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The effectiveness of early mobilization to improve flexibility after arthroplasty knee: a meta-analysis

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ABSTRACT

Background: Knee arthroplasty is a surgical procedure in the knee area to replace the joint with a fixed-bearing implant, after knee arthroplasty functional abilities will decrease. One intervention that can be carried out to improve the function after knee arthroplasty is by providing early mobilization. The purpose of this study was to evaluate how well early mobilization improves knee arthroplasty patients' range of motion.

Methods: This meta-analysis was conducted with a sample size of 9 research studies with a total of 511 subjects. The search for articles was carried out using the PICO criteria consisting of population, namely patients with knee arthroplasty conditions, the intervention provided is early mobilization, comparison with standard care, and outcomes improve flexibility and functional ability.

Results: Meta-analysis of 9 randomized controlled trial studies showed that EM significantly improved the flexibility of TKA patients (SMD=0.56; 95% CI=0.15-0.97, p=0.007), although with high heterogeneity (I2=79%) and indications of publication bias. Conclusion: EM is effective in improving the flexibility of patients after knee surgery.

Conclusion: Early mobilization can increase flexibility compared to patients who are only given standard care.

Keywords: early mobilization, flexibility, total knee arthroplasty, functional ability.
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INTRODUCTION

An arthroplasty is a surgical treatment used to replace the damaged joint area in order to improve quality of life and restore joint function.[1] The lower limbs are frequently the subject of arthroplasty due to their significant role in providing body support. Total knee arthroplasty (TKA) is a common type of lower extremity arthroplasty. Knee arthroplasty is a surgical procedure in the knee area to replace the joint with a fixed-bearing implant.[2] According to Bager *et al* osteoarthritis is a major problem underlying TKA with cases increasing in obese and elderly populations.[3] Osteoarthritis is progressive and chronic, which can cause pain to become more severe and cause disability in patients so patients will experience limitations in daily activities.[23] Based on orthopedic surgery data, TKA is one of the most commonly performed procedures in Western countries, with an incidence ranging between 150 and 200 per 100,000 people worldwide.[4]

After arthroplasty knee, pain and stiffness in the knee will be reduced. Functional abilities include limited lower limb mobility, balance stability, walking ability, and decreased flexibility.[5] Any decrease in flexibility can result in a range of limitations from reduced performance for light tasks such as sitting or dressing to a lack of coordination of movement, hence flexibility is essential for normal movement.[6]

Complications that occur after TKA include infection, nerve and vascular damage, instability, dislocation and loosening.[7] To optimize surgical outcomes and overcome limitations in lower limb mobility, an intervention is needed that can increase joint range of motion and flexibility and reduce complications that can arise after surgery.[8] Early mobilization is critical to the effectiveness of short-term inpatient programs following surgery, according to Ripoll et al.[9]

Patients engage in activities or change their positions many hours following surgery, known as early mobilization.[10] Moreover, early mobilization is described as physical exercise that improves the body and raises consciousness, strength, and range of motion while utilizing the proper interventions.[11] Both passive and active range of motion activities, such as active side turning, bed cycling, bed exercises, etc., can be included in early mobilization programs.[12] Early mobilization is a broad term of mobilization intervention, therefore it can be interpreted more specifically. A variety of early mobilization techniques were used in this study, such as home-based imagery, active heel sliding exercise, virtual reality, stretching, strengthening, stabilizing, balancing, and rigorous functional therapy.

In previous studies related to TKA, it was mentioned that early mobilization could improve functional abilities in

patients, one of which was in the research of.[13] which discusses early mobilization in the form of active heel-slide exercise. The study examined the active heel-slide exercise (AHSE) and regular physical therapy (PT) with continuous passive motion (CPM) therapies provided to TKA patients. According to the results, patients receiving total knee replacement (TKA) did not significantly increase ADL following early mobilization in the manner of intense functional rehabilitation. This was because the AHSE group was able to complete straight leg raise motions earlier than the CPM group.[14]

Based on the issues with post-knee arthroplasty and the type of treatment that was offered. The purpose of this study was to use meta-analysis to examine and debate the efficacy of early mobilization in patients recovering from total knee arthroplasty.

