Am J Transl Res 2025;17(6):4506-4515
www.ajtr.org /ISSN:1943-8141/AJTR0163906

Original Article

Effect of motor imagery training on joint function recovery following unicompartmental knee arthroplasty

Songlin Chen, Yong Wang

Department of Traumatology, Shangluo Central Hospital, Shangluo 726000, Shaanxi, China

Received February 13, 2025; Accepted May 22, 2025; Epub June 15, 2025; Published June 30, 2025

Abstract: Objective: To retrospectively investigate the effects of motor imagery (MI) training in enhancing knee joint function after unicompartmental knee arthroplasty (UKA). Methods: This study included 84 patients who underwent UKA at the Orthopedic Joint Department of Shangluo Central Hospital between January 2023 and October 2024. Patients were divided into an experimental group (n = 42) receiving MI training and a control group (n = 42) receiving standard rehabilitation. Clinical outcomes were assessed using the Oxford Knee Score (OKS), Visual Analogue Scale (VAS), range of motion (ROM), Timed Up and Go Test (TUGT), Berg Balance Scale (BBS), and Hospital for Special Surgery Knee Score (HSS) at 1, 6, and 12 months postoperatively. Imaging parameters were also analyzed at 6 months. Results: Compared to the control group, the experimental group exhibited significantly better clinical outcomes across all measured functions (OKS, VAS, ROM, TUGT, HSS, BBS, Knee flexion angle) at 1, 6, and 12 months postoperatively (all $P < 0.01$). Specifically, both groups showed significant OKS improvement and VAS reduction post-surgery. The experimental group had more pronounced OKS enhancement and VAS decrease than the control group, especially at 6 and 12 months (all $P < 0.001$). ROM, HSS, and BBS scores and knee flexion angle progressively increased over time in both groups (all $P < 0.05$), with the experimental group having higher values at all follow-up times (all $P < 0.01$). TUGT times were significantly reduced in both groups postoperatively, with greater reduction in the experimental group than the controls at each time point ($P < 0.01$). Conclusions: Motor imagery training, when combined with standard postoperative care, significantly enhances knee joint recovery following UKA, reduces patient discomfort, and accelerates functional rehabilitation.

Keywords: Unicompartmental knee arthroplasty, motor imagery, hospital for special surgery, timed up and go test

Introduction

Unicompartmental knee arthroplasty (UKA) is a surgical procedure used to treat isolated unicompartmental knee osteoarthritis [1]. Compared to age-matched patients undergoing total knee arthroplasty (TKA), those treated with UKA report higher satisfaction levels [2, 3]. Although early postoperative rehabilitation is recommended, initiating high-intensity training too soon may lead to severe pain and subsequent kinesiophobia [4, 5].

Motor imagery (MI) - a mental rehearsal technique involving the internal simulation of movement without actual execution - has been widely used in neurorehabilitation to improve upper limb function and gait in stroke patients [6]. In musculoskeletal rehabilitation, including post-injury and postoperative settings, MI has shown a beneficial effect in enhancing muscle strength.

To date, no study has systematically investigated the application of MI in the postoperative rehabilitation of UKA patients. Unlike previous research focused primarily on TKA, our study addresses the specific biomechanical and functional demands following UKA, where patients typically experience less quadriceps trauma yet require rapid functional recovery. Therefore, this retrospective study aimed to evaluate the effect of MI training on knee function recovery after UKA.

Materials and methods

General information

A total of 84 patients who underwent UKA in the Orthopedic Joint Department of Shangluo

https://doi.org/10.62347/AZKM5743

Central Hospital from January 2023 to October 2024 were enrolled. They were randomly assigned to either the experimental group (n = 42) or the control group (n = 42). Based on a pilot study (n = 10) showing a 15% difference in Oxford Knee Score (OKS) between groups, an *a priori* power analysis was performed using G*Power [7], with $\alpha = 0.05$, $\beta = 0.2$, and effect size d = 0.8. The calculated sample size was 42 per group, which was adopted to account for potential attrition.

All patients were diagnosed with knee osteoarthritis (FA01), with lesions confined to the medial compartment. Each underwent first-time unilateral medial UKA, and surgical indications met the expert consensus on UKA perioperative management. Primary functional impairments included pain (b280), joint mobility (b710), joint stability (b715), muscle power (b730), and gait pattern (b770). Participation limitations encompassed changing and maintaining body positions (d410-d415), walking and mobility (d450-d455), transportation (d470-d475), self-care (d510-d570), community integration (d910), and recreation and leisure activities (d920).

The authors oversaw all aspects of the work, ensuring the integrity and accuracy of the reported data. The study was approved by the Ethics Committee of Shangluo Central Hospital and conducted in accordance with the Declaration of Helsinki (2013 revision).

