAC total scores (−28.4 ± 11.6 vs. −14.7 ± 9.8; $p < 0.001$) and VAS pain reduction (−4.2 ± 1.8 vs. −2.1 ± 1.5; $p < 0.001$). However, subgroup analysis revealed that patients with Kellgren-Lawrence grade II showed comparable outcomes between groups ($p = 0.214$). The surgical group experienced a 12.0% complication rate versus 3.6% in the conservative group ($p = 0.005$). Patient satisfaction was high in both groups (87.3% vs. 74.1%; $p = 0.003$).

Conclusion: Surgical management of KOA yields superior pain relief and functional outcomes compared to conservative treatment, particularly in advanced disease stages. However, conservative management demonstrates comparable effectiveness in mild-to-moderate disease with significantly fewer complications, supporting a severity-guided treatment algorithm.

Keywords: Knee Osteoarthritis; Total Knee Arthroplasty; Conservative Management; Physical Therapy; WOMAC; comparative effectiveness.

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Introduction

Knee osteoarthritis is the most prevalent degenerative joint disorder globally, affecting an estimated 365 million individuals and constituting a significant burden on healthcare systems and individual quality of life [1]. The disease is characterized by progressive degradation of articular cartilage, subchondral bone remodeling, synovial inflammation, and osteophyte formation, culminating in pain, stiffness, functional limitation, and reduced mobility [2]. With the aging global population and rising obesity prevalence, the incidence and socioeconomic impact of KOA are projected to increase substantially over the coming decades [3].

Management of KOA encompasses a broad therapeutic spectrum. Conservative approaches include patient education, weight management, structured exercise and physical therapy programs, nonsteroidal anti-inflammatory drugs (NSAIDs), analgesics, and intra-articular injections of corticosteroids or hyaluronic acid [4]. These modalities are generally recommended as first-line interventions across major clinical practice guidelines, including those published by the

American Academy of Orthopaedic Surgeons (AAOS) and the Osteoarthritis Research Society International (OARSI) [5]. Surgical interventions, particularly total knee arthroplasty, are typically reserved for patients with advanced disease who have failed to respond adequately to conservative measures, representing the definitive treatment for end-stage KOA [6].

Total knee arthroplasty has demonstrated excellent long-term outcomes in appropriately selected patients, with reported survivorship rates exceeding 90% at 15 years and significant improvements in pain, function, and health-related quality of life [7]. However, TKA is associated with notable perioperative risks including thromboembolic events, surgical site infection, periprosthetic fracture, and prolonged rehabilitation requirements [8]. Arthroscopic interventions, including debridement and lavage, have been subjected to considerable scrutiny following landmark trials demonstrating limited benefit over sham surgery or conservative care for degenerative knee conditions [9].

Conversely, conservative management, while safer and less invasive, may provide insufficient symptom relief in patients with advanced structural damage, and long-term adherence to exercise programs and lifestyle modifications remains a persistent challenge [10]. Recent meta-analyses have highlighted the heterogeneity of conservative treatment protocols and the difficulty in standardizing comparisons with surgical outcomes [11]. Furthermore, the optimal timing for transitioning from conservative to surgical management remains an area of active debate, with evidence suggesting that both premature and delayed surgical intervention may lead to suboptimal outcomes [12].

Despite the substantial body of literature addressing individual treatment modalities, direct prospective comparisons between comprehensive conservative management programs and surgical interventions across the full spectrum of disease severity remain relatively scarce [13]. The majority of existing comparative studies have focused exclusively on either arthroscopy versus physical therapy in mild disease or TKA versus continued conservative care in severe disease, without integrating these comparisons within a unified analytical framework [14].

The aim of this study was to prospectively compare the clinical effectiveness, functional outcomes, patient satisfaction, and complication rates of surgical versus conservative management of knee osteoarthritis across Kellgren-Lawrence grades II through IV over a 12-month follow-up period.

Materials and Methods

Study Design and Setting: This prospective, non-randomized comparative cohort study was conducted at the Department of Orthopedic.

