ORIGINAL RESEARCH

Advantages of Total Hip Arthroplasty Using the Posterolateral Approach Combined with Phased Rehabilitation Management for Patients with Femoral Neck Fractures

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ABSTRACT

Background • Total hip arthroplasty (THA) has emerged as a pivotal approach for addressing femoral neck fractures (FNFs), a prevalent type of fracture in older people. Restoring joint functionality following surgery significantly contributes to patients' overall well-being. Therefore, the implementation of rational and effective rehabilitation exercises is crucial.

Objective • This study aims to investigate the impact of phased rehabilitation management on patients with FNFs who have undergone THA.

Methods • In this prospective comparative study, a total of 89 patients were enrolled. Among them, 49 patients underwent phased rehabilitation management, while 40 patients received conventional postoperative rehabilitation. The evaluation encompassed a range of assessments, including the Harris Hip Score (HHS) for the evaluation of hip joint function, the Five-Times-Sit-to-Stand Test (FTSST) to quantify lower limb muscle strength, the Barthel Index to assess activities of daily living, and the Visual Analog Scale (VAS) to measure pain intensity. Furthermore, preoperative and postoperative serum levels of interleukin-6 (IL-6), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR) were diligently measured to provide a comprehensive understanding of the patient's inflammatory responses.

Results • Overall, the study group exhibited a significantly higher average HHS after surgery compared to the control group. Notably, the VAS scores at 1 day and 3 days post-surgery in both groups demonstrated a reduced trend compared to preoperative values. This trend was more significant in the study group compared to the control group. The time taken for the FTSST in patients undergoing phased rehabilitation management was less compared to the control group. Furthermore, phased rehabilitation management was associated with more significant improvements in activities of daily living. Notably, IL-6 levels were higher in both the study and control groups at 1 day postoperatively than before surgery, while they decreased at 3 days postoperatively compared to the 1-day mark. The study group exhibited significantly lower levels of CRP (mg/L) and ESR (mm/h) compared to the control group.

Conclusions • Implementing phased rehabilitation management for patients with FNFs following THA improves hip joint function, lower limb muscle strength, daily living activities, pain intensity, and inflammatory response. (*Altern Ther Health Med.* 2023;29(8):512-517).

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INTRODUCTION

Femoral neck fractures (FNFs), are considered one of the most prevalent fracture types in traumatology. Their incidence substantially burdens public health due to the high morbidity and severity associated with these fractures.[1] These fractures are diagnosed through clinical identification and X-ray photographs of the pelvis and hip. The elderly population is particularly susceptible to FNFs, requiring surgical interventions for most cases.[2] The advancements in surgical techniques and the availability of innovative prosthesis materials enabled total joint arthroplasty (THA) to emerge as an exceptionally successful intervention for addressing painful and incapacitating joint diseases.[3] THA has established a remarkable efficacy, particularly in treating FNF patients exceeding the outcomes achieved by hip hemiarthroplasty.[4,5]

THA is predominantly recognized as the prime choice for individuals aged 60 years and above who exhibit self-sufficiency, physical activity, and a lack of risk factors.[6] Employing the posterior approach in THA ensures excellent

exposure and favorable working conditions, resulting in superior functional outcomes and substantial pain relief in elderly patients. However, it carries a significant risk of postoperative dislocation, particularly without careful patient selection, adherence to precise surgical techniques, and utilization of modern implant technologies.[7]

In the context of THA implantation, many studies have demonstrated the advantages of the dual mobility implant, suggesting its preference due to its distinctive design. This implant not only limits the incidence of instability but also significantly reduces the occurrence of postoperative dislocation[8,9]; this benefit becomes even more significant when coupled with the posterior approach.[10] THA affects joint mobility and patients' ability to perform their daily routines. It can also cause some levels of physical and emotional discomfort. Therefore, active and effective postoperative rehabilitation after THA is critical to improve the patient's functional outcome. The main focus of this recovery plan is to make it easier for patients to perform their daily tasks. The rehabilitation aims at improving patients' daily living activities, and therapeutic massage of the lower limb is helpful in the improvement of microcirculation and strength of hip muscles, as well as relaxation of the hip flexor and abductor.[11]