METHODS

This research uses meta-analysis, meta-analysis is a form of research that refers to quantitative methods that are systematically organized, so as to conclude the results of previous studies.[15] There were 9 articles in this study with a total of 511 subjects divided into 2 groups. The early mobilization treatment group was 261 subjects and the standard care group was 250 subjects.

The research conducted by the author was based on inclusion and exclusion criteria. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram and population, intervention, comparison, and outcomes (PICO) criteria were employed in the selection of research publications. PICO criteria consist of population, namely patients with knee arthroplasty conditions, the intervention provided is Early mobilization, comparison with standard care and outcomes improve flexibility & functional abilities.

The present investigation employed inclusion criteria consisting of randomized controlled trials (RCT) design, post-TKA patients as research subjects, lower extremity mobilization as the intervention, and published literature from 2018 to 2021.

Exclusion criteria in this study were studies with systematic reviews and meta-analyses, research subjects before TKA, and literature published before 2018. The standard mean deviation value is then computed using the review manager application (RevMan 5.3) made available by the Cochrane collaboration to examine the collected data. Data processing involved calculating effect sizes and evaluating heterogeneity with random effects model data analysis.

RESULTS

Several online journal databases, such as Google Scholar, Research Gate, and PubMed, were used to conduct journal searches. "Knee Arthroplasty," "Early Mobilization," and "randomized controlled trial" were the search terms utilized. retrieved 2228 journals between 2018 and 2021. These were subsequently filtered into 819 journals, and by using inclusion and exclusion criteria to determine the relevance of the research design, 1409 journals were obtained. 24 journals that met the research goals were chosen from a total of 356 journals that were evaluated for eligibility. Nine journals could be included in this meta-analysis study after a total of fifteen journals were eliminated for not meeting the inclusion criteria. Figure 1 shows a summary of the selection of studies.

The meta-analysis on the efficaciousness of early mobilization to enhance flexibility following knee surgery comprised a total of nine research studies. The research studies involved a total of 511 research subjects (Table 1).

Following the identification of pertinent journals, a reliable assessment of the clinical trial methodology's quality was carried out using a PEDro scale to generate