Study Population and Allocation: Adult patients aged 45 to 80 years diagnosed with primary symptomatic KOA confirmed by clinical examination and weight-bearing anteroposterior knee radiographs were screened for eligibility. Inclusion criteria comprised Kellgren-Lawrence (KL) radiographic grades II, III, or IV, symptom duration of at least 6 months, and failure of initial pharmacological management (at least 4 weeks of oral analgesic therapy). Exclusion criteria included inflammatory arthropathies (rheumatoid arthritis, gout, or psoriatic arthritis), prior knee surgery on the index joint, severe cardiopulmonary comorbidities precluding surgical candidacy, body mass index (BMI) exceeding 45 kg/m², concurrent ipsilateral hip pathology, and neurological conditions affecting lower extremity function.

Treatment allocation was based on shared clinical decision-making between the treating orthopedic surgeon and the patient. Patients electing surgical management underwent either arthroscopic debridement (for KL grade II–III with predominant mechanical symptoms) or total knee arthroplasty (for KL grade III–IV with refractory symptoms). Patients opting for conservative management received a standardized multimodal protocol.

Intervention Protocols

Surgical Group: Patients undergoing arthroscopic debridement received standardized meniscal and chondral debridement, synovectomy, and lavage under regional or general anesthesia. TKA patients received cemented posterior-stabilized prostheses through a medial parapatellar approach. Standardized postoperative rehabilitation protocols were implemented for both subgroups, including early mobilization, progressive strengthening exercises, and functional training.

Conservative Group: The conservative protocol consisted of a 12-week supervised physical therapy program (three sessions per week) incorporating quadriceps strengthening, range of motion exercises, proprioceptive training, and aerobic conditioning. Pharmacological management included acetaminophen (up to 3 g/day) and/or NSAIDs as tolerated. Intra-articular corticosteroid injections (40 mg methylprednisolone acetate) were administered at baseline and at 6 months if clinically indicated. Weight management counseling and home exercise programs were provided to all participants.

Outcome Measures: The primary outcome measure was the change in the Western Ontario and

McMaster Universities Osteoarthritis Index (WOMAC) total score from baseline to 12 months. The WOMAC comprises 24 items across three subscales: pain (5 items), stiffness (2 items), and physical function (17 items), scored on a Likert scale from 0 to 96, with higher scores indicating greater severity. The secondary primary outcome was the change in pain severity measured by a 10-cm visual analog scale (VAS).

Secondary outcomes included the Timed Up and Go (TUG) test for functional mobility, patient global satisfaction (assessed via a 5-point Likert scale, dichotomized as satisfied or not satisfied), and complication rates. Assessments were performed at baseline, 6 months, and 12 months by a blinded physiotherapist.

Sample Size Estimation: Based on pilot data and prior literature, a minimum clinically important difference (MCID) of 10 points in WOMAC total score was targeted, with an assumed standard deviation of 15 points. Using a two-sided alpha of 0.05 and 80% power, a minimum of 142 patients per group was required. Accounting for a 15% attrition rate, 168 patients per group were targeted.

Statistical Analysis: Continuous variables were summarized as mean ± standard deviation and compared using independent samples t-tests or Mann-Whitney U tests based on normality assessment via the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages and compared using chi-square tests or Fisher's exact tests. Within-group changes from baseline were analyzed using paired t-tests. Subgroup analyses were performed by KL grade. Analysis of covariance (ANCOVA) was employed to adjust for baseline differences in age, BMI, and disease severity. Statistical significance was established at $p < 0.05$ (two-tailed). All analyses were performed using SPSS version 28.0 (IBM Corp., Armonk, NY, USA) and R version 4.2.1.

Results

Baseline Characteristics: Of 374 patients initially screened, 324 met the inclusion criteria and completed the 12-month follow-up (surgical group: n = 158; conservative group: n = 166; overall retention: 86.6%). Baseline demographic and clinical characteristics are presented in Table 1. The groups were comparable regarding age, sex distribution, and symptom duration. However, the surgical group had a significantly higher proportion of patients with KL grade IV disease (38.0% vs. 12.0%; $p < 0.001$) and marginally higher baseline WOMAC scores (58.2 ± 14.3 vs. 49.6 ± 13.1; $p < 0.001$).