Studies have also highlighted that the implementation of a comprehensive rehabilitation strategy can effectively address proximal scapular muscle weakness and related dysfunctions in lateral elbow tendinopathy.[12] Similarly, for older individuals with FNF experiencing sarcopenia, a structured postoperative rehabilitation plan, including gradual physical engagement, dietary supplementation, and occupational therapy, emerges as an effective modality post-hip surgery.[13]

In current clinical practice, a significant gap persists in the availability of dependable and distinctive nursing guidance for THA, contributing to suboptimal patient recovery outcomes. The increasing incidence of FNF and the growing adoption of THA emphasizes the need to devise targeted and effective nursing interventions to enhance patient prognoses. Thus, the primary objective of this study was to evaluate the impact of a phased rehabilitation management plan, including preoperative education, postoperative massage, physical exercises, and postoperative follow-up on elderly FNF patients undergoing THA. This study seeks to establish new benchmarks and guidelines for the forthcoming surgical management of FNF patients, eventually elevating the overall quality of medical care.

MATERIALS AND METHODS

Study Design and Participants

A prospective observational study was conducted, and a consecutive series of 89 patients diagnosed with FNF and undergoing total hip arthroplasty THA via the posterolateral approach were enrolled in this study. The participants included 46 females and 43 males, 60 to 75 years old. The patients were admitted to our hospital between 2019 and 2021. This study received ethical approval from the Ethics Committee of our hospital.

Participant Characteristics and Study Groups Formation

After reviewing clinical data, 89 patients were divided into two groups: 40 received conventional postoperative rehabilitation (control group), and 49 cases underwent phased rehabilitation management during the perioperative period (study group). The two groups exhibited no significant differences in gender, age, body mass index (BMI), American Society of Anesthesiologists (ASA) score, blood loss, surgical procedure duration, or complications.

The selected patients were initially diagnosed with FNF.[14] based on thorough clinical and imaging assessments. All participants met the surgical criteria for THA and underwent unilateral THA. Patients under 60 years and those with fractures in other areas were excluded from the study. Furthermore, individuals with serious medical conditions, including mental disorders, cardiovascular diseases, liver or kidney dysfunction, and blood disorders, were excluded from the study population.

Rehabilitation Protocols for FNF Patients Undergoing Unilateral THA

Surgical Approach and Implantation. Unilateral THA was precisely performed on 89 FNF patients utilizing the posters-posterolateral approach. Notably, the procedure incorporated a dual-mobility cup administered by an expert surgeon.

Postoperative Rehabilitation Control Group. In the control group, patients underwent conventional postoperative rehabilitation.

Phased Rehabilitation Management in Study Group. Patients in the study group received comprehensive phased rehabilitation management throughout the perioperative period. Before surgery, patients received preoperative targeted rehabilitation education. The aim was to emphasize the significance of rehabilitation exercises for restoring limb function and enhancing the overall quality of life. This approach encouraged patients' commitment to lower limb functional exercises post-surgery.

The postoperative phase included the following steps: (1) personalized rehabilitation plan: a dedicated rehabilitation team designed tailored functional exercise programs for each patient. The team provided demonstrations of proper techniques for common hip joint rehabilitation movements. Additionally, guidance for addressing exercise-related challenges was also offered. (2) Early initiation of rehabilitation: rehabilitation began quickly after the surgical procedure. A rehabilitation physician-led passive training session, including massages targeting the biceps femoris, gastrocnemius, and quadriceps femoris muscles. These massages facilitated improved blood circulation and muscle tension maintenance. (3) Immediate postoperative days: isometric contraction of the quadriceps femoris and flexion and extension exercises of the ankle joints were introduced. (4) 3-5 Days post-surgery: exercises involving knee and hip joint flexion, extension, and straight leg raising were initiated. (5) 6-7 days post-surgery: patients were encouraged to

perform adduction and abduction movements. (6) One week post-surgery: nursing personnel assisted patients in walking with crutches or walking aids.

Post-Discharge Care. After discharge, patients were advised against walking unsupported and avoiding hip and knee flexion angles below 45°. Precautions were strictly followed during rehabilitation exercises, including walking, muscle strength training, and stair activities. Certain actions, such as leg crossing and squatting, were advised to be prohibited for the first three months. Regular follow-up, including reexaminations and telephone consultations, was conducted in the first, second, and third months following discharge.

Evaluation of Intervention Outcomes

Assessment of Hip Joint Function. Hip joint function was assessed using the Harris Hip Score (HSS).[15] This comprehensive score includes aspects such as pain, functional ability, joint range of motion, and deformity, with a maximum score of 100. A higher score signifies better hip joint function.