Inclusion criteria: (1) Radiographically confirmed medial compartment knee osteoarthritis, including Kellgren-Lawrence grade ≥ 2 on weight-bearing X-rays (anteroposterior, lateral, and merchant views). (2) Alignment and joint integrity criteria: varus deformity ≤ 15° (measured on full-leg standing radiographs), passively correctable to neutral; intact lateral joint space confirmed by valgus stress radiograph at 20° knee flexion. (3) Knee flexion ≥ 90° and flexion contracture < 15°. (4) Intact anterior and posterior cruciate ligaments (ACL and PCL) confirmed by negative clinical examinations [8, 9]. (5) Age > 55 years with moderate physical activity levels (Tegner Activity Scale ≥ 3). (6) No severe fixed angular deformities (e.g., > 15° requiring osteotomy). (7) Absence of inflammatory arthritis (e.g., negative serology for rheumatoid arthritis). (8) Good treatment adherence and willingness to attend at least two outpatient follow-ups per year (including imaging and functional assessments).

Exclusion criteria: (1) Age ≥ 85 years. (2) History of TKA within the past 3 months or scheduled contralateral knee replacement. (3) Revision surgery of previous UKA. (4) Neuromuscular disorders, quadriceps dysfunction, etc. (5) Pain or mobility restrictions in non-knee joints interfering with walking or sit-to-stand transitions. (6) Severe cognitive impairment or psychiatric illness precluding cooperation with rehabilitation.

Training protocol

Perioperative rehabilitation: Both groups followed a standardized orthopedic rehabilitation protocol. Surgeries were performed by the same surgical team. Rehabilitation began preoperatively and continued on the first postoperative day. After routine rehabilitation sessions, patients in the experimental group were moved to a quiet, comfortable environment for MI training over a 4-week period post-discharge.

Routine training: Cryotherapy: 20 minutes/session, four times daily for 7 days. Early mobilization: walking with a walker within 4-5 hours post-surgery. Isometric exercises, straight leg raises, and ankle pumps. Knee flexion/extension exercises (initiated once the surgical wound was dry and intact). Activities of daily living (ADL) training: dressing, stair use, toileting, transfers. Duration: 30 minutes/session, twice daily, five days per week.

MI training: The therapist prepared video guides demonstrating three movement sets: knee flexion-extension, stair descent, and the Timed Up and Go Test (TUGT) [4]. Patients observed the videos while receiving guided auditory instructions through soundproof headphones. Each movement was mentally rehearsed 10 times per set, with 1-minute breaks, totaling 15 minutes per session. Training was conducted twice daily, five days per week.

Discharge criteria and home training: Discharge criteria included stable vital signs, controlled pain, no postoperative complications, ≥ 90° knee flexion, and independent ADLs using a walker. Patients received pre-discharge education on home rehabilitation and safety. Both groups continued home-based training for 4 weeks, with therapists calling three times weekly to monitor progress and encourage adherence. Outpatient follow-up was conducted at 6 weeks postoperatively.

Assessment methods

All assessments were conducted by trained personnel preoperatively and at 1, 6, and 12 months postoperatively.

Oxford Knee Score (OKS): The OKS is a patient-reported outcome measure comprising 12 items: 5 assessing pain and 7 assessing function. Each item is scored from 1 to 5, yielding a total score ranging from 12 to 60, with lower scores indicating worse knee function [10].

Visual Analogue Scale (VAS): The VAS is a 10-point scale used to evaluate pain intensity: 0 indicates no pain; 1-3, mild pain; 4-6, moderate pain; 7-9, severe pain; and 10, the most severe and unbearable pain [10, 11].

Range of Motion (ROM): Active knee flexion was measured using a goniometer [12].

Hospital for Special Surgery Knee Score (HSS): The HSS score, ranging from 0 to 100, was used to assess knee function before surgery and at 3 months postoperatively. Higher scores indicate better function. ROM was also measured using a goniometer [13].

Berg Balance Scale (BBS): The BBS consists of 14 items evaluating functional balance, including sit-to-stand transfers, unsupported sitting and standing, and turning. Total scores range from 14 to 56, with higher scores indicating better balance function [7].

Knee flexion angle: Knee flexion angle is measured with the participant in supine position, hip in neutral position, and knee extended to 0° as the starting point. A goniometer is aligned with the lateral femoral epicondyle (axis), the midline of the femur (fixed arm), and the midline of the tibia (mobile arm). The angle is recorded at maximum knee flexion, with measurements repeated twice and averaged for accuracy.

Imaging indexes: At 3 months postoperatively, anteroposterior and lateral X-rays of the knee were obtained to assess prosthetic alignment. The following data were compared between groups: tibial component posterior slope angle (TCPSA), tibial component varus/valgus angle (TCVA), femoral component varus/valgus angle (FCVA), and femoral component posterior slope angle (FCPSA). Positive values for TCVA and FCVA denote varus alignment, and negative values indicate valgus alignment [14].

Timed Up and Go Test (TUGT): Patients were instructed to rise from a chair, walk 3 meters, turn around, walk back, and sit down. Assistive devices such as walkers were permitted if needed. After one practice trial, two measurements were taken, and the average time was recorded [15].

