SYSTEMATIC REVIEW

Hip Strengthening After Total Knee Arthroplasty: A Meta-analysis and Systematic Review

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Received: 14 November 2023 *Accepted: 5 March 2024*

Abstract

Objectives: As the population is growing older, incidence of knee osteoarthritis is largely increasing and the rate total knee arthroplasty surgery is following that same trend. However, patients post-operatively are retaining weakness in the quadriceps and hip abductors for a period reaching up to 3 years following surgery. The current literature results on the effectiveness of rehabilitation programs that also includes hip strengthening exercises are still highly contradicting. This meta-analysis studies and assesses the efficacy of hip strengthening exercises following total knee arthroplasty surgery.

Methods: PubMed, Embase, Cochrane and Google Scholar (page 1-20) were searched till January 2024. The clinical outcomes consisted of the post-operative tests (6MWT, TUG, SLS), pain, and range of motion (flexion and extension).

Results: Three randomized clinical studies were included in the meta-analysis. When compared to the standard rehabilitation, hip strengthening exercises proved a better improvement of single leg stance with no difference observed in the remaining outcomes.

Conclusion: Hip strengthening exercise protocols ensured a better improvement of single leg stance scores. However, no difference was observed in the remaining analyzed outcomes. This contradictions between studies can be explained by the different physical therapy protocols used. Nevertheless, more randomized controlled studies are needed to confirm such results.

Level of evidence: II

Keywords: Hip abductors, Knee osteoarthritis, Rehabilitation, Total knee arthroplasty, Total knee replacement

Introduction

Joint osteoarthritis is a common chronic joint disease that increases with growing ages and about one-third of persons will eventually develop osteoarthritis (OA).[1] to diminish or minimize the pain, the majority of those elderly individuals will undergo total knee arthroplasty surgery (TKA). TKA is considered an effective management tool in reducing symptoms, improve quality of life, and bring patients to preoperative functional levels six months following surgery.[2,3] However, total knee arthroplasty surgery by itself might not obtain the same end results if a proper post-operative strengthening protocol is not implemented.

When compared to healthy, age-matched controls, some patients report chronic muscular weakness, continued daily functional challenges, and persistent post-operative pain , despite clinical improvement.[4-7] Following TKA, weakness in the quadriceps and hip abductor muscles might persist for longer than 3 years.[6] These patients perform worse than expected on multiple functional outcomes and they will report more trouble achieving daily functional duties.[5-7] Therefore, it is mandatory for postoperative rehabilitation programs to address this population's rising functional deficits and persistent muscular weakness.

Most post-operative rehabilitation programs aim to regain quadriceps strength; however, functional limitations persist long after these programs ends. Some evidence suggested that hip abductor strength affects physical function after TKA and increasing hip strength following those surgeries may enhance those results.[8-10] additionally, it has been demonstrated that hip abductor strength

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present a stronger correlation with functional performance compared to quadriceps strength.[10]

Until now, there is still no consensus regarding hip abductor rehabilitation following TKA and most of the present studies are still contradictive.[11-13] Therefore, this meta-analysis consists of assessing the significance of hip muscles strengthening in patients following total knee arthroplasty surgery.

Materials and Methods

Search strategy

This study followed the PRISMA guidelines. PubMed, Embase, Scopus, Google Scholar (page 1-20) were searched updated to January 2024 (using the following keywords and Boolean terms ("Arthroplasty" OR "Replacement") AND "Knee" AND "Hip" AND ("Rehab*") in Pubmed and Embase, "Hip", "Rehabilitation", "Knee", and "Replacement" (Title/abstract) in cochrane, and "Hip", "Rehabilitation", "Knee", and "Replacement" in google scholar for the qualified studies in order to study the efficacy of hip abductors strengthening after TKA. Reference lists from articles were tracked, and online searches were used to find additional literature. One author (AG) verified the selection of the articles after another (MD) had extracted the data. The PRISMA flowchart provides an overview of the search method [Chart 1].