Measurement of Lower Limb Muscle Strength. Muscle strength of the lower limbs was quantified using the Five Times Sit-to-Stand Test (FTSST).[16] Patients were instructed to sit on an armless chair approximately 43 cm in height during this test. With arms crossed in front of the chest and back against the chair, the time taken to perform five consecutive stand-sit cycles was recorded.

Evaluation of Activities of Daily Living. The Barthel Index[17] was employed to assess patients' functional capacity in their daily activities. Individual scores reflect a range of independent behaviors, including eating, bathing, walking without external support, and ascending/descending stairs. The index yields a total score ranging from 0 to 100.

Quantification of Pain Intensity. Pain intensity was estimated utilizing the Visual Analog Scale (VAS).[18] On a scale of 0-10, higher scores indicate heightened pain perception.

Serological Inflammatory Markers Analysis. Peripheral venous blood samples of 5 ml each were obtained from patients before and after surgery. These samples were then subjected to analysis for serological inflammatory markers, including interleukin-6 (IL-6), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR).

Statistical Analysis

Statistical analysis of the data was conducted using SPSS version 21.0 software. For measurement data, means and standard deviations were computed, and a *t* test was employed to compare the groups. Meanwhile, the chi-square test was used to analyze counting data, presented in percentages (%) or cases. In all analyses, $P < .05$ indicated statistical significance.

RESULTS

Evaluation of Hip Joint Function at Different Time Points Between Study Groups

The evaluation of hip joint function for both study groups was conducted utilizing the HSS. Before surgery, no statistically significant distinction was observed in the preoperative HSS scores between the two groups ($P > 0.05$). Notably, significant differences in HSS scores were evident in patients who underwent phased rehabilitation management at the 1-month and 3-month postoperative time points compared to the control group. At the 1-month postoperative evaluation, HSS scores were recorded as 52.92 ± 6.59 for the study group and 49.98 ± 4.74 for the control group ($P = .0202$). Similarly, at the 3-month post-surgery, the HSS scores exhibited a substantial contrast between the study and control groups: 79.71 ± 6.9 versus 72.58 ± 4.9 ($P < .0001$). The cumulative analysis illustrated a statistically significant increase in the average HSS score within the study group in the postoperative phase compared to the control group, refer to Table 1.

Post-Surgical Pain at Various Time Intervals Between Study Groups

Post-surgical pain experienced by the participants was carefully assessed using the VAS. As detailed in Table 2, comparing the preoperative VAS scores and those recorded at 1 day and 3 days post-surgery revealed a consistent reduction in both study groups. Importantly, this reduction was superior in the study group, demonstrating an enhanced trend compared to the control group. The study group exhibited a notable decline in post-surgical pain, with VAS scores of 4.73 ± 1.04 at the 1-day postoperative mark, in contrast to the control group's VAS scores of 5.38 ± 1.03 ($P < .0046$). Similarly, the study group demonstrated a significant decrease in post-surgical pain at the 3-day postoperative evaluation, recording VAS scores of 3.22 ± 1.07, while the control group displayed substantially higher scores of 3.90 ± 1.13 ($P < .0048$).

Lower Limb Muscle Strength at Various Time Points Between Study Groups

FTSST is widely utilized for quantifying the muscle strength of lower limbs. We also used FTSST to assess the lower limb muscle strength in the elderly participants. A marginal variation in the preoperative FTSST timings was identified between the two groups, resulting in values of 78.45±2.80 for the study group and 77.23 ± 3.74 for the control group ($P = .0813$). Significant differences in FTSST timings were observed at the 1-month postoperative evaluation between patients undergoing phased rehabilitation management and the control group (40.94 ± 3.00 vs 44.05 ± 3.73; $P < .0001$). Furthermore, a substantial variation in FTSST timings persisted at the 3-month postoperative assessment, with the study group recording timings of 22.35±3.09 compared to the control group's 29.28 ± 3.91 ($P < .0001$), refer to Table 3.