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Surgical Group (n = 158)	Conservative Group (n = 166)	p-value
Age (years), mean ± SD	64.8 ± 8.2	62.5 ± 7.9	0.011
Female sex, n (%)	94 (59.5)	104 (62.7)	0.557
BMI (kg/m²), mean ± SD	30.4 ± 4.6	29.1 ± 4.3	0.009
Symptom duration (years), mean ± SD	5.8 ± 3.2	4.9 ± 2.8	0.008
KL Grade II, n (%)	28 (17.7)	72 (43.4)	< 0.001
KL Grade III, n (%)	70 (44.3)	74 (44.6)	0.956
KL Grade IV, n (%)	60 (38.0)	20 (12.0)	< 0.001
Baseline WOMAC total, mean ± SD	58.2 ± 14.3	49.6 ± 13.1	< 0.001
Baseline VAS pain, mean ± SD	7.1 ± 1.4	6.2 ± 1.6	< 0.001
Baseline TUG (seconds), mean ± SD	14.8 ± 4.2	12.6 ± 3.5	< 0.001
Diabetes mellitus, n (%)	34 (21.5)	28 (16.9)	0.282
Hypertension, n (%)	72 (45.6)	68 (41.0)	0.396

Primary and Secondary Outcomes: Table 2 presents the clinical outcome measures at 6 and 12 months. Both groups demonstrated significant within-group improvements from baseline across all outcome measures (all $p < 0.001$). At 12 months, the surgical group showed significantly greater improvement in WOMAC total score change (−28.4 ± 11.6 vs. −14.7 ± 9.8; $p < 0.001$), VAS pain reduction (−4.2 ± 1.8 vs. −2.1 ± 1.5; $p < 0.001$), and TUG improvement (−5.6 ± 2.9 vs. −2.8 ± 2.1; $p < 0.001$). After ANCOVA adjustment for baseline differences in age, BMI, KL grade, and baseline scores, the between-group differences remained statistically significant for all primary outcomes (adjusted $p < 0.001$).

Table 2: Clinical Outcomes at 6 and 12 Months

Outcome Measure	Surgical Group (n = 158)	Conservative Group (n = 166)	p-value
6-Month Outcomes			
WOMAC total change, mean ± SD	−22.1 ± 12.4	−11.3 ± 8.6	< 0.001
VAS pain change, mean ± SD	−3.4 ± 1.9	−1.7 ± 1.3	< 0.001
TUG change (seconds), mean ± SD	−4.1 ± 2.7	−1.9 ± 1.8	< 0.001
12-Month Outcomes			
WOMAC total change, mean ± SD	−28.4 ± 11.6	−14.7 ± 9.8	< 0.001
VAS pain change, mean ± SD	−4.2 ± 1.8	−2.1 ± 1.5	< 0.001
TUG change (seconds), mean ± SD	−5.6 ± 2.9	−2.8 ± 2.1	< 0.001
WOMAC final score, mean ± SD	29.8 ± 12.1	34.9 ± 11.4	< 0.001
Patient satisfaction (satisfied), n (%)	138 (87.3)	123 (74.1)	0.003

Subgroup Analysis and Complications: Subgroup analysis by KL grade revealed important differential treatment effects. Among patients with KL grade II disease, no statistically significant difference in WOMAC total score change was observed between groups (−16.2 ± 8.4 vs. −13.8 ± 7.9; p = 0.214). Conversely, significant between-group differences favoring surgery were observed in KL grade III (−27.6 ± 10.8 vs. −15.2 ± 9.4; p < 0.001) and KL grade IV patients (−34.8 ± 11.2 vs. −12.1 ± 10.6; p < 0.001). Complications and adverse events are detailed in Table 3.