Inclusion criteria consisted of comparative studies comparing patients who underwent a total knee arthroplasty with hip abductors strengthening performed post-operatively to a second group with a standard rehabilitation protocol. Non-comparative studies, or studies with irrelevant outcomes were excluded.

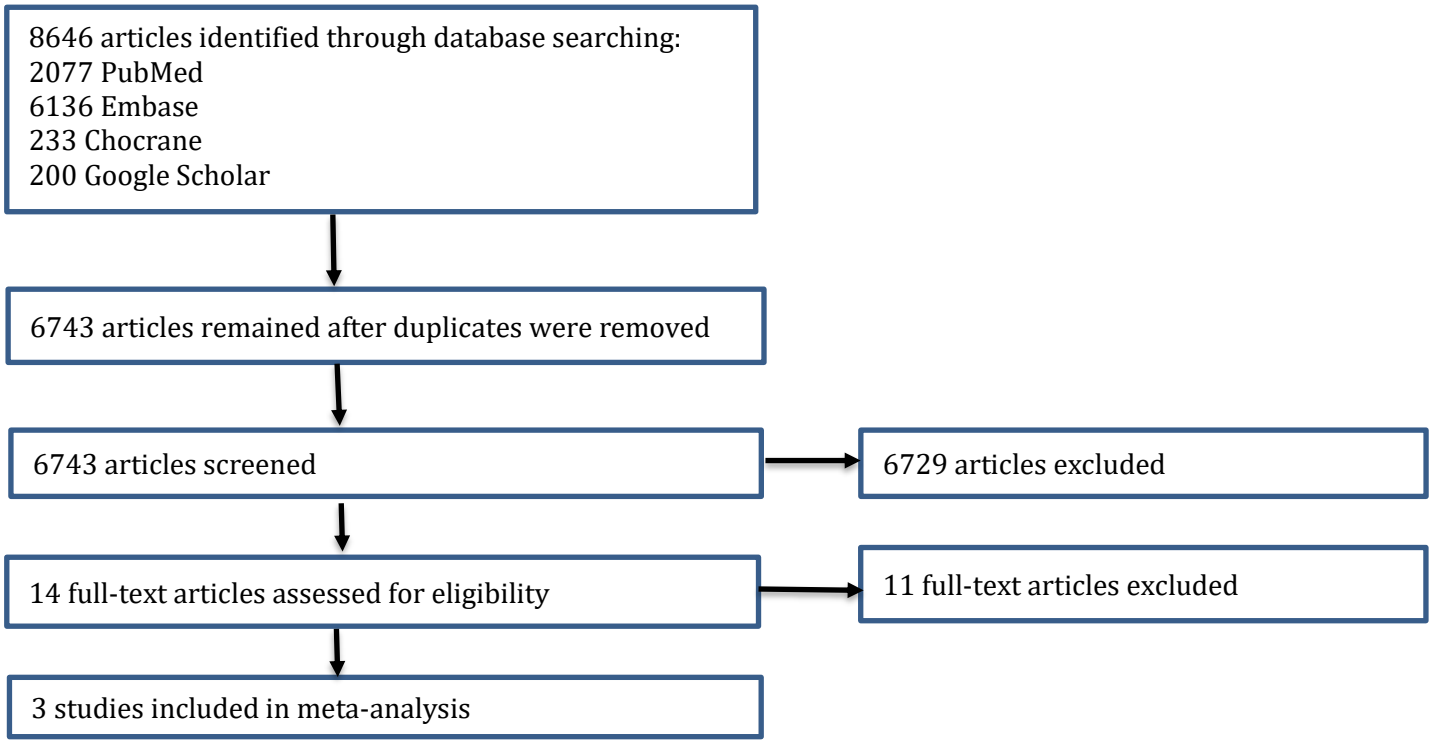

Chart 1. PRISMA flowchart for article selection process

Data extraction

The studies' eligibility was independently assessed by two reviewers. The analyzed data consisted of the 6 Minutes Walking Test (6MWT), the Timed Up and Go (TUG) test, the Single Leg Stance (SLS) test, the pain level, flexion, and extension. Any disagreement that arose between the investigators was worked out through conversation.

inadequate outcome data; and selective reporting. Trials with low risk of bias for all key domains were deemed to be at low risk of bias; those with high risk of bias for more than one key domain were deemed to be at high risk of bias; trials with low risk of bias for any other key domain were deemed to be at unclear risk of bias.