Activities of Daily Living at Different Time Points Between Study Groups

The estimation of activities of daily living was conducted using the Barthel Index. Pre-intervention evaluations in the two groups revealed insignificant differences in activities of daily living ($P = .3082$), as highlighted in Table 4. At both the

1-month and 3-month postoperative intervals, a significant correlation emerged between phased rehabilitation management and improved activities of daily living. Specifically, the study group showed improved progress in activities of daily living, with scores of 59.08 ± 4.04 at 1 month versus the control group's 56.00 ± 3.62 (P = .0003). Similarly, at the 3-month assessment, the study group exhibited marked advancement in activities of daily living, recording scores of 79.08 ± 4.04 compared to the control group's 73.75 ± 4.20 (P < .0001).

Inflammatory Response Assessment at Different Time Intervals Between Study Groups

The assessment of inflammation levels within the study groups involved the measurement of IL-6, CRP, and ESR. The study and control groups displayed a peak in IL-6 levels on the first-day post-surgery, with mean values of 118.17 ± 9.45 pg/mL and 122.25 ± 7.04 pg/mL, respectively. Subsequently, a declining trend was observed after day 3, resulting in 43.46 ± 9.12 pg/mL levels for the study group and 65.8 ± 6.72 pg/mL for the control group.

Following surgery, both study groups exhibited a significant increase in CRP (mg/L) and ESR (mm/h) levels compared to their respective preoperative levels. A comprehensive overview of these trends is presented in Table 5. The study group showed significantly lower levels of CPR (mg/L) and ESR (mm/h) compared to the control group, highlighting the potential benefits of the phased rehabilitation management approach.

Table 1. HSS of the Two Groups at Multiple Time Points

Group	n	HSS (Score)		
		Before Surgery	1 Month After Surgery	3 Months After Surgery
Study Group	49	40.53±5.95	52.92±6.59	79.71±6.9
Control Group	40	39.65±4.60	49.98±4.74	72.58±4.9
t		0.7670	2.367	5.507
P value		.4451	.0202	<.0001

Note: The table presents the Harris Hip Score (HSS) values for both study groups at various time points.

Table 2. VAS of The Two Groups at Multiple Time Points

Group	n	VAS (Score)		
		Before Surgery	1 Day After Surgery	3 Days After Surgery
Study Group	49	7.24 ± 0.92	4.73 ± 1.04	3.22 ± 1.07
Control Group	40	7.30 ± 0.61	5.38 ± 1.03	3.90 ± 1.13
t		0.3239	2.907	2.898
P value		.7468	.0046	.0048

Note: VAS, Visual Analog Scale; Score: Pain Intensity Score.

Table 3. FTSST of The Two Groups at Multiple Time Points

Group	n	FTSST (s)		
		Before Surgery	1 Month After Surgery	3 Month After Surgery
Study Group	49	78.45 ± 2.80	40.94±3.00	22.35 ± 3.09
Control Group	40	77.23 ± 3.74	44.05 ± 3.73	29.28 ± 3.91
t		1.7630	4.362	9.345
P value		.0813	<.0001	<.0001

Note: FTSST, Five Times Sit-to-Stand Test; s, Seconds (Time Measurement).

Table 4. Barthel Index of The Two Groups at Multiple Time Points

Group	n	Barthel Index (Score)		
		Before surgery	1 month after surgery	3 month after surgery
Study group	49	29.08 ± 4.04	59.08 ± 4.04	79.08 ± 4.04
Control group	40	28.25 ± 3.5	56.00 ± 3.62	73.75 ± 4.20
t		1.0250	3.75	6.084
P value		.3082	.0003	<.0001

DISCUSSION

THA is one of the most efficacious treatments to address the insufficiencies encountered with conservative treatments for elderly patients afflicted by FNF.[19] Postoperatively, patients commonly encounter limitations in joint range of motion, daily activity range, and distance due to pain and muscle tension. Therefore, the functional outcomes of THA are intricately tied to the implementation of appropriate rehabilitation exercises.[20]

Traditional postoperative rehabilitation, while covering psychological and daily life nursing aspects, often falls short due to its limited and singular intervention content. This limitation results in less than optimal clinical outcomes. Phased rehabilitation management emerges as a non-conventional passive nursing approach, supporting a patient-centered paradigm. This approach aims to enhance the clinical effectiveness of patients by adapting to individual patient circumstances, thereby offering a more comprehensive and impactful rehabilitation strategy.[13]

This study enrolled older adults aged 60 or above who underwent THA via the posterolateral approach. These participants were categorized into two groups: those who received conventional postoperative rehabilitation and those who underwent phased rehabilitation management. Postoperative pain emerges as the predominant clinical symptom after FNF surgery.[21] This occurrence can be attributed to the surgical procedure's impact on tissue integrity, releasing numerous inflammatory substances from tissue cells. These substances include leukotriene, histamine, bradykinin, and arachidonic acid.[22,23] These combined factors contribute to the initiation and increase of the postoperative pain experienced by patients.