Statistical analysis

All statistical analyses were conducted using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). For normally distributed continuous variables, presented as mean ± standard deviation, independent samples t-test and paired samples t-test were employed for between-group and within-group comparisons, respectively. For categorical variables, presented as counts and percentages (%), Pearson's chi-square test or (when cell counts were < 5) Fisher's exact test were used to assess associations. Non-normally distributed variables were analyzed using the Kruskal-Wallis test and Mann-Whitney U-test. Longitudinal data were assessed using repeated-measures ANOVA (RM-ANOVA) with Bonferroni correction for within-group comparisons. A p-value < 0.05 was considered significant.

Results

Comparison of baseline characteristics

All patients completed follow-up. No complications such as wound infection, prosthesis malposition, or loosening were observed. Baseline demographics, surgical variables, and preoperative scores did not significantly differ between groups (all $P > 0.05$; **Table 1**), confirming comparability.

Comparison of OKS

There was no significant difference in preoperative OKS between groups ($P > 0.05$). Postoperatively, both groups showed significant

Table 1. Comparison of baseline data

Group	Control group	Experimental group	χ^2/t	P
n	42	42		
Gender (male/female)/n	20/22	23/19	0.428	0.512
Age/years, mean ± SD	70.33±5.94	70.47±7.43	0.095	0.933
Operated side (left/right)/n	18/24	19/23	0.048	0.826
Blood loss				
Occult blood loss	256.16±52.71	253.18±51.67	0.261	0.933
Overt blood loss	261.17±60.37	259.65±71.67	0.105	0.933
Operative time (min)	81.37±4.81	79.62±4.69	1.688	0.576
Surgical blood loss (mL)	231.50±5.53	229.87±5.84	1.313	0.583
Incision length (cm)	12.87±1.75	12.56±1.83	0.793	0.868

improvement in OKS (P < 0.01), with the experimental group demonstrating superior improvement compared to the control group (P < 0.01; **Figure 1A**, **1B**).

Comparison of VAS

VAS scores were similar between groups before treatment (P > 0.05). Both groups experienced significant reductions postoperatively (P < 0.001), with the experimental group showing greater reductions than the control group at 6 and 12 months (both P < 0.001; **Figure 1C**, **1D**).

Comparison of ROM

There was no significant difference in preoperative ROM between groups (P > 0.05). Postoperative ROM improved significantly in the experimental group (P < 0.05) and was significantly greater than that of the control group (P < 0.01; **Figure 1E**, **1F**).

Comparison of HSS scores

Preoperative HSS scores were comparable (P > 0.05). Both groups showed progressive improvement at 1, 6, and 12 months postoperatively, with significantly higher scores in the experimental group (P < 0.05; **Figure 1G**, **1H**).

Comparison of TUGT

No significant preoperative difference between groups was observed in TUGT time (P > 0.05). Both groups demonstrated significantly shorter times at 1, 6, and 12 months postoperatively (P < 0.01), with the experimental group consistently outperforming the control group (P < 0.01; **Table 2**).

Comparison of BBS and knee flexion angle

There were no significant differences in BBS scores before surgery (P > 0.05). Both groups showed gradual improvements at 1, 6, and 12 months postoperatively, with significantly higher scores in the experimental group (all P < 0.05, **Table 3**). Before surgery, knee flexion angles did not differ significantly between the groups (t = 0.716, P = 0.120). After surgery, the experimental group showed greater improvements at 1, 6, and 12 months (all P < 0.001, **Table 4**).

Comparison of imaging parameters at 6 months

At 6 months postoperatively, there were no significant differences between groups in prosthesis alignment parameters, including TCPSA, TCVA, FCVA, and FCPSA (all P > 0.05; **Table 5**).

Radiographic observations

Preoperative (**Figure 2A**, **2B**, **2E**, **2F**): Natural bone morphology of the knee joint was visible. Although specific pathologic features were not definitively identified, signs such as joint space narrowing and irregular articular surfaces suggested degenerative changes.

Postoperative (**Figure 2C**, **2D**, **2G**, **2H**): The diseased joint structures were replaced with prosthetic components. The implants were well-aligned and closely fitted to the surrounding bone, indicating successful structural restoration and improved joint morphology.

Discussion

Motor imagery (MI) refers to the mental simulation of physical movement without actual exe-

