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The Effectiveness of Postoperative Physical Therapy Treatment in Patients Who Have Undergone Arthroscopic Partial Meniscectomy: Systematic Review With Meta-analysis

STUDY DESIGN: Systematic review with meta-analysis.

OBJECTIVES: To evaluate the effectiveness of postoperative physical therapy treatment for patients who have undergone arthroscopic partial meniscectomy.

BACKGROUND: There is no consensus on which treatment is best for patients post meniscectomy.

METHODS: A search for articles published from 1950 to March 2013 was conducted in the MEDLINE, Embase, CINAHL, LILACS, SciELO, IBECS, Scopus, Web of Science, PEDro, Academic Search Premier, and Cochrane Central Register of Controlled Trials databases. The key words were *physiotherapy, physical therapy modalities, exercise therapy, rehabilitation, knee, placebo, groups, tibial meniscus, meniscus, arthroscopy, meniscectomy, partial meniscectomy, randomized controlled trial, controlled clinical trial, randomized, systematic review*, and *meta-analysis*.

RESULTS: Eighteen randomized controlled trials were included in the review, 6 of which were included in the meta-analysis. Outpatient physical therapy plus a home exercise program, compared to a home program alone, improved function compared to a home program alone (mean difference, 10.3; 95% confidence interval: 1.3, 19.3; $P = .02$) and knee flexion range of motion (mean difference, 9.1; 95% confidence interval: 3.7, 14.5; $P = .0009$). Inpatient physical therapy alone compared to inpatient plus outpatient physical therapy reduced the likelihood of effusion (odds ratio = 0.25; 95% confidence interval: 0.10, 0.61; $P = .003$).

CONCLUSION: Physical therapy associated with home exercises seems to be effective in improving patient-reported knee function and range of motion in patients post–arthroscopic meniscectomy, although the included randomized controlled trials were classified from moderate to high risk of bias and should be interpreted with caution.

LEVEL OF EVIDENCE: Therapy, level 1a–.
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KEY WORDS: *arthroscopy, knee joint, menisci tibial, physical therapy, systematic review*

Meniscal surgery is among the most common orthopaedic procedures performed today. The American Academy of Orthopaedic Surgeons estimates that about 636 000 knee arthroscopy procedures are performed every year in the United States, and that up to 80% of magnetic resonance imaging scans performed in this country identify the presence of meniscal tears.[7,15] Many studies have confirmed the importance of the meniscus to the knee joint, and its loss is associated with instability and degeneration of the joint.[38]

There are 2 main groups of patients with meniscus injuries who undergo arthroscopy: those with acute injuries and those with degenerative injuries. Acute lesions generally occur when an axial load is transmitted directly to the flexed knee associated with rotation.[46] In contrast, degenerative lesions are typical of the elderly and accompanied by degenerative changes in cartilage.[16,36] When injured, the meniscus has little regenerative capacity, mainly due to its vascular system. Middle-aged patients with degenerative meniscal lesions usually present pain and disability and have impairments in quadriceps muscle strength and lower extremity performance.[42]

Despite the minimally invasive nature, studies have shown that patients undergoing arthroscopic meniscectomy have pain, effusion, loss of range of motion (ROM), functional changes, neuromuscular and biomechanical changes, loss of quadriceps muscle strength, and a reduced quality of life.[5,8,12,13,27,30,31,33]

Herrlin et al[17] showed that for middle-aged patients with simple lesions in the meniscus, physical therapy has yielded

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TABLE 1 Interventions of Randomized Controlled Trials Evaluated

Active exercise of ankle plantar flexion and dorsiflexion
Active exercise of flexion and extension of the knee
Patellar mobilization
Stretching
Isometric exercise of the quadriceps
Strengthening exercises: isokinetic and isotonic
• Abductors, adductors, flexors, and extensors of the hip
• Flexors and extensors of the knee
Straight leg raise
Electrical stimulation of the quadriceps
Electromyographic biofeedback
Neuromuscular training
Gait training
Stationary bike
Compressive bandage
Ice

results as favorable as those of arthroscopy, whereas other authors have pointed out that exercise has been shown to be effective in improving the quality of cartilage after meniscectomy.[4,43] When the treatment option is surgery, physical therapy is typically initiated in the early postoperative phase and progressed as tolerated to restore function to preoperative levels.[15,45] Although there are many studies on this topic, there is no consensus on which interventions and outcomes should be evaluated. This lack of standardization complicates the comparison of studies and thus the determination of which treatment is best suited for this type of patient.

There are 2 narrative literature reviews published on this subject: the first was written by Goodyear-Smith and Arroll[15] in 2001 and the second by Goodwin and Morrissey[13] in 2003. Both reviews have notable limitations due to lack of assessment of risk of bias, inclusion of nonrandomized clinical trials, lack of clarity in explaining the search and retrieval of studies, and lack of quantitative analysis, thus not allowing reproducibility and applicability.

The importance of the matter, the lack of consensus on the treatment, and the publication of new randomized controlled trials (RCTs) justify a systematic review that contains only RCTs, is conducted in the Cochrane Collaboration precepts, and can provide a summary of the evidence for use in clinical decision making. Thus, the objective of this study was to evaluate the effectiveness of postoperative physical therapy treatment on patient-reported knee function, ROM, effusion, and other outcomes of patients undergoing arthroscopic partial meniscectomy.

METHODS

Type of Study

This study is a systematic review of RCTs, with meta-analysis.[19] A systematic review requires standardization; therefore, this study followed the recommendations of the PRISMA statement[35] and the Cochrane Collaboration.[19]

Eligibility Criteria

Studies were included that evaluated the effectiveness of postoperative physical therapy treatment on patients with a diagnosis of meniscal tears who had undergone arthroscopic partial meniscectomy for either degenerative or traumatic injuries. Comparisons were made between the different physical therapy contexts or their frequency, and physical therapy versus the isolated use of specific modalities.

((randomized controlled trial [pt]) OR (controlled clinical trial [pt]) OR (randomized [tiab]) OR (placebo [tiab]) OR (groups [tiab])) NOT (animals [mh] NOT (humans [mh])) AND ((meniscectomy [tiab]) OR (arthroscopy [mh]) OR (knee [mh]) OR (tibial meniscus [mh])) AND ((physiotherapy [tiab]) OR (physical therapy modalities [mh]) OR (exercise therapy [mh]) OR (rehabilitation [sh]))

FIGURE 1. Search strategy for the MEDLINE database.

According to the recommendations of the Cochrane Collaboration,[19] only RCTs were accepted. There were no restrictions as to the age of the participants.

Types of Intervention

Interventions in the included studies were a mix of specific interventions—such as aerobic, flexibility, and strengthening exercise; sensory motor training; muscle activation (electromyographic [EMG] biofeedback, electrical stimulation); joint mobility exercise; thermotherapy; gait training; and use of plaster or compressive bandage—and patient information and educational programs. Interventions are listed in **TABLE 1**.

Outcome Types

The outcomes evaluated were patient-reported function, ROM, effusion, functional tests, quadriceps isokinetic strength, thigh circumference, pain, muscle activity, functional activities, gait, quality of life, muscle histological analyses, time to return to work, and satisfaction.

Information Sources and Search

The search strategy was formulated by 2 of the authors, assisted by a specialist librarian, in the following databases: MEDLINE (1950-March 2013), Embase (1980-March 2013), CINAHL (1982-March 2013), LILACS (1982-March 2013), SciELO (1998-March 2013), Web of Science, PEDro, Academic Search Premier, and the Cochrane Central Register of Controlled Trials, IBECS, and Scopus. The search included the following key words: *physiotherapy, physical therapy modalities,*