Table 5. Inflammatory Cytokines of the Two Groups at Multiple Time Points

Group	n	IL-6 (pg/mL)			CPR (mg/L)			ESR (mm/h)		
		Pre-Operation	Postoperative Day 1	Postoperative Day 3	Pre-Operation	Postoperative Day 1	Postoperative Day 3	Pre-Operation	Postoperative Day 1	Postoperative Day 3
Study Group	49	33.56 ± 8.96	118.17 ± 9.45	43.46 ± 9.12	4.89 ± 2.03	76.34 ± 4.41	135.17 ± 4.97	15.19 ± 4.69	33.97 ± 5.16	61.01 ± 5.39
Control Group	40	32.93 ± 7.2	122.25 ± 7.04	65.8 ± 6.72	4.74 ± 1.93	80.27 ± 3.5	141.89 ± 4.3	14.25 ± 5.39	36.93 ± 7.75	65.82 ± 5.7
t		0.3616	2.264	12.89	0.3377	4.584	6.738	0.8813	2.153	4.087
P value		.7185	.0261	<.0001	.7364	<.0001	<.0001	.3806	.0341	<.0001

Note: IL-6, Interleukin-6; CPR, C-reactive protein; ESR, Erythrocyte Sedimentation Rate.

Our study results revealed a significant difference in postoperative pain among patients undergoing phased rehabilitation management exhibiting markedly lower VAS scores. These findings highlight the advantageous impact of phased rehabilitation management in mitigating postoperative pain. Our approach to phased rehabilitation management includes two distinct stages: preoperative and postoperative. The plan covers personalized guidance at different intervals within the postoperative stage. This personalized approach incorporates diverse exercises such as passive training, ankle flexion, and extension, knee and hip flexion and extension, and supported walking routines. Our objective was to foster comprehensive rehabilitation and promote early recovery by carefully addressing each stage.

The findings of our study revealed significant differences between the study group and the control group. Specifically, the study group exhibited significantly reduced time in the FTSST) superior HSS, and a lower Barthel index post-intervention compared to the control group. Numerous clinical studies have explained that patients undergoing THA frequently experience increased inflammatory reactions because of the inherent surgical trauma. These local inflammatory responses play a crucial role in the recovery process after surgery.[24,25]

Our study highlighted a significant difference in IL-6, CPR, and ESR levels post-surgery, indicating significantly lower values in the study group compared to the control group. These findings suggest the efficacy of phased rehabilitation management in alleviating the intensity of the inflammatory response. This inference indicates the potential of phased rehabilitation management in promoting an early postoperative recovery process.

A previous study demonstrated similar findings that phased rehabilitation enhanced postoperative pain management and reduced inflammatory reactions in patients after radical multiple trauma surgery.[26] This consistency in outcomes adds further credibility to our findings. Furthermore, the study by Vangelder et al.[27] highlighted that staged rehabilitation management could improve post-surgical mobility among patients with lumbar disc herniation. These collective insights suggest that staged rehabilitation management holds the potential to improve inflammatory responses and also to increase patient mobility. These results contribute to the improved clinical management of patients undergoing THA.

Study Limitations

Despite the valuable insights garnered from this study, it is crucial to acknowledge certain limitations. Firstly, the study design involved a retrospective approach, which may have introduced inherent biases and hindered the establishment of causal relationships. Secondly, the sample size was confined to a specific age group and surgical approach, potentially impacting the generalizability of the findings to broader populations. Additionally, the study's focus on selected outcome measures might have omitted other relevant aspects of patient recovery. Furthermore, the observational nature of the study precludes controlling for all potential confounding variables that might influence the observed outcomes. Lastly, the absence of long-term follow-up may limit the ability to assess the durability of the effects observed. Recognizing these limitations encourages the context for interpreting the study's findings and points toward possibilities for future research.