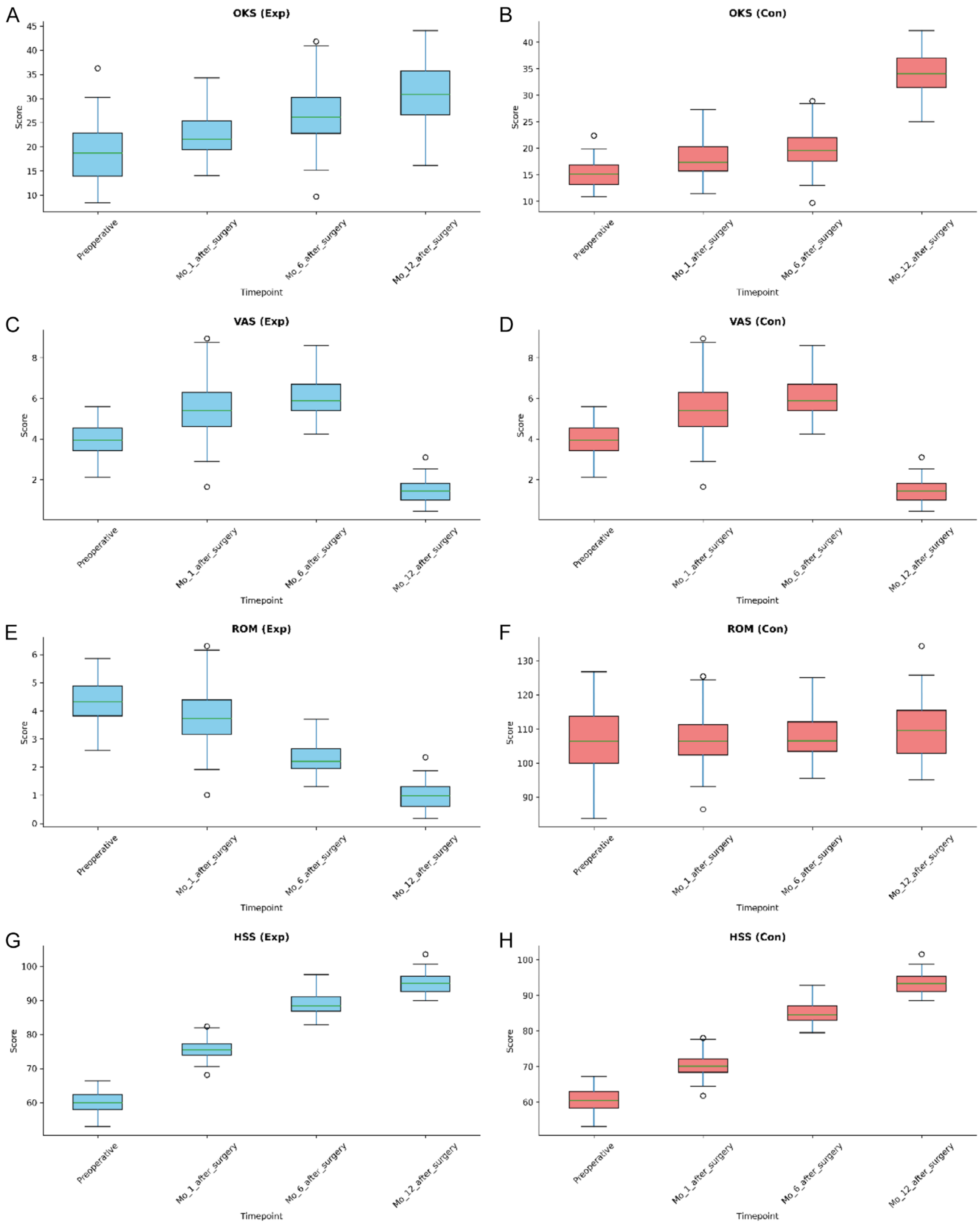

Figure 1. Box plots of OKS, VAS, ROM, and HSS scores. A: Box plots of OKS scores in the control group at 1, 6, and 12 months before operation; B: Box plots of OKS scores in the experimental group before surgery and at 1, 6, and 12 months after surgery; C: Box plots of VAS scores in the control group before surgery and at 1, 6, and 12 months after surgery; D: Box plots of VAS scores in the experimental group before surgery and at 1, 6, and 12 months after surgery; E: Box plots of ROM scores in the control group before surgery and at 1, 6, and 12 months after surgery; F: Box plots of ROM scores in the experimental group before surgery and at 1, 6, and 12 months after surgery; G: Box plots of HSS scores in the control group before surgery and at 1, 6, and 12 months after surgery; H: Box plots of HSS scores in the experimental group before surgery and at 1, 6, and 12 months after surgery; Oxford Knee Score, OKS; Visual Analogue Scale, VAS; Range of motion, ROM; Hospital for Special Surgery knee score, HSS.

Table 2. Comparison of TUGT time before and after treatment

Group	Control group	Experimental group	t	P
n	42	42		
Before surgery	9.56±1.68	8.72±1.20	2.637	0.003
1 month after surgery	9.46±1.60	7.57±0.81	6.830	< 0.001
6 months after surgery	8.95±1.65	7.42±1.21	4.846	0.001
12 months after surgery	8.65±1.72	6.25±1.19	7.437	< 0.001

TUGT, Timed Up and Go Test.

Table 3. Comparison of BBS scores before and after surgery

Group	Control group	Experimental group	t	P
n	42	42		
Before surgery	34.47±5.40	35.02±4.85	0.491	0.157
1 month after surgery	40.04±5.88	44.48±5.20	3.666	0.001
6 months after surgery	44.50±5.03	49.76±4.77	4.918	0.001
12 months after surgery	45.23±5.12	56.32±4.98	10.060	< 0.001

BBS, Berg Balance Scale.