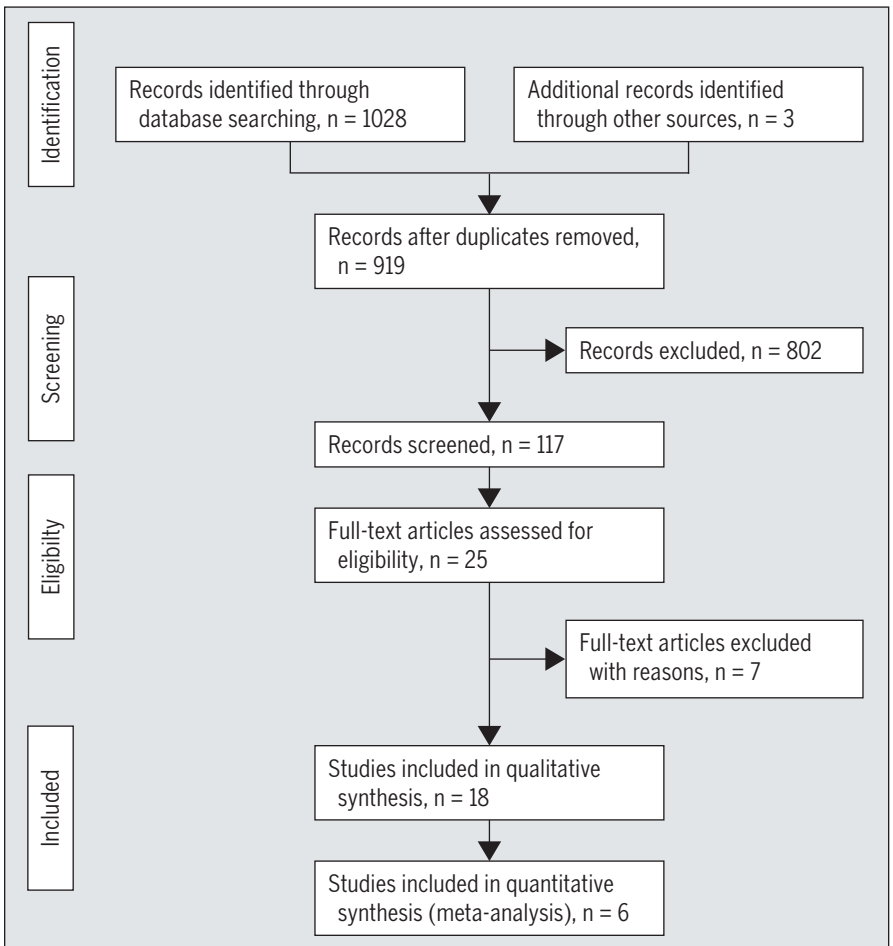


FIGURE 2. Flow chart.

exercise therapy, rehabilitation, knee, placebo, groups, tibial meniscus, meniscus, arthroscopy, meniscectomy, partial meniscectomy, randomized controlled trial, controlled clinical trial, randomized, systematic review, and *meta-analysis*.

Knee-injury experts were also consulted for information about additional trials that might not have appeared in the databases. The search was not restricted to any specific language. The search strategy is demonstrated in **FIGURE 1** and the flow chart in **FIGURE 2**.

Study Selection and Data-Collection Process

Studies were independently assessed for eligibility by 2 researchers. After concluding the preliminary search findings, each of the studies was examined for relevance to the topic as well as for additional references of interest that were not revealed in the original search.

Seven comparison categories were created based on the methodologies of the included studies: outpatient physical therapy plus home exercise versus home exercise, outpatient physical therapy versus home exercise, outpatient physical therapy versus control group, outpatient physical therapy versus modalities alone, ward treatment versus ward plus outpatient treatment, routine physical therapy versus intensive physical therapy, and early versus delayed treatment.

Assessment of Risk of Bias

The studies were evaluated for risk of bias by 2 independent reviewers. When there were disagreements, a third experienced reviewer was consulted to rule on the decision. For evaluation, we adopted items in accordance with the handbook of the Cochrane Collaboration.[19] The risk-of-bias items evaluated were the method of randomization, allocation concealed, patient blinding, care provider blinding, outcome assessor blinding, dropout rate, intention-to-treat analysis, reports on the study free of suggestion, change to baseline similarity of participants, cointerventions avoided, compliance, timing of the outcome assessment, and follow-up.[11] These items were evaluated as yes, no, or unclear, according to the recommendations of Furlan et al.[11] More information is provided in **TABLE 2**.

The system described by the Centre for Evidence-based Medicine (Oxford, UK) was used to classify the evidence in this review. The complete table of criteria and details of the grading can be found on the web at http://www.cebm.net. An abbreviated version of the grading system[30] is as follows: level 1, evidence obtained from high-quality diagnostic studies, RCTs; level 2, evidence obtained from lesser-quality RCTs (eg, improper randomization, no blinding, less than 80% follow-up); level 3, case-controlled studies or retrospective studies; level 4, case series; level 5, expert opinion. The grades of recommendations follow the following criteria: grade A, a preponderance of level 1 and/or level 2 studies support the recommendation (this must include at least 1 level 1 study [strong evidence]); grade B, a single high-quality RCT or a preponderance of level 2 studies support the recommendation (moderate evidence); grade C, a single level 2 study or a preponderance of level 3 and 4 studies including statements of consensus by content experts support the recommendation (weak evidence); grade D, high-quality studies conducted on this topic disagree with respect to their conclusions (the recommendation is based on these conflicting studies [conflicting evidence]).

Data Analysis

Information from the included studies was presented descriptively. To evaluate the percentage of agreement of the results of the risk of bias of the studies analyzed between the 2 raters, the kappa coefficient was used. When the result was greater than 0.81, the agreement was considered excellent; for a kappa between 0.61 and 0.80, the agreement was considered good; a kappa between 0.41 and 0.60 was considered moderate; and, for a result below 0.40, agreement was considered poor.[4] The 95% confidence intervals (CIs) were calculated for kappa values.

For the analysis of dichotomous data, the results were expressed as an odds ratio with a 95% CI. The mean difference was used for analysis of continuous data, with a 95% CI. For all analyses, a fixed-effects model was used if the results were homogeneous ($P>.10$), and a random-effects model was used if heterogeneity was present ($P\leq.10$). All analyses were performed using RevMan 5.1.4 software (The Nordic Cochrane Centre, Copenhagen, Denmark).

TABLE 2 Criteria for a Judgment of "Yes" for the Sources of Risk of Bias

1. Adequate sequence generation	A random (unpredictable) assignment sequence. Examples of adequate methods are coin toss (for studies with 2 groups), rolling dice (for studies with 2 or more groups), drawing of balls of different colors, drawing of ballots with the study group labels from a dark bag, computer-generated random sequence, preordered sealed envelopes, sequentially ordered vials, telephone call to a central office, and preordered list of treatment assignments. Examples of inadequate methods are alternation, birth date, social insurance/security number, date on which they are invited to participate in the study, and hospital registration number.
2. Allocation concealment	Assignment generated by an independent person not responsible for determining the eligibility of the patients. This person has no information about the persons included in the trial and has no influence on the assignment sequence or on the decision about eligibility of the patient.
3. Patient blinded	This item should be scored "yes" if the index and control groups are indistinguishable for the patients or if the success of blinding was tested among the patients and it was successful.
4. Care provider blinded	This item should be scored "yes" if the index and control groups are indistinguishable for the care providers or if the success of blinding was tested among the care providers and it was successful.
5. Assessor blinded	Adequacy of blinding should be assessed for the primary outcomes. This item should be scored "yes" if the success of blinding was tested among the outcome assessors and it was successful.
6. Dropout rate acceptable	The number of participants who were included in the study but did not complete the observation period or were not included in the analysis must be described and reasons given. If the percentage of withdrawals and dropouts does not exceed 20% for short-term follow-up and 30% for long-term follow-up and does not lead to substantial bias, a "yes" is scored. (Note: these percentages are arbitrary, not supported by literature.)
7. Intention-to-treat analysis performed	All randomized patients are reported/analyzed in the group they were allocated to by randomization for the most important moments of effect measurement (minus missing values), irrespective of noncompliance and cointerventions.
8. Free of selective reporting	In order to receive a "yes," the review author determines if all the results from all prespecified outcomes have been adequately reported in the published report of the trial. This information is either obtained by comparing the protocol and the report or, in the absence of the protocol, assessing that the published report includes enough information to make this judgment.
9. Groups similar at baseline	In order to receive a "yes," groups have to be similar at baseline regarding demographic factors, duration and severity of complaints, percentage of patients with neurological symptoms, and value of main outcome measure(s).
10. Cointerventions avoided	This item should be scored "yes" if there were no cointerventions or they were similar between the index and control groups.
11. Compliance acceptable	The reviewer determines if the compliance with the interventions is acceptable, based on the reported intensity, duration, number, and frequency of sessions for both the index intervention and control intervention(s). For example, physiotherapy treatment is usually administered over several sessions; therefore, it is necessary to assess how many sessions each patient attended. For single-session interventions (eg, surgery), this item is irrelevant.
12. Timing of the outcome assessment similar	Timing of outcome assessment should be identical for all intervention groups and for all important outcome assessments.
13. Follow-up	If patients were followed up after the intervention period.