CONCLUSION

This study reveals the promising potential of phased rehabilitation management among patients undergoing THA for FNF. Our findings emphasize its multifaceted advantages, including enhanced hip joint function, alleviated postoperative pain, improved muscle strength of lower limbs, and better activities of daily living. Notably, the implementation of phased rehabilitation management resonates with reducing inflammatory responses, further supporting its holistic benefits. These results contribute to the growing body of evidence supporting the efficacy of a patient-centric, phased approach in post-THA recovery. Despite certain limitations, such as its retrospective nature and the confined sample size, it paves the way for future research to potentially refine and expand the scope of phased rehabilitation management's impact on post-THA outcomes.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

The authors report no conflict of interest.

AUTHORS' CONTRIBUTION

Linyu Yang created and designed the project and wrote the paper. Jian Yang and Jiangping Kang generated the data. Han Yang analyzed the data. Daoyin Yang and Lian Tang modified the manuscript. All authors gave final approval of the version to be published and agree to be accountable for all aspects of the work.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Not applicable.

REFERENCES

1. Fischer H, Maleitzke T, Eder C, Ahmad S, Stöckle U, Braun KF. Management of proximal femur fractures in the elderly: current concepts and treatment options. *Eur J Med Res*. 2021;26(1):86. doi:10.1186/s40001-021-00556-0
2. Vazquez O, Gamulin A, Hannouche D, Belaieff W. Osteosynthesis of non-displaced femoral neck fractures in the elderly population using the femoral neck system (FNS): short-term clinical and radiological outcomes. *J Orthop Surg Res*. 2021;16(1):477. doi:10.1186/s13018-021-02622-z
3. Corten K, Holzapfel BM. Direct anterior approach for total hip arthroplasty using the "bikini incision". *Oper Orthop Traumatol*. 2021;33(4):318-330. doi:10.1007/s00064-021-00721-y
4. Lutnick E, Kang J, Freccero DM. Surgical Treatment of Femoral Neck Fractures: A Brief Review. *Geriatrics (Basel)*. 2020;5(2):22. doi:10.3390/geriatrics5020022
5. Lewis DP, Wæver D, Thorninger R, Donnelly WJ. Hemiarthroplasty vs Total Hip Arthroplasty for the Management of Displaced Neck of Femur Fractures: A Systematic Review and Meta-Analysis. *J Arthroplasty*. 2019;34(8):1837-1843.e2. doi:10.1016/j.arth.2019.03.070
6. Guyen O. Hemiarthroplasty or total hip arthroplasty in recent femoral neck fractures? *Orthop Traumatol Surg Res*. 2019;105(1S):S95-S101. doi:10.1016/j.otsr.2018.04.034
7. Cnudde PHJ, Nåtman J, Hailer NP, Rogmark C. Total, hemi, or dual-mobility arthroplasty for the treatment of femoral neck fractures in patients with neurological disease : analysis of 9,638 patients from the Swedish Hip Arthroplasty Register. *Bone Joint J*. 2022;104-B(1):134-141. doi:10.1302/0301-620X.104B1.BJJ-2021-0855.R1
8. Fahad S, Nawaz Khan MZ, Aqueel T, Hashmi P. Comparison of bipolar hemiarthroplasty and total hip arthroplasty with dual mobility cup in the treatment of old active patients with displaced neck of femur fracture: A retrospective cohort study. *Ann Med Surg (Lond)*. 2019;45:62-65. doi:10.1016/j.amsu.2019.07.025
9. McCalden RW, Masters J, Cuthbert AR, et al. CORR Insights®: Do Dual-mobility Cups Reduce Revision Risk in Femoral Neck Fractures Compared With Conventional THA Designs? An International Meta-analysis of Arthroplasty Registries. *Clin Orthop Relat Res*. 2022;480(10):1926-1928. doi:10.1097/CORR.0000000000002353
10. Singh V, Thomas J, Arraut J, et al. Similar Outcomes Achieved Between Anterior and Posterior Approach Total Hip Arthroplasty Using Dual Mobility Implants. *Iowa Orthop J*. 2022;42(1):137-143.