Table 4. Comparison of knee flexion before and after treatment

Group	Control group	Experimental group	t	P
n	42	42		
Before surgery	84.31±4.87	83.56±4.72	0.716	0.120
1 month after surgery	94.46±4.24	105.50±4.14	12.070	< 0.001
6 months after surgery	109.57±4.31	119.37±4.26	10.480	< 0.001
12 months after surgery	121.37±4.88	126.87±4.11	5.587	< 0.001

Table 5. Imaging data were observed in the two groups at 6 months after surgery

Group	Control group	Experimental group	t	P
n	42	42		
TCPSA	5.25±1.82	5.03±1.35	0.629	0.530
TCVA	1.13±0.74	1.20±0.59	0.479	0.632
FCVA	2.46±1.04	2.64±1.15	0.752	0.453
FCPSA	15.48±3.02	16.55±4.33	1.314	0.192

Note: TCPSA is the posterior angle of the tibial prosthesis; TCVA is the valgus angle of the tibial prosthesis; FCVA is the valgus angle of the femoral prosthesis; FCPSA is the flexion angle of the femoral prosthesis.

cution and has been shown to enhance athletic performance [16-18]. During MI training, brain regions associated with motor control are activated. Kober et al. [19] demonstrated that MI and execution involve similar neural circuits, including the bilateral precentral gyrus, inferior frontal gyrus, basal ganglia, insula, supplementary motor areas, and cerebellum [20-22]. Similarly, Deiber et al. [23] reported that the prefrontal cortex, premotor cortex, cerebellum, and basal ganglia were engaged during both imagined and executed movements. Notably, the corticospinal tract is activated during MI. Avanzion et al. [24] found that MI modulates PAS25- and PAS10-induced plasticity in the primary somatosensory cortex. Somatosensory input, akin to physical exercise, contributes to motor function improvement during MI.

In elderly patients, MI combined with conventional training has demonstrated benefits following total hip arthroplasty and TKA [11]. A systematic review reported that MI in TKA patients enhanced muscle strength, reduced

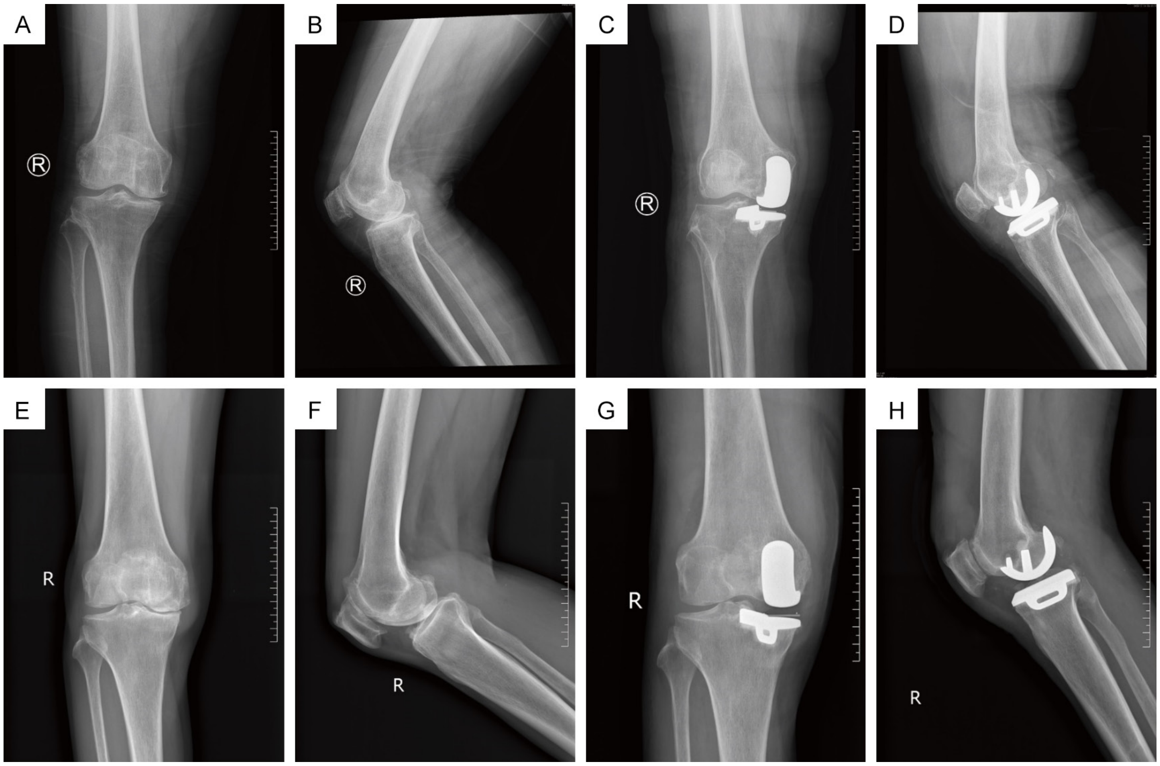

Figure 2. Comparison of pre-treatment and post-treatment (6 months) knee imaging. A: Preoperative anteroposterior radiograph of Case 1; B: Preoperative lateral radiograph of Case 1; C: Postoperative anteroposterior radiograph of Case 1 (6 months); D: Postoperative lateral radiograph of Case 1 (6 months); E: Preoperative anteroposterior radiograph of Case2; F: Preoperative lateral radiograph of Case 2; G: Postoperative anteroposterior radiograph of Case 2 (6 months); H: Postoperative lateral radiograph of Case 2 (6 months).

pain, and improved physical performance. Paravlic et al. [25] found that incorporating MI into routine physical therapy after TKA yielded both specific and general functional improvements. Moukarzel et al. [8] showed that MI during the chronic phase post-TKA improved quadriceps strength without increasing training intensity.