Table 3: Complications and Adverse Events by Treatment Group

Complication	Surgical Group (n = 158), n (%)	Conservative Group (n = 166), n (%)	p-value
Any complication	19 (12.0)	6 (3.6)	0.005
Surgical site infection	5 (3.2)	—	—
Deep vein thrombosis	3 (1.9)	—	—
Joint stiffness requiring MUA	4 (2.5)	—	—
Periprosthetic fracture	1 (0.6)	—	—
Wound dehiscence	2 (1.3)	—	—
Hemarthrosis	2 (1.3)	—	—
Persistent joint effusion	2 (1.3)	2 (1.2)	0.944
Gastrointestinal adverse events (NSAID)	—	4 (2.4)	—
Reoperation/revision at 12 months	3 (1.9)	—	—
Crossover to surgery	—	14 (8.4)	—

Notably, 14 patients (8.4%) in the conservative group crossed over to surgical intervention during the follow-up period, predominantly those with KL grade III–IV disease (12 of 14 crossover patients). These patients were analyzed in their original allocated group per the intention-to-treat principle.

Discussion

The present study provides prospective comparative evidence demonstrating that surgical management of knee osteoarthritis confers significantly greater improvements in pain, functional status, and patient satisfaction compared to structured conservative management over a 12-month follow-up period. However, the critical finding that these differences are substantially attenuated in patients with mild-to-moderate radiographic disease severity (KL grade II) carries important implications for clinical decision-making and treatment algorithm design.

The magnitude of improvement observed in the surgical group, with a mean WOMAC reduction of 28.4 points, is consistent with outcomes reported in large registry studies and randomized controlled trials evaluating TKA effectiveness. Skou et al. demonstrated in a landmark randomized trial that TKA followed by non-surgical treatment resulted in significantly greater improvement than non-surgical treatment alone in patients with moderate-to-severe KOA, with a between-group difference of 13.4 points on the KOOS pain subscale at 12 months [15]. Our observed between-group difference of 13.7 points in WOMAC total score aligns closely with these findings, reinforcing the clinical meaningfulness of the surgical advantage in this population.

The comparable outcomes between surgical and conservative management in KL grade II patients are particularly noteworthy and consistent with evolving evidence questioning the role of surgical intervention in early disease. The landmark METEOR trial by Katz et al. demonstrated that arthroscopic partial meniscectomy offered no significant advantage over physical therapy in patients with knee osteoarthritis and meniscal tears, particularly those without mechanical locking [16]. Similarly, the Finnish Degenerative Meniscal Lesion Study (FIDELITY) confirmed that

arthroscopic surgery provided no clinically meaningful benefit over sham surgery for degenerative meniscal tears [17]. These findings collectively support the prioritization of conservative management in early-stage KOA.

The conservative treatment protocol employed in this study, incorporating structured physical therapy, pharmacological management, and intra-articular injections, produced meaningful clinical improvements across all disease stages. The mean WOMAC reduction of 14.7 points in the conservative group exceeds the commonly cited MCID of 10 points, indicating clinically relevant benefit [18]. These improvements are consistent with systematic reviews demonstrating moderate-to-large effect sizes for exercise therapy in KOA, particularly when programs incorporate both strengthening and aerobic components delivered under supervised conditions [19].

The higher complication rate in the surgical group (12.0% vs. 3.6%) underscores the inherent risks associated with operative intervention and emphasizes the importance of appropriate patient selection. The observed surgical complication profile, including surgical site infection (3.2%), deep vein thrombosis (1.9%), and joint stiffness requiring manipulation under anesthesia (2.5%), is consistent with published institutional and registry data [20]. The crossover rate of 8.4% from conservative to surgical management, predominantly among patients with advanced disease, reflects the recognized trajectory of progressive disease in which conservative measures may become insufficient [21].

Patient satisfaction was significantly higher in the surgical group (87.3% vs. 74.1%), a finding that may reflect the greater magnitude of symptom improvement achieved. However, the 74.1% satisfaction rate in the conservative group is notable and suggests that well-structured non-operative programs can meet patient expectations in a substantial proportion of cases. Previous studies have identified baseline pain severity, realistic expectation management, and shared decision-making as key determinants of treatment satisfaction in KOA [22].