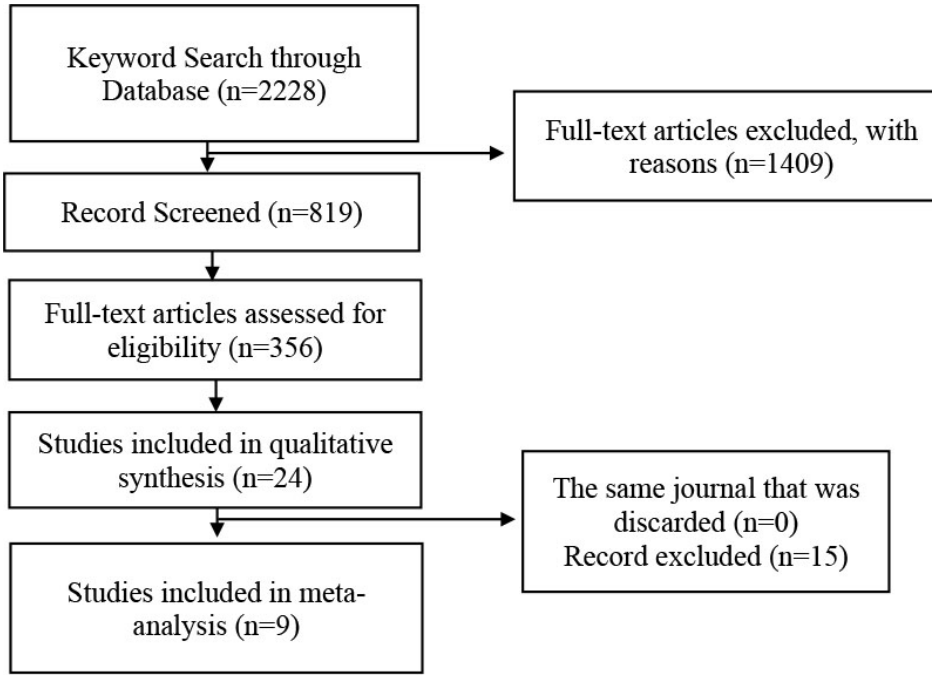

Figure 1. PRISMA Flow Chart.

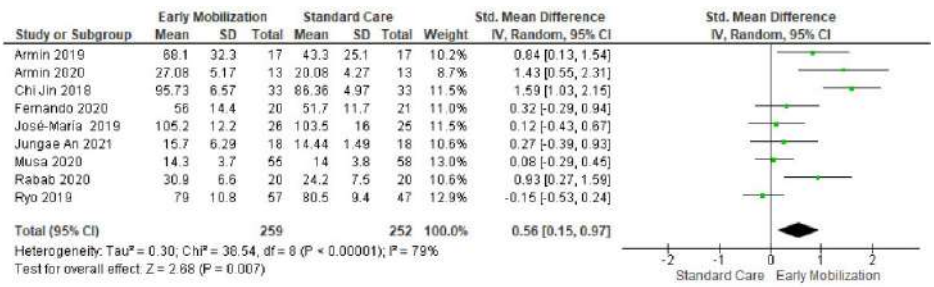

Figure 2. Forest Plot.

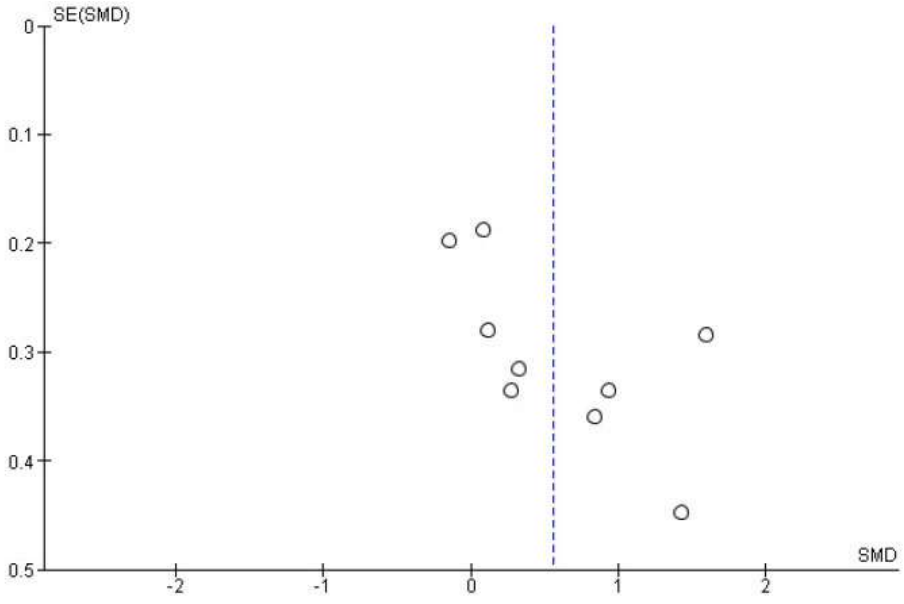

Figure 3. Funnel Plot.

a total score. This score can be utilized as an interval-level measurement and is then amenable to parametric statistical analysis (Table 2).

The analysis in this study (Figure 2) revealed that patients who underwent early mobilization after total knee arthroplasty had 0.56 units more flexibility than patients who received standard care (SMD = 0.56; 95% CI = 0.15 to 0.97). These differences were statistically significant (p = 0.007). The study's data heterogeneity revealed an I2 = 79% random effect model.