Risk of bias assessment

By utilizing the Cochrane risk-of-bias method, two researchers (MD and AG) evaluated the risk of bias separately. Each trial's risk of bias was evaluated and rated as high, low, or unclear: random sequence generation; allocation concealment; participant and staff blinding to the research procedure; blinding of outcome assessment;

Statistical analysis

The statistical analysis was performed using Review Manager 5.4 (The Cochrane Collaboration, 2020). Standardized mean differences (SMD) were utilized with 95% confidence intervals (CI). Q tests and I2 statistics were

used to evaluate heterogeneity indicating considerable heterogeneity if $p \leq 0.05$ or $I2 > 50\%$. The latter was handled by the random-effects model, otherwise the fixed-effect model was chosen. Statistical significance threshold was p=0.05.

Results

Characteristics of the included studies

Three studies were included in this meta-analysis [11–13]. All were randomized controlled trials who met the inclusion criteria. This study involved 77 subjects in the hip strengthening protocol group compared to 74 subjects in the standard rehabilitation group. The main characteristics of the included studies are summarized in [Table 1]. The results of the Bias assessment are summarized in [Figure 1A, B].

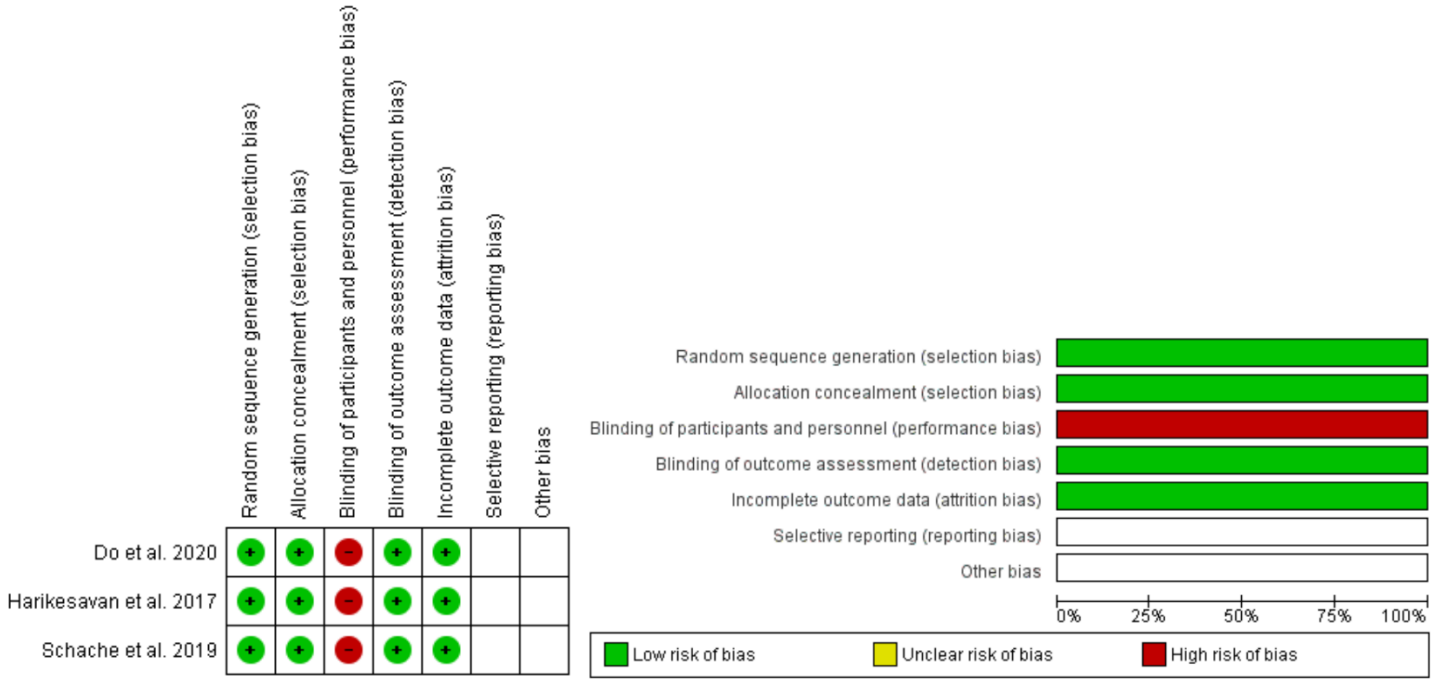

Figure 1. (A): Risk of bias item for each included study. (B) Risk of bias item presented as percentages across all included studies