Several limitations of this study warrant consideration. The non-randomized design introduces the possibility of selection bias, as patients electing surgery may differ systematically from those choosing conservative care in ways not fully captured by measured covariates. The significant baseline differences in disease severity between groups, while statistically adjusted, may influence outcome interpretation. The 12-month follow-up period, while adequate for assessing intermediate-term outcomes, is insufficient for evaluating long-term prosthetic survivorship, late complications, or sustained conservative treatment effects. Additionally, the single-center design may limit generalizability across different healthcare systems and patient populations [23]. Future multicenter randomized controlled trials with extended follow-up periods and health-economic analyses would provide more definitive evidence to guide severity-stratified treatment recommendations [24].

Conclusion

This study demonstrates that surgical management of knee osteoarthritis provides superior pain relief, functional improvement, and patient satisfaction compared to comprehensive conservative management at 12-month follow-up, particularly among patients with moderate-to-severe radiographic disease (Kellgren-Lawrence grades III and IV). However, in patients with mild-to-moderate disease (Kellgren-Lawrence grade II), conservative management achieves comparable clinical outcomes with a substantially lower complication burden. These findings support a severity-guided, stepwise treatment paradigm in which structured conservative management should be optimized as the initial approach for early-to-moderate KOA, with surgical intervention reserved for patients with advanced structural disease or those who demonstrate inadequate response to comprehensive non-operative care. The integration of radiographic severity, symptom burden, patient preferences, and comorbidity profiles into individualized treatment algorithms is essential for optimizing outcomes and resource utilization in this highly prevalent condition.

References

1. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393(10182):1745–1759. DOI: 10.1016/S0140-6736(19)30417-9. PMID: 31034380.
2. Loeser RF, Goldring SR, Scanzello CR, Goldring MB. Osteoarthritis: a disease of the joint as an organ. Arthritis Rheum. 2012;64(6): 1697–1707. DOI: 10.1002/art.34453. PMID: 22392533.
3. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: estimates from the Global Burden of Disease 2010 study. Ann Rheum Dis. 2014;73(7):1323–1330. DOI: 10.1136/annrheumdis-2013-204763. PMID: 24553908.
4. Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis Cartilage. 2019;2 7(11):1578–1589. DOI: 10.1016/j.joca.2019. 06.011. PMID: 31278997.