Publication bias is indicated by the funnel plot, which displays the distribution of impact estimates from primary studies using this RCT meta-analysis design lying more to the left than to the right of the mean vertical line (Figure 3). The publication bias tends to minimize the true impact of early mobilization on improving flexibility in patients undergoing total knee arthroplasty because it is oriented to the left of the mean vertical line, which differs from the location of the diamond shape in the forest plot.

DISCUSSION

Based on a previous journal by Jin *et al* with a method carried out as many as 66 OA patients who underwent TKA were randomized in 2 groups, namely the experimental group with VR rehabilitation and control with conventional rehabilitation. At 3, 7, and 14 days following total knee arthroplasty (TKI), the experimental group's knee range of motion (ROM) was considerably greater than that of the control group (P<0.05).[16]

According to earlier research published in journals by Tanaka et al., 104 patients with osteoarthritis in their knees who had total knee arthroplasty (TKA) were randomly assigned to the experimental group, where 57 received standard care and the control group, which received standard care and the Intensive Functional Rehabilitation (IFR) program. 42 patients who were in the experimental group and control group had their functional independence measure (FIM) and barthel index (BI) scores measured two weeks after surgery. The results demonstrated that, in comparison to standard care, the two-week IFR program did not significantly improve ADL.[14]

Research conducted by Navarro *et al* divided into two groups, namely the experimental group with two types of programs, namely patients who were only given strengthening totalling 28 people and patients who were given strengthening + balance exercise totalling 28 people, and the control group totalling 26 people. One week prior to surgery, two weeks following surgery, and six weeks following surgery were allotted for the program. The Knee Injury and Osteoarthritis Outcome Score-Activity Daily Life (KOOS-ADL) revealed, with a total score of p<0.001, that the strengthening and strengthening + balance groups performed better than the control group from the start to one week prior to surgery. Six weeks following the operation, the control group's knee extensor muscle strength was significantly lower in the strengthening and strengthening + balance groups.[24]

Based on previous journals by Paravlic *et al* which used a randomized controlled experimental method conducted according to the consolidated standards of reporting trials (CONSORT) guideline with the patient program randomly assigned to the motor imagery practice (MIP) exercise group performed 15 minutes per day for 5 days per week and the control group only did physical therapy for 4 weeks. Significant variations were observed in the control group's response to the MIP therapy, as evidenced by a reduced decline in strength (ES = 1.15, 95% CI: 0.32, 1.99, p = 0.022) and an improvement in sit-stand performance (ES = 1.45, big, 95% CI: 0.58, 2.31, p = 0.004). It was demonstrated that the inclusion of Motor Imagery Practice (MIP) increased the operated knee's maximal isometric extension strength.[18]

Based on previous journals by Blasco *et al* which use a three-group randomized controlled trial method with participant criteria with an age range between 60-80 years. There were 86 participants in this journal article, 77 of whom were analyzed and had an average age of 72.1 (SD 7.6) years, with 68% of the participants being female. The Knee Injury and Osteoarthritis Outcome Score Function in Activities in Daily Living (KOOS-ADL) and the Berg Balance Scale were the primary outcome measures. Secondary assessments focused on knee function, balance and mobility, quality of life, and self-reported outcomes, with the primary endpoint being six weeks following surgery. The home group and the hospital group were the interventions. The home group received the same instruction, but in a domiciliary setting, while the hospital group participated in a 4-week preoperative outpatient balancing intervention. All that was required of the control group was that they carry out their regular tasks. Results showed that