Table 1. Main characteristics of the included studies

	Methods	Participants		Mean age (SD)		Measured Outcomes	Follow-up time
		Hip rehab	Standard rehab	Hip Rehab	Standard rehab		
Do & Yim 2020 [12]	Randomized Controlled Trial	19	16	72.84 7.03	73.13 NA	Flexion, extension, WOMAC-P, WOMAC-F, AST, FTSST, TUG, SLS, 6MWT, stride, single stance, double stance, speed	12 weeks
Harikesavan et al. 2017 [11]	Randomized Controlled Trial	10	10	63.3 5.4	62.8 5.9	6MWT, SLS, TUG, pain	12 months
Schache et al. 2019 [13]	Randomized Controlled Trial	48	48	70 7	69 7	Pain, flexion, extension, chair stand, stair climb, TUG, 40 m fast spaced walk, 6MWT, step taps, KOOS, LEFS, SF12	26 Weeks

Post-operative Tests

MWT

Three studies on 151 subjects reported data on post-operative 6MWT results. The results showed no differences between Standard rehabilitation, and hip abductors strengthening (Mean Difference, 54.6; 95% CI -21.21–130.4, p=0.16, [Chart 2A]).

TUG

Three studies on 151 subjects reported data on post-operative TUG results. The results showed no differences between Standard rehabilitation, and hip abductors strengthening (Mean Difference, -2.45; 95% CI -5.65–0.76, p=0.13, [Chart 2B]).

SLS

Two studies on 55 subjects reported data on post-operative SLS results. The results showed that when compared to Standard rehabilitation, hip abductors strengthening showed better results (Mean Difference, 2.43; 95% CI 0.47–4.38, p=0.01, [Chart 2C]).