Adapted from: Furlan AD, Pennick V, Bombardier C, van Tulder M. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. Spine. 2009;34:1929-1941. http://dx.doi.org/10.1097/BRS.0b013e3181b1c99f

RESULTS

The database search identified 1028 articles. Of these, 25 were read in full, and 7 were excluded because they did not meet the inclusion criteria (4 were nonrandomized, 1 was quasi-randomized, and in 2 studies the control group did not undergo arthroscopic partial meniscectomy).[2,17,18,20,26,37,41] Eighteen RCTs were included in the review, only 6 of which were included in the meta-analysis due to methodological issues. The others were presented descriptively. The characteristics of included studies are shown in **TABLES 3** through **9**.

The agreement between the 2 reviewers assessing the risk of bias was $\kappa = 1.0$ (95% CI: 1, 1) for the method of randomization, $\kappa = 0.43$ (95% CI: 0.04, 0.82) for allocation concealed, $\kappa = 1.0$ (95% CI: 1, 1) for patient blinding, $\kappa = 1.0$ (95% CI: 1, 1) for care provider blinding, $\kappa =$

TABLE 3 Characteristics of Included Studies of the Group Outpatient Physical Therapy Plus Home Exercise Versus Home Exercise

Study	Participants	Interventions	Study Outcomes	Results*
Birch et al[3]	Home exercise group: 47 participants; mean age, 31.6 y; 6 female, 41 male NSAID group: 52 participants; mean age, 36.5 y; 7 female, 45 male Physical therapy group: 21 participants; mean age, 36.7 y; 4 female, 17 male	Home exercise group: home exercise NSAID group: diclofenac for 7 d plus home exercise Physical therapy group: physical therapy plus home exercise	Assessment times: pre, post 1 wk, 2 wk, and 6 wk Measure: Noyes score	Home exercise group: pre, 114.5 ± 19.9; 6 wk, 144.8 ± 8.6 NSAID group: pre, 110.4 ± 22; 6 wk, 144.3 ± 7.7 Physical therapy group: pre, 108.4 ± 19.2; 6 wk, 141.1 ± 6.6
Goodwin et al[14]	Home exercise group: 41 participants; mean ± SD age, 41 ± 9 y; 6 female, 35 male Treatment group: 45 participants; mean ± SD age, 38 ± 8 y; 6 female, 39 male	Home exercise group: home exercise (3 times per wk for 6 wk) Treatment group: physical therapy and home exercise (3 times per wk for 6 wk)	Assessment times: pre, post 6 wk Measures: Hughston Clinic Questionnaire, SF-36, EQ-5D, maximum-minimum knee angle during stair ascent stance phase (deg), knee circumference (difference between injured and uninjured knees in cm), number of d taken to return to work after surgery/FORS score, injured-uninjured limb vertical jump ratio	Home exercise group: • Hughston Clinic Questionnaire: pre, 59.1 ± 17.3; 6 wk, 24.8 ± 16.7 • SF-36: pre, 0.69 ± 0.10; 6 wk, 0.76 ± 0.10 • EQ-5D: pre, 0.54 ± 0.20; 6 wk, 0.81 ± 0.12 • Maximum-minimum knee angle during stair ascent stance phase: pre, 40 ± 8; 6 wk, 51 ± 5 • Knee circumference: pre, 1.3 ± 1.2; 6 wk, NA • Number of d taken to return to work after surgery/FORS score: pre, NA; 6 wk, 1.4 ± 1.5 • Injured-uninjured limb vertical jump ratio: pre, NA; 6 wk, 0.82 ± 0.18 Treatment group: • Hughston Clinic Questionnaire: pre, 58.5 ± 14.8; 6 wk, 27.7 ± 18.4 • SF-36: pre, 0.68 ± 0.12; 6 wk, 0.75 ± 0.12 • EQ-5D: pre, 0.56 ± 0.22; 6 wk, 0.75 ± 0.21 • Maximum-minimum knee angle during stair ascent stance phase: pre, 42 ± 6; 6 wk, 49 ± 6 • Knee circumference: pre, 1.4 ± 1.0; 6 wk, NA • Number of d taken to return to work after surgery/FORS score: pre, NA; 6 wk, 1.5 ± 1.8 • Injured-uninjured limb vertical jump ratio: pre, NA; 6 wk, 0.88 ± 0.19
Kelln et al[24]	Home exercise group: 15 participants; mean ± SD age, 47.1 ± 12.4 y; 10 female, 5 male Experimental group: 16 participants; mean ± SD age, 47.1 ± 12.4 y; 10 female, 6 male	Home exercise group: home exercise (3 times per wk for 2 wk) Experimental group: physical therapy in stationary bike plus home exercise (3 times per wk for 2 wk)	Assessment times: pre, post 1 d, 1 wk, 2 wk, 4 wk, and 12 wk Measures: girth at midpatella, knee flexion (deg), knee extension (deg), gait evaluation, quality of quadriceps, IKDC	Cohen *d* effect size (CI) for group differences: • Girth at midpatella: pre, 0.58 (−2.16, 3.61); 12 wk, 0.62 (−2.17, 3.50) • Knee flexion: pre, 0.65 (−9.56, 5.07); 12 wk, 0.59 (−6.41, 4.47) • Knee extension: pre, 0.44 (−1.72, 2.07); 12 wk, −0.07 (−1.67, 0.92) • Gait evaluation: NA • Quality of quadriceps: NA • IKDC: pre, 0.33 (−6.56, 7.97); 12 wk, 0.47 (−8.92, 9.45)

Table continues on page 565.

0.87 (95% CI: 0.64, 1.1) for outcome assessor blinding, κ = 0.46 (95% CI: 0.03, 0.89) for dropout rate, κ = 0.61 (95% CI: 0.16, 0.86) for intention-to-treat analysis, κ = 0.21 (95% CI: −0.14, 0.5) for reports of the study free of suggestion, κ = 0.26 (95% CI: −0.19, 0.71) for baseline similar, κ = 0.15 (95% CI: −0.3, 0.6) for cointerventions avoided, κ = 0.43 (95% CI: −0.31, 0.87) for compliance, κ = 0.56 (95% CI: −0.2, 0.83) for timing of the outcome assessment, and κ = 0.34 (95% CI: 0.03, 0.65) for follow-up. The risks of bias are presented in **FIGURES 3** and **4**.

Outpatient Physical Therapy Plus Home Exercise Versus Home Exercise

Six studies were evaluated in this category, which included a total of 326 patients and a duration of treatment between 2 weeks and 6 weeks. Both groups performed exercises as described in the study methods. The difference between the groups was that the outpatient physical therapy group was supervised by a physical therapist and the home exercise group received only an exercise program and information.

Birch et al[3] studied 120 patients randomized into 3 groups. There were 47 patients in the home exercise group (mean age, 31.6 years), 52 in the nonsteroidal anti-inflammatory drug group (mean age, 36.5 years), and 21 in the physical therapy group (mean age, 36.7 years). The last one had a mean of 3.1 (range,

TABLE 3 Characteristics of Included Studies of the Group Outpatient Physical Therapy Plus Home Exercise Versus Home Exercise (continued)