Forward et al. [26] reported that MI alleviated pain and anxiety after hip and knee arthroplasty. Hoyek et al. [27] observed that MI enhanced pain relief and shoulder mobility in stage II subacromial impingement syndrome. However, Paravlic et al. [28] found no significant differences in knee ROM and pain between TKA patients undergoing MI-based home training and controls. Zapparoli et al. [29] showed that TKA patients receiving computer-visualized MI had improved gait, knee motion, and pain outcomes. These inconsistent results may stem from variation in MI protocols, individual MI ability, and evaluation methods. Perceptual MI primarily activates the motor cortex and enhances motor function, while visual MI mainly stimulates the visual processing cortex. Future studies should assess patients' MI capability during recruitment and consider combining perceptual and visual imagery for optimal outcomes.

MI targeting quadriceps strengthening has been shown to improve physical function in TKA patients [30-33]. Compared to TKA, UKA causes less quadriceps disruption, resulting in superior outcomes in pain, ROM, and function. Our findings align with neuroimaging studies demonstrating MI-induced activation of the premotor cortex and cerebellum [19, 24], which may enhance proprioceptive feedback and motor planning in UKA patients. In contrast to Goodwin et al. [12], who found limited MI benefits in TKA, our study observed superior ROM gains - possibly due to less soft tissue trauma in UKA, which allows for earlier neural adaptation. Typically, functional recovery peaks at 3 months after TKA and at 6 months after UKA. The MI tasks in this study were designed to promote functional activity without increasing physical training intensity [34-38].

TUGT is a reliable, quantitative measure of functional activity, particularly in elderly patients. Our findings, along with multiple studies [39-42], confirm that MI enhances functional recovery post-UKA. The OKS, a patient-reported outcome used for TKA assessment [12], also showed significant reduction with MI intervention in this study. Our longitudinal design-featuring 1-, 6-, and 12-month follow-ups - extends previous research [28] and demonstrates the sustained benefits of MI in UKA patients. Furthermore, our MI protocol incorporated audiovisual guidance, differing from traditional mental rehearsal methods, and this may improve patient adherence and cortical engagement [29].

Despite these promising findings, this study had limitations, including a small sample size and a reliance on semi-quantitative assessment tools. Future studies should incorporate objective measures such as gait analysis, assess MI capability during patient selection, and extend follow-up to evaluate long-term effects.

In conclusion, adding MI to early postoperative rehabilitation in UKA patients can significantly improve knee function without increasing training intensity, making it a promising clinical adjunct. However, no significant improvement was observed in imaging data, possibly due to limitations in the imaging assessment methods used.

Disclosure of conflict of interest

None.

Address correspondence to: Yong Wang, Department of Traumatology, Shangluo Central Hospital, No. 37 Shangyang Avenue, Shangzhou District, Shangluo 726000, Shaanxi, China. Tel: +86-0914-2035530; E-mail: wywy612501@163.com

References

[1] Kloos J, Vandenneucker H and Berger P. Prevalence of unexpected intraoperative cultures (UPIC) in revision total knee arthroplasty (TKA) and risk of periprosthetic joint infection (PJI). Arch Orthop Trauma Surg 2024; 144: 5301-5309.

[2] Brivio A, Al-Jabri T, Martin J, Barrett D and Maffulli N. Debridement, antibiotics and implant retention (DAIR) is successful in the management of acutely infected unicompartmental knee arthroplasty: a case series. Ann Med 2023; 55: 680-688.

[3] Putnis SE, Klasan A, Bott B, Ridley W, Hudson B and Coolican MRJ. The microbiology of knee prosthetic joint infection and its influence on persistent infection. J Knee Surg 2024; 37: 834-842.

[4] Gaudiani MA, Samuel LT, Diana JN, DeBattista JL, Coon TM, Moore RE and Kamath AF. 5-year survivorship and outcomes of robotic-arm-assisted medial unicompartmental knee arthroplasty. Appl Bionics Biomech 2022; 2022: 8995358.

[5] Gaudiani MA, Samuel LT, Diana JN, DeBattista JL, Coon TM, Moore RE and Kamath AF. Robotic-arm assisted lateral unicompartmental knee arthroplasty: 5-Year outcomes & survivorship. J Orthop Surg (Hong Kong) 2023; 31: 10225536221138986.