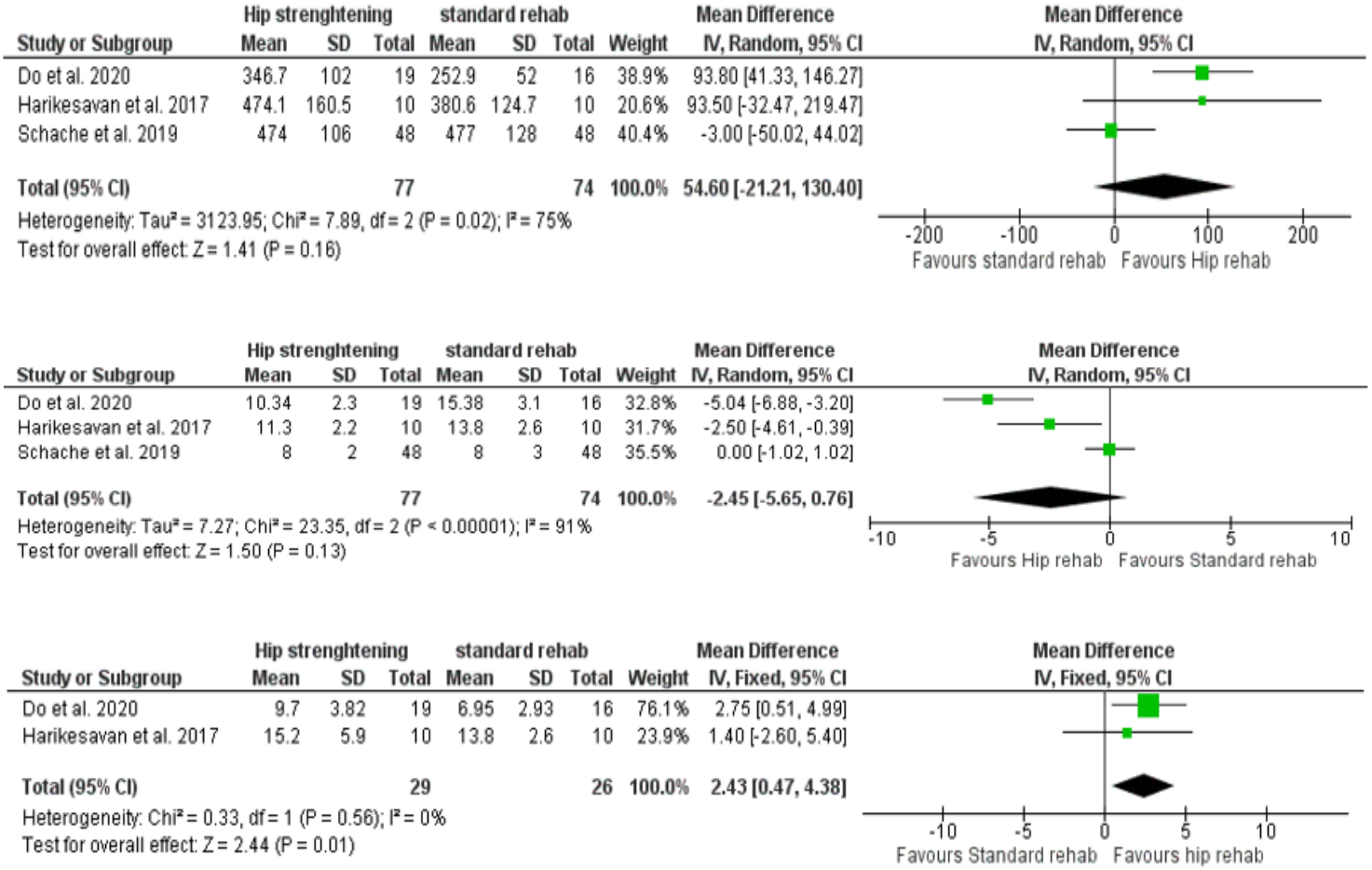

Chart 2. (A): Forest plot showing the post-operative 6MWT results in hip strengthening rehabilitation and standard rehabilitation. (B): Forest plot showing the post-operative TUG results in hip strengthening rehabilitation and standard rehabilitation. (C): Forest plot showing the post-operative SLS results in hip strengthening rehabilitation and standard rehabilitation

Pain

Two studies on 116 subjects reported data on post-operative pain. The results showed no statistically significant difference between standard rehabilitation and hip abductors rehabilitation (Mean Difference, -0.39; 95% CI -1.66–0.88, p=0.55, [Chart 3]).