Study	Participants	Interventions	Study Outcomes	Results*
Kirnap et al[25]	Home exercise group: 20 participants; mean ± SD age, 34.5 ± 10.3 y; 20 male Experimental group: 20 participants; mean ± SD age, 34.5 ± 10.3 y; 20 male	Home exercise group: home exercise (5 times per wk for 2 wk) Experimental group: physical therapy with EMG-B plus home exercise (5 times per wk for 2 wk)	Assessment times: pre, post 3 d, 2 wk, and 6 wk Measures: thigh and knee circumference, knee flexion ROM (deg), Lysholm questionnaire, maximum contraction and mean contraction values of VMO and VL	Home exercise group: • Thigh and knee circumference: NA • Knee flexion ROM: pre, 130.2 ± 8.8; 6 wk, 129.2 ± 7.4 • Lysholm questionnaire: pre, 69.1 ± 12.9; 6 wk, 79.6 ± 10.1 • Maximum contraction and mean contraction values of VMO and VL: NA Experimental group: • Thigh and knee circumference: NA • Knee flexion ROM: pre, 134.3 ± 9.3; 6 wk, 137.1 ± 6.5 • Lysholm questionnaire: pre, 70.3 ± 14.3; 6 wk, 95.4 ± 3.7 • Maximum contraction and mean contraction values of VMO and VL: NA
Moffet et al[34]	Home exercise group : 16 participants; mean ± SD age, 38 ± 7 y; 16 male Treatment group: 15 participants; mean ± SD age, 42 ± 9 y; 15 male	Home exercise group: home exercise (3 times per wk for 3 wk) Treatment group: physical therapy plus home exercise (3 times per wk for 3 wk)	Assessment times: pre, post 3 wk, 3 mo, and 6 mo Measures: ROM, effusion, thigh atrophy, strength test (isokinetic), Lysholm questionnaire, Gillquist questionnaire	Home exercise group: • ROM: NA • Effusion: NA • Thigh atrophy: NA • Strength test (isokinetic): NA • Lysholm questionnaire: pre, 74 ± 23; 6 mo, 89 ± 16 • Gillquist questionnaire: NA Treatment group: • ROM: NA • Effusion: NA • Thigh atrophy: NA • Strength test (isokinetic): NA • Lysholm questionnaire: pre, 70 ± 19; 6 mo, 91 ± 14 • Gillquist questionnaire: NA
Vervest et al[47]	Group A: 10 participants; mean ± SD age, 35.7 ± 5.74 y; 2 female, 8 male Group B: 10 participants; mean ± SD age, 31.1 ± 7.09 y; 4 female, 6 male	Group A: home exercise (3 times per wk for 30 min for 3 wk) Group B: physical therapy according to a dynamic protocol plus home exercise (3 times per wk for 30 min for 3 wk)	Assessment times: post 1 wk, 2 wk, 3 wk, and 4 wk Measures: height of 1-leg jump (cm), distance of 1-leg jump (cm), Tegner score, Lysholm questionnaire, sports activity rating scale, FORS, pain (VAS in mm), satisfaction with function (1-10), satisfaction with treatment (1-10)	Group A: • Height of 1-leg jump: 1 wk, 18.6 ± 7.8; 4 wk, 20.1 ± 9.3 • Distance of 1-leg jump: 1 wk, 87.3 ± 38.5; 4 wk, 94.7 ± 46.7 • Tegner score: 1 wk, 0.6 ± 0.7; 4 wk, 2.1 ± 1.4 • Lysholm questionnaire: 1 wk, 65.1 ± 21.3; 4 wk, 79.4 ± 18.8 • Sports activity rating scale: 1 wk, 28.0 ± 10.3; 4 wk, 28.0 ± 14.0 • FORS: 1 wk, 16.8 ± 7.8; 4 wk, 25.0 ± 11.3 • Pain: 1 wk, 14.3 ± 16.6; 4 wk, 14.2 ± 26.0 • Satisfaction with function: 1 wk, 8.0 ± 1.3; 4 wk, 6.7 ± 2.4 • Satisfaction with treatment: 1 wk, 8.4 ± 1.5; 4 wk, 8.1 ± 2.0 Group B: • Height of 1-leg jump: 1 wk, 11.1 ± 7.9; 4 wk, 22.5 ± 5.0 • Distance of 1-leg jump: 1 wk, 57.3 ± 37.8; 4 wk, 113.8 ± 18.9 • Tegner score: 1 wk, 1.0 ± 0.8; 4 wk, 2.8 ± 1.8 • Lysholm questionnaire: 1 wk, 66.4 ± 22.6; 4 wk, 88.7 ± 13.9 • Sports activity rating scale: 1 wk, 30.0 ± 10.5; 4 wk, 48.3 ± 24.1 • FORS: 1 wk, 16.5 ± 8.9; 4 wk, 24.4 ± 12.8 • Pain: 1 wk, 26.0 ± 27.3; 4 wk, 6.6 ± 7.3 • Satisfaction with function: 1 wk, 6.8 ± 1.4; 4 wk, 7.8 ± 1.1 • Satisfaction with treatment: 1 wk, 7.8 ± 0.5; 4 wk, 8.3 ± 0.9

Abbreviations: CI, confidence interval; EMG-B, electromyography biofeedback; EQ-5D, European Quality of Life-5 Dimensions; FORS, Factor Occupational Rating Scale; IKDC, International Knee Documentation Committee; NA, not available; NSAID, nonsteroidal anti-inflammatory drug; post, postoperative; pre, preoperative; ROM, range of motion; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; VAS, visual analog scale; VL, vastus lateralis; VMO, vastus medialis oblique.
**Values are mean ± SD unless otherwise indicated.*

1-11) treatment sessions. There was no significant benefit from either type of postoperative treatment compared with the exercise group.

Goodwin et al[14] evaluated the effectiveness of supervised physical therapy in the early period after arthroscopic partial meniscectomy. Forty-one patients were allocated to the home exercise group (mean ± SD age, 41 ± 9 years) and 45 to the treatment group (outpatient physical therapy plus home exercise) (mean ±

TABLE 4 Characteristics of Included Study of the Group Outpatient Physical Therapy Versus Home Exercise

Study	Participants	Interventions	Study Outcomes	Results
Jokl et al[21]	Group 1: 15 participants; mean ± SD age, 30.7 ± 13.9 y; 3 female, 12 male Group 2: 15 participants; mean ± SD age, 33.5 ± 6.8 y; 4 female, 11 male	Group 1: physical therapy (3 times per wk for 45 min for 4 wk) Group 2: home exercises (3 times per wk for 45 min for 4 wk)	Assessment times: post 2 wk, 4 wk, and 8 wk Measures: overall knee function, degrees of knee pain, isokinetic muscle strength (mean percent deficit): quadriceps and hamstrings, qualitative evaluation of knee functions	Group 1: • Overall knee function: 8 wk: excellent, 9; good, 4; fair, 0; poor, 0 • Degrees of knee pain: 2 wk: severe, 1; moderate, 4; mild, 4; none, 4. 8 wk: severe, 0; moderate, 0; mild, 3; none, 11 • Isokinetic muscle strength: quadriceps: 2 wk, 40.1; 8 wk, 11.9 • Isokinetic muscle strength: hamstrings: 2 wk, 22.3; 8 wk, 4.1 • Qualitative evaluation of knee functions: NA Group 2: • Overall knee function: 8 wk: excellent, 9; good, 4; fair, 1; poor, 0 • Degrees of knee pain: 2 wk: severe, 0; moderate, 2; mild, 10; none, 2. 8 wk: severe, 0; moderate, 1; mild, 4; none, 10 • Isokinetic muscle strength: quadriceps: 2 wk, 35.9; 8 wk, 6.5 • Isokinetic muscle strength: hamstrings: 2 wk, 19.6; 8 wk, 2.6 • Qualitative evaluation of knee functions: NA

Abbreviations: NA, not available; post, postoperative.

TABLE 5 Characteristics of Included Study of the Group Outpatient Physical Therapy Versus Control Group

Study	Participants	Interventions	Study Outcomes	Results*
Ericsson et al[6]	Control group: 23 participants; mean ± SD age, 45.9 ± 3.2 y; 9 female, 14 male Exercise therapy group: 22 participants; mean ± SD age, 45.4 ± 3.2 y; 7 female, 15 male	Control group: no treatment Exercise therapy group: physical therapy with emphasis on neuromuscular training (3 times per wk for 1 h for 4 mo)	Assessment times: pre, post 4 mo Measures: 1-leg hop for distance (cm), 1-leg rise (n), square hop (n), isokinetic muscle strength testing: quadriceps strength, isokinetic muscle strength testing: quadriceps endurance, isokinetic muscle strength testing: hamstrings strength, isokinetic muscle strength testing: hamstrings endurance, KOOS	Control group: • 1-leg hop for distance: pre, 108 ± 37; 4 mo, 111 ± 37 • 1-leg rise: pre, 10 ± 8; 4 mo, 13 ± 14 • Square hop: pre, 6 ± 5; 4 mo, 7 ± 4 • Isokinetic muscle strength testing: - Quadriceps strength: pre, 169 ± 53; 4 mo, 171 ± 48 - Quadriceps endurance: pre, 2443 ± 642; 4 mo, 2403 ± 623 - Hamstrings strength: pre, 90 ± 20; 4 mo, 90 ± 28 - Hamstrings endurance: pre, 1283 ± 450; 4 mo, 1282 ± 474 • KOOS: NA Exercise therapy group: • 1-leg hop for distance: pre, 106 ± 29; 4 mo, 114 ± 30 • 1-leg rise: pre, 13 ± 11; 4 mo, 20 ± 23 • Square hop: pre, 5 ± 2; 4 mo, 8 ± 4 • Isokinetic muscle strength testing: - Quadriceps strength: pre, 152 ± 44; 4 mo, 154 ± 42 - Quadriceps endurance: pre, 2122 ± 480; 4 mo, 2277 ± 605 - Hamstrings strength: pre, 81 ± 26; 4 mo, 89 ± 28 - Hamstrings endurance: pre, 1174 ± 336; 4 mo, 1251 ± 398 • KOOS: NA

Abbreviations: KOOS, Knee injury and Osteoarthritis Outcome Score; NA, not available; post, postoperative; pre, preoperative.
**Values are mean ± SD unless otherwise indicated.*

SD age, 38 ± 8 years). The average number of sessions for the physical therapy group was 12. Both groups showed improvements compared to the initial assessment, but there were no significant between-group differences.