[6] Różańska A, Baranowska-Tateno K, Pac A, Gajda M and Wójkowska-Mach J. Post-discharge surveillance of urinary tract infections in patients following hip and knee arthroplasty: identifying targets for infection prevention and control. Am J Infect Control 2024; 52: 852-856.

[7] Kiyohara M, Hamai S, Okazaki K, Fujiyoshi D, Mizu-Uchi H and Nakashima Y. Evaluation of the balance function before and after total knee arthroplasty using Berg balance scale. Arch Orthop Trauma Surg 2022; 142: 3461-3467.

[8] Moukarzel M, Guillot A, Di Rienzo F and Hoyek N. The therapeutic role of motor imagery during the chronic phase after total knee arthroplasty: a pilot randomized controlled trial. Eur J Phys Rehabil Med 2019; 55: 806-815.

[9] Navarro Vergara AD, Navarro Fretes A, Anibal Arrellaga Alonso R and Medina Villate MM. Management of pediatric humeral supracondylar fractures in a referral center from a developing country: a comparison with American academy of Orthopaedic Surgeons (AAOS) guidelines. Cureus 2023; 15: e44430.

[10] Tu Y, Xue H, Ma T, Wen T, Yang T, Zhang H and Cai M. Superior femoral component alignment can be achieved with Oxford microplasty instrumentation after minimally invasive unicompartmental knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2017; 25: 729-735.

[11] Cavagnaro L, Chiarlone F, Mosconi L, Zanirato A, Formica M and Burastero G. Two-stage revision for periprosthetic joint infection in unicompartmental knee arthroplasty: clinical and radiological results. Arch Orthop Trauma Surg 2022; 142: 2031-2038.

[12] Goodwin TM, Brazier BG, Cien AJ, Riggle PK, Popovich JM, Penny PC and Cochran JM. The effect of postoperative sleeping position on knee extension and range of motion following primary total knee arthroplasty. Orthop Nurs 2024; 43: 218-222.

[13] Zhang B, Qian H, Wu H and Yang X. Unicompartmental knee arthroplasty versus high tibial osteotomy for medial knee osteoarthritis: a systematic review and meta-analysis. J Orthop Surg (Hong Kong) 2023; 31: 10225536231162829.

[14] Xu ZQ, Zhuang ZK, Gong ZB, Wu RK and Xu FD. Comparison of outcomes of mixed unicompartmental knee arthroplasty and total knee arthroplasty in the treatment of medial osteoarthritis of the knee. Zhongguo Gu Shang 2023; 36: 507-513.

[15] Chau WW, Lau MY, Choi TL, Lam GY, Ong MT and Ho KK. Effect of a tailor-made hydrotherapy on physical functions in patients after unilateral unicompartmental knee arthroplasty-a feasibility study. Arthroplasty 2025; 7: 9.

[16] Valle C, Stemmler S, Baier C and Matziolis G. Postoperative rehabilitation after knee arthroplasty. Orthopadie (Heidelb) 2024; 53: 824-832.

[17] Akram F, Tseng J, Behery O and Levine BR. Comorbidities in total hip and knee arthroplasty patients: when is it okay to say no? Orthop Clin North Am 2025; 56: 1-12.

[18] Puri S, Bornes TD, Neitzke CC, Jones AD, Hamilton AA, Premkumar A, Sculco PK and Chalmers BP. Survivorship and functional outcomes after complex primary total knee arthroplasty with contemporary rotating-hinge implants. HSS J 2024; 15563316241276869.

[19] Kober SE, Spork R, Bauernfeind G and Wood G. Age-related differences in the within-session trainability of hemodynamic parameters: a near-infrared spectroscopy-based neurofeedback study. Neurobiol Aging 2019; 81: 127-137.

[20] Lara-Taranchenko Y, Moreira T, Alfaraj AA, Sandiford NA, Guerra-Farfán E, Gehrke T and Citak M. Unexpected positive cultures in revision total knee arthroplasty after unicompartmental knee arthroplasty. Int Orthop 2024; 48: 2041-2046.

[21] Lonner JH, Seidenstein AD, Charters MA, North WT, Cafferky NL, Durbhakula SM and Kamath AF. Improved accuracy and reproducibility of a novel CT-free robotic surgical assistant for medial unicompartmental knee arthroplasty compared to conventional instrumentation: a cadaveric study. Knee Surg Sports Traumatol Arthrosc 2022; 30: 2759-2767.

[22] Barberis L, Abdelrahman T, Driscoll DA, Daşcı MF, Gehrke T and Citak M. Unexpected positive cultures in hip and knee periprosthetic fractures. J Arthroplasty 2024; 39: 1834-1839.

[23] Deiber MP, Ibanez V, Honda M, Sadato N, Raman R and Hallett M. Cerebral processes related to visuomotor imagery and generation of simple finger movements studied with positron emission tomography. Neuroimage 1998; 7: 73-85.

[24] Avanzino L, Gueugneau N, Bisio A, Ruggeri P, Papaxanthis C and Bove M. Motor cortical plasticity induced by motor learning through mental practice. Front Behav Neurosci 2015; 9: 105.