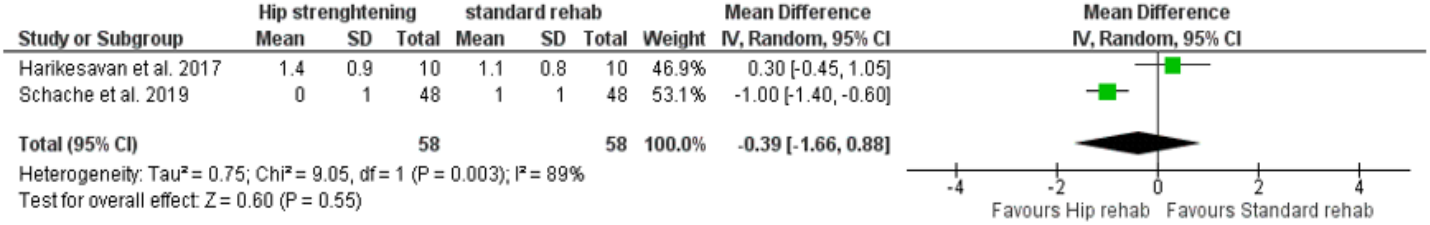

Chart 3. Forest plot showing the post-operative pain in hip strengthening rehabilitation and standard rehabilitation

Range of Motion

Two studies on 131 subjects reported data on the post-operative range of motion (flexion and extension). The results showed no differences between Standard rehabilitation, and hip abductors strengthening in both flexion (Mean Difference, 2.4; 95% CI -0.19–4.98, p=0.07, [Chart 4A]), and extension (Mean Difference, 0.01; 95% CI -0.59–0.62, p=0.96, [Chart 4B]).

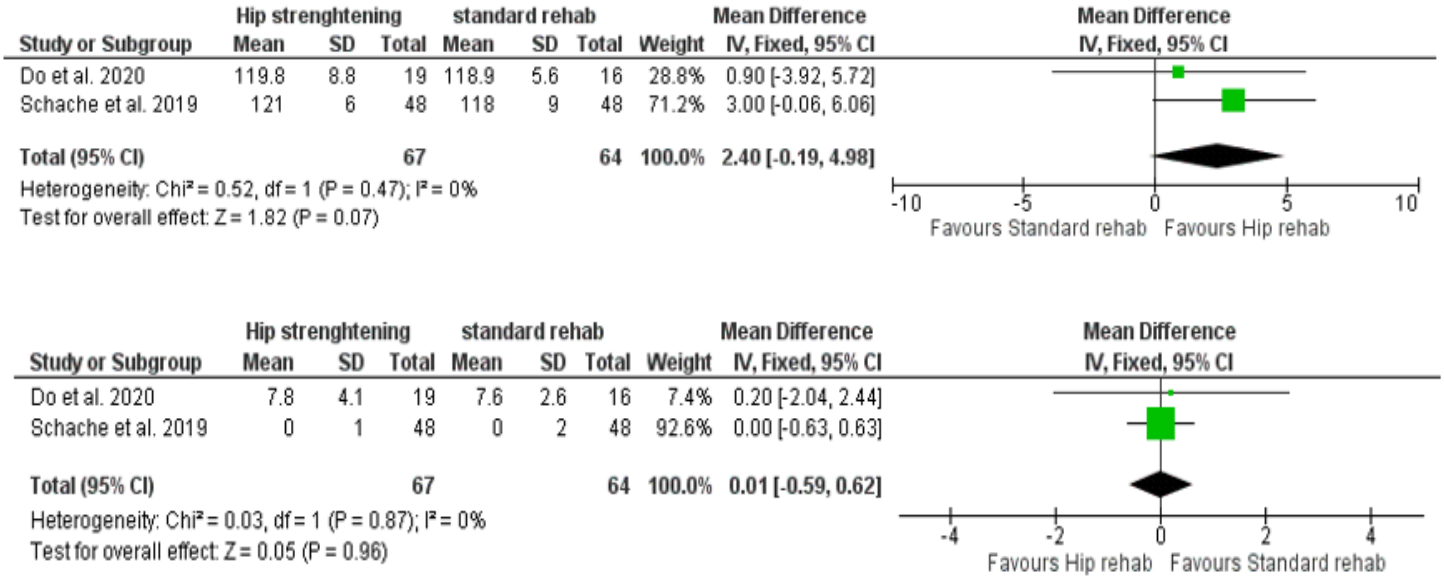

Chart 4. (A): Forest plot showing the post-operative flexion in hip strengthening rehabilitation and standard rehabilitation. (B): Forest plot showing the post-operative extension in hip strengthening rehabilitation and standard rehabilitation