In the Kelln et al[24] study, the treatment group was composed of 16 patients who underwent outpatient physical therapy on a stationary bike plus home exercise. The comparison group consisted of 15 patients treated with home exercise. The mean ± SD age of the participants was 47.1 ± 12.4 years. There were no statistically significant differences between the groups, but both groups showed improvement throughout the study. The outcomes patient-reported knee function (assessed by International Knee Documentation Committee [IKDC] Subjective Knee Evaluation Form), knee flexion ROM, and knee circumference showed high values for the effect size (0.97, 0.71, and 0.86, respectively). Results of the knee

TABLE 6 Characteristics of Included Studies of the Group Outpatient Physical Therapy Versus Modalities Alone

Study	Participants	Interventions	Study Outcomes	Results*
Akkaya et al[1]	Home exercise group: 15 participants; mean ± SD age, 49.8 ± 11.6 y; 7 female, 8 male EMG biofeedback group: 15 participants; mean ± SD age, 48.3 ± 9.3 y; 10 female, 5 male Electrical stimulation group: 15 participants; mean ± SD age, 42.7 ± 10.2 y; 9 female, 6 male	Home exercise group: home exercise (5 times per wk for 4 wk) EMG biofeedback group: EMG biofeedback (5 times per wk for 2 wk) plus home exercise (5 times per wk for 4 wk) Electrical stimulation group: electrical stimulation (5 times per wk for 2 wk) plus home exercise (5 times per wk for 4 wk)	Assessment times: pre, post 2 wk and 6 wk Measures: pain (VAS), velocity of gait, time using a walking aid, functionality (Lysholm), ROM of the knee, thigh and knee circumference, muscle power (VMO and VL)	Home exercise group: • Pain: pre, 6.6 ± 2.2; 6 wk, 3.4 ± 2.9 • Velocity of gait: pre, 0.84 ± 0.27; 6 wk, 0.89 ± 0.24 • Time using a walking aid: pre, 0; 6 wk, 8.3 ± 8.0 • Functionality: pre, 54.1 ± 12.2; 6 wk, 77.2 ± 14.3 • ROM of the knee: NA • Thigh and knee circumference: NA • Muscle power: NA EMG biofeedback group: • Pain: pre, 5.3 ± 2.1; 6 wk, 2.3 ± 2.1 • Velocity of gait: pre, 0.86 ± 0.20; 6 wk, 1.03 ± 0.25 • Time using a walking aid: pre, 0; 6 wk, 1.5 ± 2.5 • Functionality: pre, 62.2 ± 10.6; 6 wk, 85.9 ± 7.0 • ROM of the knee: NA • Thigh and knee circumference: NA • Muscle power: NA Electrical stimulation group: • Pain: pre, 6.9 ± 2.7; 6 wk, 3.4 ± 2.5 • Velocity of gait: pre, 0.82 ± 0.35; 6 wk, 0.99 ± 0.28 • Time using a walking aid: pre, 0; 6 wk, 4.5 ± 5.5 • Functionality: pre, 53.1 ± 13.5; 6 wk, 81.0 ± 7.4 • ROM of the knee: NA • Thigh and knee circumference: NA • Muscle power: NA
Felicetti et al[9]	Group 1: 15 participants; age range, 20-40 y; 7 female, 8 male Group 2: 15 participants; age range, 20-40 y; 6 female, 9 male	Group 1: isometric and isotonic exercises (5 times per wk for 45 min for 3 wk) Group 2: isokinetic exercise (5 times per wk for 45 min for 3 wk)	Assessment times: pre, post 3 wk and 4 wk Measures: muscle strength (knee flexor and extensor muscles), muscle power (knee flexor and extensor muscles)	NA
Krebs[28]	EMG feedback group: 28 participants; mean ± SD age, 35.5 ± 3.4 y; 5 female, 23 male Physical therapy group: 31 participants; mean ± SD age, 35.9 ± 1.9 y; 9 female, 22 male	EMG feedback group: isometric quadriceps muscle exercise with feedback plus SLR plus crutch walking Physical therapy group: isometric quadriceps muscle exercise plus SLR plus crutch walking	Assessment times: pre, post 3 d Measures: change in resting EMG, posttest maximum EMG, change in maximum EMG, change in manual muscle test, weight-bearing tolerance	EMG feedback group†: • Change in resting EMG: 3 d, 0.0 ± 0.0 • Posttest maximum EMG: 3 d, 39.69 ± 5.96 • Change in maximum EMG: 3 d, 25.24 ± 4.19 • Change in manual muscle test‡: 3 d, 0.30 • Weight-bearing tolerance: 3 d, 1.27 ± 0.15 Physical therapy group†: • Change in resting EMG: 3 d, 0.01 ± 0.01 • Posttest maximum EMG: 3 d, 18.63 ± 4.32 • Change in maximum EMG: 3 d, 2.45 ± 0.84 • Change in manual muscle test‡: 3 d, 0.01 • Weight-bearing tolerance: 3 d, 1.26 ± 0.16
Williams et al[48]	Outpatient physical therapy group: 8 participants; age range, 22-46 y; 3 female, 5 male Experimental group: 13 participants; age range, 18-44 y; 13 male	Outpatient physical therapy group: physical therapy (3 times per wk for 3 wk) Experimental group: electrical stimulation to the quadriceps (5 times per wk for 10 min for 3 wk) plus physical therapy (3 times per wk for 3 wk)	Assessment times: pre, post 3 wk Measures: thigh circumference, torque production: isokinetic (extension and flexion)	Outpatient physical therapy group: • Thigh circumference: pre, 55.2; 3 wk, 56.6 • Torque production: isokinetic: pre, 59.8 ± 29.8; 3 wk, 66.7 ± 29 Experimental group: • Thigh circumference: pre, 56; 3 wk, 56.9 • Torque production: isokinetic: pre, 81.8 ± 17.4; 3 wk, 89 ± 18.2

Abbreviations: EMG, electromyography; NA, not available; post, postoperative; pre, preoperative; ROM, range of motion; SLR, straight leg raise; VAS, visual analog scale; VL, vastus lateralis; VMO, vastus medialis oblique.
**Values are mean ± SD unless otherwise indicated.*
†Values are mean ± standard error of mean.
‡Value is median.

TABLE 7 Characteristics of Included Studies of the Group Inpatient Treatment Versus Inpatient Plus Outpatient Treatment

Study	Participants	Interventions	Study Outcomes	Results
Forster and Frost[10]	Control group: 42 participants; age range, 16-45 y; 42 male Test group: 44 participants; age range, 16-45 y; 44 male	Control group: treatment in the inpatient (12 d) Test group: treatment in the inpatient (12 d) plus outpatient physical therapy (3 times per wk for 12 wk)	Assessment times: pre, post 10 d, 4 wk, 6 wk, 10 wk, 14 wk, and 26 wk Measures: quadriceps circumference (cm), range of knee movement (deg), effusion (%), knee gives way (%), ability to crouch impaired (%), gait impaired (%), gait ascending impaired (%), gait descending impaired (%), running down stairs impaired (%), wound not healed (%)	Control group: • Quadriceps circumference: pre, 46.3; 26 wk, 46.3 • Range of knee movement: pre, 124.3; 26 wk, 139.9 • Effusion: pre, 23.8; 26 wk, 4.9 • Knee gives way: pre, 61.9; 26 wk, 12.2 • Ability to crouch impaired: pre, 71.4; 26 wk, 29.3 • Gait impaired: pre, 40.5; 26 wk, 4.9 • Gait ascending impaired: pre, 4.8; 26 wk, 0 • Gait descending impaired: pre, 14.3; 26 wk, 0 • Running down stairs impaired: pre, 54.8; 26 wk, 7.3 • Wound not healed: pre, NA; 26 wk, 0 Test group: • Quadriceps circumference: pre, 46.2; 26 wk, 46.8 • Range of knee movement: pre, 122.3; 26 wk, 139.6 • Effusion: pre, 20.5; 26 wk, 6.8 • Knee gives way: pre, 45.5; 26 wk, 15.9 • Ability to crouch impaired: pre, 68.2; 26 wk, 34.9 • Gait impaired: pre, 36.4; 26 wk, 2.3 • Gait ascending impaired: pre, 9.1; 26 wk, 2.3 • Gait descending impaired: pre, 15.9; 26 wk, 0 • Running down stairs impaired: pre, 61.4; 26 wk, 4.7 • Wound not healed: pre, NA; 26 wk, 0
Seymour[40]	Group A: 35 participants Group B: 35 participants	Group A: treatment in the inpatient (10 d) Group B: treatment in the inpatient plus outpatient physical therapy (3 times per wk for 6 wk)	Assessment times: pre, post 10 d, 3 wk, 4 wk, 6 wk, and 3 mo Measures: effusion present (participants, n), ROM (average deg), wasting of the thigh (participants, n), time to return to work and full activity	Group A: • Effusion present: pre, 20; 3 mo, 3 • ROM: 10 d, 45; 3 mo, 135 • Wasting of the thigh: 6 wk: same, 18; worse, 9; better, 8 • Time to return to work and full activity: NA Group B: • Effusion present: pre, 22; 3 mo, 15 • ROM: 10 d, 67; 3 mo, 137 • Wasting of the thigh: 6 wk: same, 15; worse, 9; better, 11 • Time to return to work and full activity: NA

Abbreviations: NA, not available; post, postoperative; pre, preoperative; ROM, range of motion.

flexion ROM measure at the second postoperative week were (mean ± SD) 127.6° ± 12.3° for the outpatient physical therapy plus home exercise group and 121.3° ± 12.5° for the home exercise group.