Table 1. Characteristics of each journal

No	Title	Author	Year	Amount Respondents	Journal Origin	Intervention Early Mobilization	Control Standard Care
1	Virtual reality intervention in postoperative rehabilitation after total knee arthroplasty: a prospective and randomized controlled clinical trial	Jin *et al.*	2018	66 people	China	93.73 ± 6.57	86.36 ± 4.97
2	Effect of an intensive functional rehabilitation program on the recovery of activities of daily living after total knee arthroplasty: A multicenter, randomized, controlled trial	Tanaka *et al.*	2019	104 people	Japan	79.0 (10.8)	80.5 (9.4)
3	A randomized controlled trial assessing the efects of preoperative strengthening plus balance training on balance and functional outcome up to 1 year following total knee replacement	Dominguez-Navarro*et al.*	2020	41 people	German	56.0 (14.4)	51.7 (11.7)
4	Specific and general adaptations following motor imagery practice focused on muscle strength in total knee arthroplasty rehabilitation: A randomized controlled trial	Paravlic *et al.*	2019	34 people	USA	117.3 ± 48.6	134.3 ± 47.1
5	The effects of preoperative balance training on balance and functional outcome after total knee replacement: a randomized controlled trial	Blasco *et al.*	2019	51 people	United Kingdom	105.2 (12.2)	103.5 (16.0)
6	Effects of Preoperative Telerehabilitation on Muscle Strength, Range of Motion, and Functional Outcomes in Candidates for Total Knee Arthroplasty: A Single-Blind Randomized Controlled Trial	An *et al.*	2021	36 people	Switzerland	15.70 ± 6.29	14.44 ± 1.49
7	Home-based motor imagery intervention improves functional performance following total knee arthroplasty in the short term: a randomized controlled trial	Paravlic *et al.*	2020	26 people	United Kingdom	27.08 ± 5.17	20.08 ± 4.27
8	Active heel-slide exercise therapy facilitates the functional and proprioceptive enhancement following total knee arthroplasty compared to continuous passive motion	Eymir *et al.*	2020	113 people	Jerman	14.3±3.7	14.0±3.8
9	Comparison of two different models of rehabilitation programs following total knee replacement operations	Zaghlol *et al.*	2020	40 people	Mesir	30.9 ± 6.6	24.2 ± 7.5

the hospital group and home group had a better effect than the control group on increasing knee flexion.[17]

An et al.'s earlier journals provide information on the effects of a preoperative Telerehabilitation Program (PT) on knee joint range of motion (LGS), muscle strength, and functional outcomes in TKA candidates. This study included 60 participants, all of whom were scheduled for bilateral TKA and had an average age range of 70.53 ± 2.7 years. The method used was a single-blind randomized controlled trial method with three groups, parallel groups, and single-blind. The physical treatment program implemented following surgery involved cold compress therapy, intermittent pneumatic compression, and continuous passive motion training. On the next day, manual treatment, cryotherapy, and

Table 2. ***PEDro Scale*** **result**

PEDro Scale	Jin Chin *et al.*, (2018)	Tanaka Ryo *et al.*, (2019)	Navarro Dominguez Fernando *et al.*, (2020)	Paravlic Armin H *et al.*, (2019)	Blasco Jose-Maria *et al.*, (2019)	An Jungae *et al.*, (2021)	Paravlic Armin H *et al.*, (2020)	Musa Eymir *et al.*, (2020)	Zaglol Rabab S (2020)
Eligibility	1	1	1	1	1	1	1	1	1
Random allocated	1	1	1	1	1	1	1	1	1
Concealed allocation	1	1	1	1	0	1	1	1	1
Baseline Comparability	1	0	1	1	1	1	1	1	1
Blinding all subjects	0	1	0	0	0	1	1	0	1
Blinding all therapist	0	0	1	1	0	1	1	0	1
Blinding all assessors	0	1	1	1	0	1	0	0	1
Adequate follow-up	0	0	1	0	1	0	0	1	1
Intention-to-treat analysis	1	1	1	1	0	1	1	1	1
Between-group comparisons	1	1	1	1	1	1	1	1	1
Point estimated variability	1	1	1	1	1	1	1	1	1
Score	6/10	8/10	10/10	9/10	6/10	9/10	8/10	7/10	10/10
Quality	Good	Excellent	Excellent	Excellent	Good	Excellent	Excellent	Good	Excellent

weight-bearing with the use of a walker were all used. The third week added resistance training, strength training, and walking up and down stairs. The results showed that it could improve the Deviation of the knee joint axis compared to the control group.[19]