11. Labanca L, Ciardulli F, Bonsanto F, Sommella N, Di Martino A, Benedetti MG. Balance and proprioception impairment, assessment tools, and rehabilitation training in patients with total hip arthroplasty: a systematic review. *BMC Musculoskelet Disord*. 2021;22(1):1055. doi:10.1186/s12891-021-04919-w
12. Day JM, Lucado AM, Uhl TL. A Comprehensive Rehabilitation Program for Treating Lateral Elbow Tendinopathy. *Int J Sports Phys Ther*. 2019;14(5):818-829. doi:10.26603/ijspt20190818
13. Avola M, Mangano GRA, Testa G, et al. Rehabilitation Strategies for Patients with Femoral Neck Fractures in Sarcopenia: A Narrative Review. *J Clin Med*. 2020;9(10):3115. doi:10.3390/jcm9103115
14. Jones CB, Walker JB. Diagnosis and Management of Ipsilateral Femoral Neck and Shaft Fractures. *J Am Acad Orthop Surg*. 2018;26(21):e448-e454. doi:10.5435/JAAOS-D-17-00497
15. Hersnaes PN, Gromov K, Otte KS, Gebuhr PH, Troelsen A. Harris Hip Score and SF-36 following metal-on-metal total hip arthroplasty and hip resurfacing - a randomized controlled trial with 5-years follow up including 75 patients. *BMC Musculoskelet Disord*. 2021;22(1):781. doi:10.1186/s12891-021-04671-1
16. Goldberg A. The five-times-sit-to-stand-test (FTSST), the short version of the activities-specific balance confidence (ABC) scale, and fear of falling predict step execution time (SET) in older adults. *Arch Gerontol Geriatr*. 2012;54(3):434-438. doi:10.1016/j.archger.2011.06.017
17. Liu F, Tsang RC, Zhou J, et al. Relationship of Barthel Index and its Short Form with the Modified Rankin Scale in acute stroke patients. *J Stroke Cerebrovasc Dis*. 2020;29(9):105033. doi:10.1016/j.jstrokecerebrovasdis.2020.105033
18. Shafshak TS, Elnemr R. The Visual Analogue Scale Versus Numerical Rating Scale in Measuring Pain Severity and Predicting Disability in Low Back Pain. *J Clin Rheumatol*. 2021;27(7):282-285. doi:10.1097/RHU.0000000000001320
19. Gausden EB, Cross WW III, Mabry TM, Pagnano MW, Berry DJ, Abdel MP. Total Hip Arthroplasty for Femoral Neck Fracture: What Are the Contemporary Reasons for Failure? *J Arthroplasty*. 2021;36(7S):S272-S276. doi:10.1016/j.arth.2021.02.008
20. De Rosis S, Pennucci F, Lungu DA, Manca M, Nuti S. A continuous PREMs and PROMs Observatory for elective hip and knee arthroplasty: study protocol. *BMJ Open*. 2021;11(9):e049826. doi:10.1136/bmjopen-2021-049826
21. Rogmark C, Kristensen MT, Viberg B, Rönnquist SS, Overgaard S, Palm H. Hip fractures in the non-elderly-Who, why and whither? *Injury*. 2018;49(8):1445-1450. doi:10.1016/j.injury.2018.06.028
22. Nunns GR, Stringham JR, Gamboni F, et al. Trauma and hemorrhagic shock activate molecular association of 5-lipoxygenase and 5-lipoxygenase-Activating protein in lung tissue. *J Surg Res*. 2018;229:262-270. doi:10.1016/j.jss.2018.03.023
23. Chi Y, Liu X, Chai J. A narrative review of changes in microvascular permeability after burn. *Ann Transl Med*. 2021;9(8):719. doi:10.21037/atm-21-1267
24. Wang X, Jiang W, Huang Q, Pei F. Dexamethasone Attenuates the Perioperative Acute Phase Response for Simultaneous Bilateral Total Hip Arthroplasty. *J Arthroplasty*. 2022;37(5):888-891. doi:10.1016/j.arth.2022.01.010
25. Wang D, Yang Y, He C, et al. Effect of Multiple Doses of Oral Tranexamic Acid on Haemostasis and Inflammatory Reaction in Total Hip Arthroplasty: A Randomized Controlled Trial. *Thromb Haemost*. 2019;119(1):92-103. doi:10.1055/s-0038-1676625
26. Peng S, He J, Huang J, et al. Self-management interventions for chronic kidney disease: a systematic review and meta-analysis. *BMC Nephrol*. 2019;20(1):142. doi:10.1186/s12882-019-1309-y
27. Vangelder LH, Hoogenboom BJ, Vaughn DW. A phased rehabilitation protocol for athletes with lumbar intervertebral disc herniation. *Int J Sports Phys Ther*. 2013;8(4):482-516.