In the gait assessment, the chi-square test showed a statistical difference between groups: 2 weeks postsurgery for antalgic gait, $P = .046$; 1 week, 2 weeks, and 1 month postsurgery for hobble, $P = .008$, $P = .003$, and $P = .025$, respectively. All results were in favor of the outpatient physical therapy plus home exercise group. For the quadriceps control outcome, patients in the home exercise group showed a delay in knee extension greater than patients in the outpatient physical therapy plus home exercise group ($P = .032$).

Kirnap et al[25] compared the effect of EMG biofeedback on quadriceps muscle strength after meniscectomy. The mean ± SD age of the participants was 34.5 ± 10.3 years. There were 20 patients in the home exercise group and 20 in the experimental group (outpatient physical therapy with EMG biofeedback plus home exercise). Results showed a statistically significant difference in favor of the intervention group for the outcomes ROM of knee flexion, patient-reported knee function (evaluated by the Lysholm questionnaire), and the maximum and average activation of the vastus medialis oblique and vastus lateralis at 2 and 6 weeks postsurgery.

Moffet et al[34] studied 15 patients in the outpatient physical therapy plus home exercise group (mean ± SD age, 42 ± 9 years) and 16 in the home exercise group (mean ± SD age, 38 ± 7 years). Results showed that the outpatient physical therapy group obtained a larger recovery of knee extension deficits when compared with the home exercise group. In the evaluation of clinical symptoms, such as pain and patient-reported knee function, no differences were found between the groups.

In the study by Vervest et al,[47] a comparison of outpatient physical therapy plus home exercise (mean ± SD age, 31.1 ± 7.1 years) versus home exercise (mean ± SD age, 35.7 ± 5.7 years) showed that

TABLE 8 Characteristics of Included Studies of the Group Routine Physical Therapy Versus Intensive Physical Therapy

Study	Participants	Interventions	Study Outcomes	Results*
Karumo[22]	Group A: 27 participants; mean ± SD age, 36.26 ± 12.34 y; 4 female, 23 male Group B: 29 participants; mean ± SD age, 34 ± 9.21 y; 5 female, 24 male	Group A: routine physical therapy (7 times per wk, once per d, for 1 wk) Group B: intensive physical therapy (7 times per wk, twice per d, for 1 wk)	Assessment times: pre, post 1 wk, 2 wk, and 4 wk Measures: isokinetic and isotonic muscle strength of quadriceps, knee ROM (deg)	NA
Karumo et al[23]	Group A: 8 participants; mean ± SD age, 40.3 ± 9.2 y; 2 female, 6 male Group B: 8 participants; mean ± SD age, 29.6 ± 7.2 y; 1 female, 7 male Group C: 15 participants; mean ± SD age, 28.6 ± 6.2 y; 3 female, 12 male	Group A: routine physical therapy (7 times per wk, once per d, for 1 wk) Group B: intensive physical therapy (7 times per wk, twice per d, for 1 wk) Group C: healthy volunteer controls	Assessment times: pre, post 4 wk Measures: deficit of active knee extension, knee flexion (deg), thigh girth (cm), quadriceps strength (kp), 10-repetition maximum (kp), red fibers (%), white fibers (%), area of red fibers (%), area of white fibers (%)	Group A: • Deficit of active knee extension: pre, 4.4 ± 4.2; 4 wk, 12.5 ± 7.6 • Knee flexion: pre, 125 ± 8.6; 4 wk, 107 ± 18.3 • Thigh girth: pre, 49.4 ± 4.5; 4 wk, 47.9 ± 4.1 • Quadriceps strength: pre, 28.6 ± 9.5; 4 wk, 23.2 ± 9.8 • 10-repetition maximum: pre, 24.7 ± 6.8; 4 wk, 15.4 ± 16.1 • Red fibers: pre, 52 ± 9.8; 4 wk, 52 ± 13.5 • White fibers: pre, 47 ± 9.8; 4 wk, 47 ± 13.5 • Area of red fibers: pre, 50.3 ± 6.94; 4 wk, 51.7 ± 18 • Area of white fibers: pre, 49.7 ± 6.94; 4 wk, 48.2 ± 18 Group B: • Deficit of active knee extension: pre, 4.4 ± 9; 4 wk, 15 ± 3.8 • Knee flexion: pre, 133 ± 10.3; 4 wk, 111 ± 15.6 • Thigh girth: pre, 50.5 ± 4; 4 wk, 48.9 ± 3.8 • Quadriceps strength: pre, 38.6 ± 16.8; 4 wk, 21 ± 13.1 • 10-repetition maximum: pre, 35.5 ± 13; 4 wk, 15 ± 10.8 • Red fibers: pre, 61 ± 9.2; 4 wk, 60 ± 9.7 • White fibers: pre, 39 ± 9.2; 4 wk, 39 ± 9.7 • Area of red fibers: pre, 60 ± 14.6; 4 wk, 59.1 ± 13.8 • Area of white fibers: pre, 40 ± 14.6; 4 wk, 40.9 ± 13.8 Group C: • Deficit of active knee extension: NA • Knee flexion: NA • Thigh girth: 49 ± 3.4 • Quadriceps strength: 40.4 ± 14.1 • 10-repetition maximum: 40.8 ± 13.7 • Red fibers: 55 ± 13.6 • White fibers: 44 ± 13.6 • Area of red fibers: 54.3 ± 14.7 • Area of white fibers: 45.7 ± 14.7

Abbreviations: kp, kilopound; NA, not available; post, postoperative; pre, preoperative; ROM, range of motion.
**Values are mean ± SD unless otherwise indicated.*

for the outcomes single-leg vertical and horizontal hop test and for the sports activity rating scale questionnaire, there was a statistical difference in favor of the first group. For other outcomes, there were no differences between groups.

FIGURES 5 and **6** refer to the meta-analyses of studies that evaluated patient-reported knee function through the Lysholm questionnaire[25,34,47] and ROM of knee flexion.[24,25] For patient-reported knee function evaluated at 4 weeks postsurgery, comparing the outpatient physical therapy plus home exercise versus home exercise groups, a statistically significant difference was found in favor of the first group (mean difference, 10.35; 95% CI: 1.33, 19.36; $P = .02$) (**FIGURE 5**). The average treatment time of the studies included in this meta-analysis was 2.6 weeks. For the outcome of knee flexion, a statistically significant difference in favor of the first group was found (mean difference, 9.13; 95% CI: 3.74, 14.53; $P = .0009$) (**FIGURE 6**). The average treatment time of the studies included in this meta-analysis was 2 weeks.