[25] Paravlic AH, Pisot R and Marusic U. Specific and general adaptations following motor imagery practice focused on muscle strength in total knee arthroplasty rehabilitation: a randomized controlled trial. PLoS One 2019; 14: e0221089.

[26] Forward JB, Greuter NE, Crisall SJ and Lester HF. Effect of structured touch and guided imagery for pain and anxiety in elective joint replacement patients--a randomized controlled trial: M-TIJRP. Perm J 2015; 19: 18-28.

[27] Hoyek N, Di Rienzo F, Collet C, Hoyek F and Guillot A. The therapeutic role of motor imagery on the functional rehabilitation of a stage II shoulder impingement syndrome. Disabil Rehabil 2014; 36: 1113-1119.

[28] Paravlic AH, Maffulli N, Kovac S and Pisot R. Home-based motor imagery intervention improves functional performance following total knee arthroplasty in the short term: a randomized controlled trial. J Orthop Surg Res 2020; 15: 451.

[29] Zapparoli L, Sacheli LM, Seghezzi S, Preti M, Stucovitz E, Negrini F, Pelosi C, Ursino N, Banfi G and Paulesu E. Motor imagery training speeds up gait recovery and decreases the risk of falls in patients submitted to total knee arthroplasty. Sci Rep 2020; 10: 8917.

[30] Iñiguez M, Negrín R, Duboy J, Reyes NO and Díaz R. Robot-assisted unicompartmental knee arthroplasty: increasing surgical accuracy? A cadaveric study. J Knee Surg 2021; 34: 628-634.

[31] Arapovic AE, Zalikha AK, Zamzam M, Keeley J, Hajj Hussein I and El-Othmani MM. Frailty among revision total knee arthroplasty recipients: epidemiology and propensity score-weighted analysis of effect on in-hospital post-operative outcomes. J Am Acad Orthop Surg 2024; 32: e387-e395.

[32] van Veghel MHW, van Steenbergen LN, Wertheim HFL, van der Kooi TII, Schreurs BW and Hannink G. Early periprosthetic joint infections in total hip and knee arthroplasty: microorganisms, mortality, and implant survival using a combined dataset from the dutch arthro-

plasty register and the dutch national nosocomial surveillance network. J Arthroplasty 2025; 40: 208-213, e201.
[33] Zalikha AK and El-Othmani MM. Frailty among total hip and knee arthroplasty recipients: epidemiology and propensity score-weighted analysis of effect on in-hospital postoperative outcomes. J Am Acad Orthop Surg 2024; 32: e357-e358.
[34] Bonanzinga T, Tanzi P, Altomare D, Dorotei A, Iacono F and Marcacci M. High survivorship rate and good clinical outcomes at mid-term follow-up for lateral UKA: a systematic literature review. Knee Surg Sports Traumatol Arthrosc 2021; 29: 3262-3271.
[35] Basso M, Arnaldi E, Bruno AAM and Formica M. Outcomes of cementless fixation in medial unicompartmental knee arthroplasty: review of recent literature. Musculoskelet Surg 2021; 105: 131-138.
[36] Awad F, Boktor J, Joseph V, Lewis MH, Silva C, Sarasin S and Lewis PM. Debridement, antibiotics and implant retention (DAIR) following hip and knee arthroplasty: results and findings of a multidisciplinary approach from a non-specialist prosthetic infection centre. Ann R Coll Surg Engl 2024; 106: 633-641.
[37] Aoun M, Chalhoub R, Nham FH, Kassis E, Daher M and El-Othmani MM. Evolution and hotspots in bilateral total joint arthroplasty research: a bibliometric analysis. Clin Orthop Surg 2024; 16: 880-889.
[38] Wu CJ, Leal J, Seyler TM, Jiranek WA, Wellman SS, Bolognesi MP and Ryan SP. Unsuspected positive intraoperative cultures in aseptic revision knee arthroplasty: prevalence, management, and infection-free survivorship. J Arthroplasty 2024; 39: 2581-2590.
[39] Oetojo W, Feffer M, Wesolowski M, Hopkinson WJ and Brown NM. Incidence and risk factors for acid-fast bacillus/fungal culture positivity in primary, conversion, and revision hip and knee arthroplasty. J Am Acad Orthop Surg 2024; 32: e576-e584.
[40] Anneberg M, Kristiansen EB, Troelsen A, Gundtoft P, Sørensen HT and Pedersen AB. Enhancing the data capture of periprosthetic joint infections in the Danish knee arthroplasty registry: validity assessment and incidence estimation. Acta Orthop 2024; 95: 166-173.
[41] Ergin M, Budin M, Canbaz SB, Ciloglu O, Gehrke T and Citak M. Microbiological profiles in periprosthetic joint infections after total knee arthroplasty: a comparative analysis of diabetic and non-diabetic patients. Int Orthop 2024; 48: 2633-2640.
[42] Gutierrez FG, Ojeaga P and Sambandam S. Total knee arthroplasty in schizophrenia patients: early complications and cost in a propensity-matched national database study. Arch Orthop Trauma Surg 2024; 144: 3583-3590.