Discussion

In our modern days, total knee arthroplasty is an increasing surgical intervention.[1] Nevertheless, this surgical is associated with persistent chronic muscle weakness in both the quadriceps muscle and hip abductor muscle groups. This weakness might persist for more than 3 years post-operatively.[6] However, post-operative rehabilitation programs focus solely on quadriceps strengthening rather than paying more attention to hip abductor muscle groups. The data assessing the efficacity of hip abductors strengthening after TKA is still unclear. For that reason, this meta-analysis compares hip abductors strengthening rehabilitation programs to the standard post-operative protocol in relation to three factors: 1) post-operative tests, (the 6MWT which assesses the distance walked in 6 minutes, TUG test which uses the time that a person takes to rise from a chair, walk three meters turn around 180 degrees, walk back to the chair, and sit down while turning 180 degrees, and the SLS test which assesses the time that the patient can keep standing on one leg.), 2) post-operative pain, and 3) range of motion while using different methods. The hip abductors strengthening group proved better single leg stance when compared to standard protocol however, there was no difference between both groups in the other studied outcomes.

According to a previous study performed by Sled et al, patients with knee joint osteoarthritis experienced less pain and improved functional outcomes when hip muscles and proximal core strengthening was involved compared to single peri-joint knee muscles.[14] This study finding raised the possibility that proximal hip muscles, may be more responsible in the mechanical changes around the knee joint. However, our results showed no difference in the 6MWT TUG tests, and post-operative pain between both rehabilitation protocols. Some of the contradictin results observed between those studies can be attributed to the difference in the rehabilitation protocols. However, adding extra physical therapy sessions can increase the cost of rehabilitation reducing its accessibility to the patients.[13]

Nevertheless, SLS results were improved when hip abductors were strengthened. This can be explained by the fact that lateral and medial hip muscles are crucial for stabilizing the pelvis and trunk.[15-19] This was proved by our results as well as a study performed by Do et al.[12] Since the Single leg stance test requires the subjects to balance on a single leg, it appears that stabilizing the muscles that govern hip movement in the frontal plane had a bigger effect on stabilizing the pelvis and trunk rather than stabilizing the knees in the sagittal plane.[12]

In fact, our results showed no difference between both groups in the post-operative range of motion (flexion and extension). Furthermore, a study by Schache et al. reported

no added value of the hip abductors strengthening in terms of functional scores (KOOS score)[13] as did other studies performed by Henderson et al. and Bade et al.[20,21] In addition, studies demonstrated that hip abductor strength during non-specific functional activities has highly comparable results when compared to targeted hip abductor protocols when to hip abductor rehabilitation. Additionally, the fact that only randomized controlled trials were included in this meta-analysis reduced the possibility of operative matching and other forms of bias. Lastly, a more selective selection procedure reduced the possibility of bias and made the study less heterogeneous. However, there are certain limitations in this study: The number of included studies is limited, and the data used for analysis was pooled because individual patient data were unavailable, which could limit more thorough analyses. Furthermore, each study had different inclusion and exclusion criteria for patients, as well as rehabilitation programs.

Conclusion

This study is the first meta-analysis assessing the efficacity of hip strengthening exercises following total knee arthroplasty. Hip strengthening protocols showed a better improvement of Single leg stance results. However, there was no significant difference in the remaining analyzed outcomes such as the 6 minutes walking test, timed up and go test, post-operative pain, and post-operative flexion and extension This contradictions between studies can be explained by different physical therapy sessions intensity and frequency in the hip strengthening group which might increase the costs of post-operative rehabilitation protocols. Nevertheless, additional randomized controlled studies analyzing cost-effectiveness and added value of undergoing these additional rehabilitation exercises.

Strengths and limitations

This is the first meta-analysis that compares typical rehabilitation regimens after total knee arthroplasty implemented.[13]

Acknowledgement

Not applicable

Conflict of interest: None

Funding: None

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