Outpatient Physical Therapy Versus Home Exercise

Jokl et al[21] evaluated 30 patients with traumatic lesions. The treatment duration was 4.5 weeks. The home exercise group consisted of 15 patients (mean ± SD age, 33.5 ± 6.8 years) who received only an exercise program and information, and the outpatient physical therapy group consisted of 15 patients (mean ± SD age, 30.7 ± 13.9 years) who were supervised by a physical therapist. Both groups performed exercises as described

TABLE 9 Characteristics of Included Studies of the Group Early Versus Delayed Treatment

Study	Participants	Interventions	Study Outcomes	Results
Leonard[29]	Early treatment group: 53 participants; mean age (range), 34.4 y (13-68 y) Delayed treatment group: 47 participants; mean age (range), 35.2 y (16-56 y)	Early treatment group: physical therapy plus plaster and weight bearing within 3 d post Delayed treatment group: physical therapy plus compression bandage and weight bearing within 10 d post	Assessment time: post 6 mo Measures: average d to full weight bearing, bed occupancy (d), average d to full ROM, average duration of effusion post (d), patients with effusion (%), average d of physical therapy, average d off work	Early treatment group*: • Average d to full weight bearing: 4 (2-21) • Bed occupancy: 5.9 (3-11) • Average d to full ROM: 71 (12-120) • Average duration of effusion post: 49.4 • Patients with effusion: 75 • Average d of physical therapy: 32 • Average d off work: 51 (7-140) Delayed treatment group*: • Average d to full weight bearing: 13.4 (10-42) • Bed occupancy: 14.7 (10-31) • Average d to full ROM: 75 (20-112) • Average duration of effusion post: 51 • Patients with effusion: 77 • Average d of physical therapy: 28 • Average d off work: 53.5 (12-101)
St-Pierre et al[44]	Early training group: 7 participants; mean ± SD age, 35.8 ± 6 y; 7 male Delayed training group: 9 participants; mean ± SD age, 35.8 ± 12.9 y; 3 female, 6 male	Early training group: physical therapy within 2 wk post plus home exercise (3 times per wk for 4-8 wk) Delayed training group: physical therapy within 6 wk post plus home exercise (3 times per wk for 4-8 wk)	Assessment times: pre, post 2 wk, 6 wk, and 10 wk Measures: quadriceps and hamstrings peak torques, torques developed by the quadriceps and hamstrings, fatigue of the quadriceps, total work (J), average power (W), fatigue index, fatigue of the hamstrings, total work (J), average power (W), fatigue index	Early training group†: • Quadriceps and hamstrings peak torques: NA • Torques developed by the quadriceps and hamstrings: NA • Fatigue of the quadriceps: – Total work: pre, 1330.6 ± 326.3; 10 wk, 1565.8 ± 384.1 – Average power: pre, 158.2 ± 52.7; 10 wk, 177.7 ± 52 – Fatigue index: pre, 78.9 ± 13.9; 10 wk, 82.7 ± 10.1 • Fatigue of the hamstrings: – Total work: pre, 741.1 ± 237.8; 10 wk, 935.3 ± 366.9 – Average power: pre, 85.1 ± 24.2; 10 wk, 104.9 ± 42.9 – Fatigue index: pre, 74.5 ± 24; 10 wk, 75.3 ± 10.4 Delayed training group†: • Quadriceps and hamstrings peak torques: NA • Torques developed by the quadriceps and hamstrings: NA • Fatigue of the quadriceps: – Total work: pre, 1648.2 ± 526; 10 wk, 1838.9 ± 637.3 – Average power: pre, 187.4 ± 61.5; 10 wk, 209.4 ± 69.9 – Fatigue index: pre, 81.5 ± 18.2; 10 wk, 77.4 ± 4.4 • Fatigue of the hamstrings: – Total work: pre, 938.5 ± 493.4; 10 wk, 1311 ± 490.8 – Average power: pre, 105.6 ± 56.1; 10 wk, 148 ± 54.6 – Fatigue index: pre, 79.8 ± 17.5; 10 wk, 73.6 ± 6.3

Abbreviations: NA, not available; post, postoperative; pre, preoperative; ROM, range of motion.
**Values are mean (range).*
†Values are mean ± SD.

in the study methods. There were no statistically significant differences between the 2 groups. At 4 weeks postsurgery, the mean percent deficit in torque between the affected and unaffected limbs was 22.1% in the supervised rehabilitation group and 22% in the home exercise group. The percent deficit in terms of endurance was 7.7% in the supervised group and 3.6% in the home group. Similar results were noted in the subjective evaluation of knee function and the ability to resume work and recreational activities.

Outpatient Physical Therapy Versus Control Group

Ericsson et al[6] evaluated the effect of exercise on functional performance and muscle strength after partial meniscectomy. Forty-five participants were randomized (22 in the intervention group and 23 in the control group). The patients in the intervention group (mean ± SD age, 45.4 ± 3.2 years) underwent supervised physical therapy for 4 months, with a frequency of 3 times per week. Patients in the control group received no treatment (mean ± SD age, 45.9 ± 3.2 years). The exercise program comprised postural stability training and functional strength and endurance exercises for leg and trunk muscles. Statistically significant differences were found in favor of the intervention

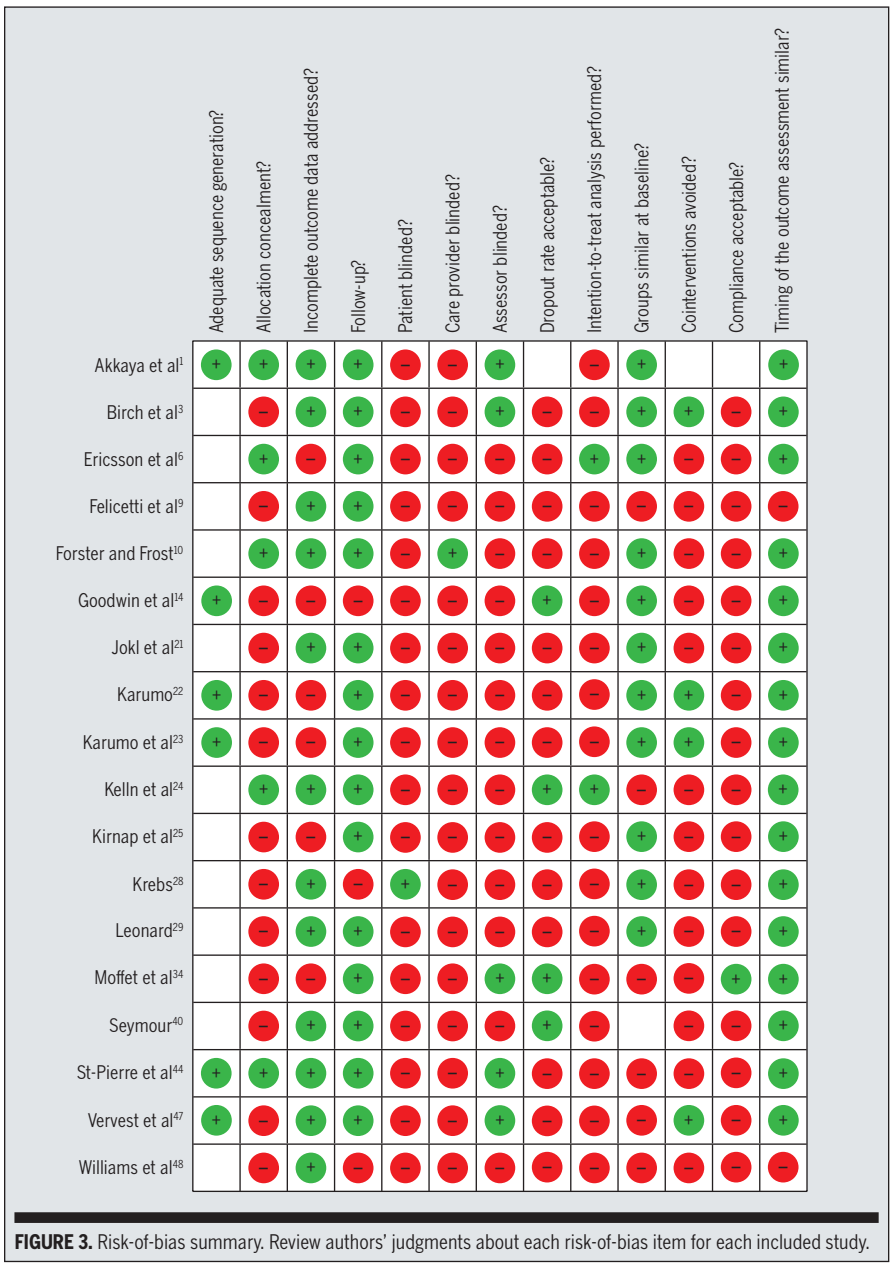


FIGURE 3. Risk-of-bias summary. Review authors' judgments about each risk-of-bias item for each included study.

group for the 1-leg hop test for distance (P = .04), hamstring strength (P = .03), and quadriceps strength (P = .001).

Outpatient Physical Therapy Versus Modalities Alone

Four studies compared the benefits of outpatient physical therapy (mix of specific interventions) and the use of modalities alone. Outpatient physical therapy consisted of aerobic, flexibility, joint mobility, and strengthening exercises and gait training; the modalities alone were EMG biofeedback, electrical stimulation, and isokinetic training.