5. Kolasinski SL, Neogi T, Hochberg MC, Oatis C, Guyatt G, Block J, et al. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. Arthritis Care Res (Hoboken). 2020;72(2):149–162. DOI: 10.1002/acr.24131. PMID: 31908163.
6. Price AJ, Alvand A, Troelsen A, Katz JN, Hooper G, Gray A, et al. Knee replacement. Lancet. 2018;392(10158):1672–1682. DOI: 10.1016/S0140-6736(18)32344-4. PMID: 30496082.
7. Evans JT, Walker RW, Evans JP, Blom AW, Sayers A, Whitehouse MR. How long does a knee replacement last? A systematic review and meta-analysis of case series and national registry reports with more than 15 years of follow-up. Lancet. 2019;393(10172):655–663. DOI: 10.1016/S0140-6736(18)32531-5. PMI D: 30782341.
8. Parvizi J, Zmistowski B, Berbari EF, Bauer TW, Springer BD, Della Valle CJ, et al. New definition for periprosthetic joint infection: from the Workgroup of the Musculoskeletal Infection Society. Clin Orthop Relat Res. 2011;469(11):2992–2994. DOI: 10.1007/ s11999-011-2102-9. PMID: 21938532.
9. Moseley JB, O'Malley K, Petersen NJ, Menke TJ, Brody BA, Kuykendall DH, et al. A controlled trial of arthroscopic surgery for osteoarthritis of the knee. N Engl J Med. 2002;347(2):81–88. DOI: 10.1056/NEJMoa0 13259. PMID: 12110735.
10. Marks R. Knee osteoarthritis and exercise adherence: a review. Curr Aging Sci. 2012;5(1):72–83. DOI: 10.2174/18746 09811205010072. PMID: 21834789.
11. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br J Sports Med. 2015;49(24):1554–1557. DOI: 10.1136/bjspo rts-2015-095424. PMID: 26405113.
12. Ackerman IN, Bohensky MA, Zomer E, Tacey M, Gorelik A, Brand CA, et al. The projected burden of primary total knee and hip replacement for osteoarthritis in Australia to the year 2030. BMC Musculoskelet Disord. 2019;20(1):90. DOI: 10.1186/s12891-019-2411-9. PMID: 30797228.
13. Thorlund JB, Juhl CB, Roos EM, Lohmander LS. Arthroscopic surgery for degenerative knee: systematic review and meta-analysis of benefits and harms. BMJ. 2015;350:h2747. DOI: 10.1136/bmj.h2747. PMID: 26080045.
14. Kise NJ, Risberg MA, Stensrud S, Ranstam J, Engebretsen L, Roos EM. Exercise therapy versus arthroscopic partial meniscectomy for degenerative meniscal tear in middle aged patients: randomised controlled trial with two year follow-up. BMJ. 2016;354:i3740. DOI: 10.1136/bmj.i3740. PMID: 27440192.
15. Skou ST, Roos EM, Laursen MB, Rathleff MS, Arendt-Nielsen L, Simonsen O, et al. A randomized, controlled trial of total knee replacement. N Engl J Med. 2015;373 (17):1597–1606. DOI: 10.1056/NEJMo a1505467. PMID: 26488691.
16. Katz JN, Brophy RH, Chaisson CE, de Chaves L, Cole BJ, Dahm DL, et al. Surgery versus physical therapy for a meniscal tear and osteoarthritis. N Engl J Med. 2013;368(18): 1675–1684. DOI: 10.1056/NEJMoa1301408. PMID: 23506518.
17. Sihvonen R, Paavola M, Malmivaara A, Itälä A, Joukainen A, Nurmi H, et al. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. N Engl J Med. 2013;369(26):2515–2524. DOI: 10.1056/NEJ Moa1305189. PMID: 24369076.
18. Angst F, Aeschlimann A, Stucki G. Smallest detectable and minimal clinically important differences of rehabilitation intervention with their implications for required sample sizes using WOMAC and SF-36 quality of life measurement instruments in patients with osteoarthritis of the lower extremities. Arthritis Rheum. 2001;45(4):384–391. DOI: 10.1002/15 29-0131(200108)45:4<384::AID-ART352>3.0.CO;2-0. PMID: 11501727.
19. Juhl C, Christensen R, Roos EM, Zhang W, Lund H. Impact of exercise type and dose on pain and disability in knee osteoarthritis: a systematic review and meta-regression analysis of randomized controlled trials. Arthritis Rheumatol. 2014;66(3):622–636. DOI: 10.100 2/art.38290. PMID: 24574223.
20. Singh JA, Yu S, Chen L, Cleveland JD. Rates of total joint replacement in the United States: future projections to 2020-2040 using the National Inpatient Sample. J Rheumatol. 2019;46(9):1134–1140. DOI: 10.3899/jrheum. 170990. PMID: 30988126.
21. Beswick AD, Wylde V, Gooberman-Hill R, Blom A, Dieppe P. What proportion of patients report long-term pain after total hip or knee replacement for osteoarthritis? A systematic review of prospective studies in unselected patients. BMJ Open. 2012;2(1):e000435. DOI: 10.1136/bmjopen-2011-000435. PMID: 22357571.
22. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? Clin Orthop Relat Res. 2010;468(1):57–63. DOI: 10.1007/s11 999-009-1119-9. PMID: 19844772.
23. Carr AJ, Robertsson O, Graves S, Price AJ, Arden NK, Judge A, et al. Knee replacement. Lancet. 2012;379(9823):1331–1340. DOI:

10.1016/S0140-6736(11)60752-6. PMID: 22398175.

24. Defined Losina E, Walensky RP, Kessler CL, Emrani PS, Reichmann WM, Wright EA, et al. Cost-effectiveness of total knee arthroplasty in the United States: patient risk and hospital volume. Arch Intern Med. 2009;169(12):1113–1121. DOI: 10.1001/archinternmed.2009.136. PMID: 19546411.

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