Paravlic *et al* in their research used the RCT method by dividing into 2 groups, each group consisting of 13 patients. While the control group only got RPT, the motor imagery (MI) program group also received either MIp or routine physical therapy (RPT). MI is a type of physical activity without bodily movement that is administered to patients with the goal of improving motor performance and flexibility over the course of five days. After receiving MI exercises, participants are encouraged to take a two-day break from the program. MIp results showed significant improvement in the Oxford Knee Score (OKS) when compared to the control group.[20]

Based on a prior publication by Eymir et al. that sought to ascertain postoperative outcomes by comparing active heel-slide AHSE + PT with CPM + PT during inpatient rehabilitation of TKA patients. Patients are allocated at random to the AHSE and CPM groups as part of the procedure. Following that, during their hospital stay, both groups got PT therapies, such as joint mobility exercises, strengthening, and ambulation. Outcome assessments were conducted preoperatively, at hospital discharge, and postoperatively. Results showed that AHSE at month 3 postoperative was better than CPM in terms of functional improvement.[13]

Forty patients in total were split into two groups of 20, each, by Zaghlol et al. for their research. The first group received a high intensity (HI) rehabilitation program, while the second group had a traditional low intensity (LI) rehabilitation program. Within one week of the patients' hospital release, the two groups' rehabilitation programs began, with a total of 24 visits spread over 12 weeks (twice a week). Each 45–50 minutes training session was held. With four phases, resistance training is the main focus of the HI program. Simple workouts like heel slides, squats, active knees, and ankles make up Phase 1 (weeks 0-2). Phase 1 exercises, such as active straight leg raises, muscular stretches, and sit-stand exercises, are included in phase 2 (weeks 0-4). Exercises that grow in intensity from phase 2 to phase 3 (weeks 2-12) include wall exercises, stair-climbing (stepping) activities, and single-leg calf workouts. Lastly, phase 4 (weeks 6–12) marks the start of eccentric resistance training and the continuation of the exercise regimen from phase 3. In stage 3, strengthening exercises that met the same developmental criteria as the HI program were gradually introduced, while the first two stages of the LI rehabilitation program were similar to the HI program. The data demonstrated that while low- and high-intensity rehabilitation programs were equally successful, the HI program outperformed the LI program in terms of functional gains and patient-reported outcomes.[21]

The study conducted by Harikesaven et al., titled Influence of early mobilization programs on pain, self-reported, and performance-based functional parameters following total knee replacement, is consistent with the aforementioned research. Early mobilization is defined as occurring no later than seven hours following total knee replacement surgery. The study's findings demonstrated a notable improvement in knee range of motion and a change in knee strength (ROM).[22]

Most trials had varying and frequently insufficient methodological quality and reporting. Few research used blinded assessors. Lack of information in many reports may not always mean that the trial was poorly executed, but in the absence of this information, it is challenging to determine the degree of bias in each experiment. The methodological

quality of trials in physiotherapy for TKA needs to be further improved.

CONCLUSION

Based on the data obtained, it can be concluded that the effect of early mobilization on postoperative knee patients is effective in increasing flexibility compared to patients who are only given standard care.

ETHICAL CLEARANCE

This meta-analysis used publicly accessible documents as evidence and did not require institutional ethics approval.

CONFLICT OF INTEREST

There is no conflict of interest that the author declares following the publication.

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This study received no grant from any institution.

AUTHOR CONTRIBUTIONS

AP; conceived the study design and analyzed the data. DTA; analyzed the data, drafted the manuscript drafted the manuscript and interpreted the data analysis. I; collected and analyzed the data, drafted the manuscript, drafted the manuscript and interpreted the data analysis AK; collected and analyzed the data, and drafted the manuscript. PIFA; drafted the manuscript and interpreted the data analysis. SW; drafted the manuscript and interpreted the data analysis.

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