Akkaya et al[1] compared the effectiveness of EMG biofeedback training and electrical stimulation therapy. Forty-five patients were evaluated (15 in the home exercise group, 15 in the EMG biofeedback group, and 15 in the electrical stimulation group). The mean age was 46.9 years. There was a statistically significant difference in favor of the EMG biofeedback group compared with the home exercise group for the outcomes of time using a walking aid (P<.017) and patient-reported knee function evaluated through the Lysholm questionnaire (P<.017).

Felicetti et al[9] evaluated 30 participants and found that isometric and dynamic training produced greater strength recovery of the knee extensors, whereas isokinetic training led to greater strength in the knee flexors. Krebs[28] evaluated the effects of EMG biofeedback on quadriceps muscle strength. Patients (n = 26) were divided into 2 groups: isometric exercises with biofeedback (mean ± SD age, 35.5 ± 3.4 years) and isometric exercises without biofeedback (mean ± SD age, 35.9 ± 1.9 years). The results showed statistically significant changes in muscle activation (biofeedback, 25 μV; physical therapy, 2.5 μV; P<.0001) and hand-grip test (P<.0001) between groups.

Williams et al[48] compared the effect of outpatient physical therapy and electrical stimulation on torque and thigh circumference in patients between the ages of 18 and 46 years. The results showed that both groups showed improvement; however, no comparisons were made between groups.

Inpatient Treatment Versus Inpatient Plus Outpatient Treatment

Two studies fit this category[10,40] by comparing treatment given only during the period of hospitalization to receiving both inpatient and outpatient treatment. The results from both studies showed no statistical differences between the groups. The age of the participants ranged from 16 to 45 years.[10]

FIGURE 7 refers to the meta-analysis that evaluated effusion in these studies. Comparing the inpatient physical therapy group to the inpatient physical therapy plus outpatient physical therapy group, a statistically significant difference was found in favor of the inpatient physical therapy group (odds ratio = 0.25; 95% CI: 0.10, 0.61; P = .003). This means that the inpatient group showed a 75% lower risk of effusion. In the studies, the inpatient group had a mean treatment time of

10 days and the inpatient plus outpatient physical therapy group had a mean treatment time of 5 weeks.

Routine Physical Therapy Versus Intensive Physical Therapy

Karumo[22] evaluated 56 patients and compared the effects of a treatment performed twice a day (intensive; mean ± SD age, 34 ± 9.2 years) versus once daily (routine; mean ± SD age, 36.2 ± 12.3 years). Clinical findings showed no differences between the groups. With respect to the strength of the knee flexors, the routine physical therapy group showed more improvement than the intensive physical therapy group ($P<.0001$). As for the outcome ability to walk, when evaluated at 2 weeks postsurgery, the intensive group was better than the routine group; however, this difference disappeared in the evaluation at 4 weeks.

Early Versus Delayed Treatment

Two studies compared early versus delayed treatment. Leonard[29] evaluated 100 patients divided into 2 groups. The standard regime (delayed) consisted of physical therapy, compression bandage, and weight bearing at 10 days postsurgery (mean age, 35.2 years). The plaster regime (early) consisted of physical therapy plus plaster and weight bearing at 3 days postsurgery (mean age, 34.4 years). The results did not show significant differences between groups. St-Pierre et al[44] evaluated 16 patients divided into an early training group (physical therapy at 2 weeks postsurgery plus home exercise; mean ± SD age, 35.8 ± 6 years) and a delayed training group (physical therapy at 6 weeks postsurgery plus home exercise; mean ± SD age, 35.8 ± 12.9 years). The authors concluded that training in the early stages following arthroscopic meniscectomy did not appear to improve the recovery of strength, and the importance of timing of the training stimulus was suggested.

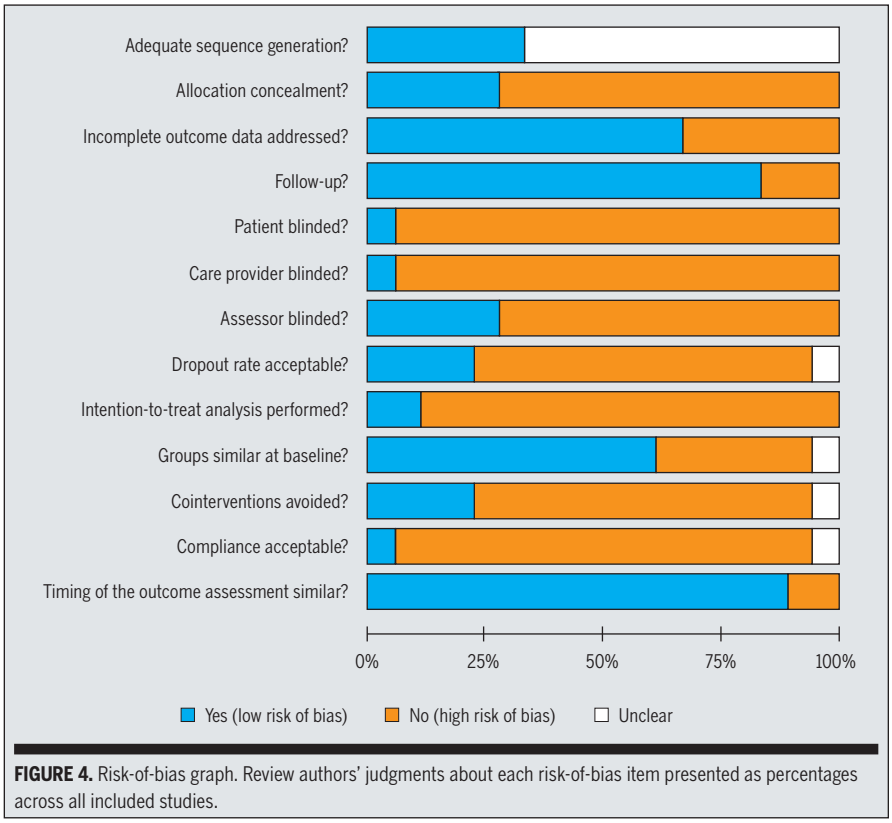


FIGURE 4. Risk-of-bias graph. Review authors' judgments about each risk-of-bias item presented as percentages across all included studies.

DISCUSSION

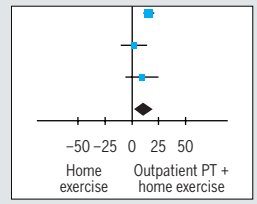
This study evaluated the effectiveness of modalities alone, such as EMG biofeedback, electrical stimulation, and isokinetic training, and the effectiveness of using different contexts for physical therapy interventions on the recovery of patients who have undergone arthroscopic partial meniscectomy. Patients who have undergone arthroscopic meniscectomy report various symptoms, such as pain, decreased ROM, and muscle atrophy. There are a wide range of interventions described for the treatment of these symptoms; however, there are few high-quality RCTs demonstrating the benefits of physical therapy for these patients.[30]

For studies comparing outpatient physical therapy with home exercise to home exercise alone, there were some disagreements among the individual studies. In 3 RCTs,[25,34,47] differences were found in favor of using outpatient physical therapy for the outcomes of ROM, patient-reported knee function, and functional tests. However, the other 3 RCTs[3,14,24] found no differences between the groups. In meta-analysis, a significant improvement was found in favor of the outpatient physical therapy group for the outcome of patient-reported knee function (**FIGURE 5**) on the Lysholm questionnaire. Studies have reported that the use of EMG biofeedback as a resource in the treatment of patients with an unstable knee promotes stability and a decrease in muscle inhibition.[32] However, other studies[34,47] have found no differences with the use of EMG for the outcome of patient-reported knee function. These authors reported that a small sample size might have influenced their results, and others have reported that the Lysholm questionnaire may not be sensitive enough to evaluate clinical changes in patients post–partial meniscectomy.

The second meta-analysis, comparing outpatient physical therapy with home exercise versus home exercise alone for the outcome of knee ROM, used 2 studies.[24,25] When analyzed together in the meta-analysis, a significant difference in knee flexion ROM for the interven-

Patient-Reported Knee Function (Lysholm Questionnaire)*

	Outpatient PT Plus Home Exercise		Home Exercise			
Study	Mean ± SD	Total, n	Mean ± SD	Total, n	Weight	Mean Difference IV, Random (95% CI)
Kirnap et al[25]	95.4 ± 3.7	20	79.6 ± 10.1	20	48.4%	15.80 (11.09, 20.51)
Moffet et al[34]	80 ± 14	15	78 ± 19	16	28.8%	2.00 (−9.70, 13.70)
Vervest et al[47]	88.7 ± 13.9	10	79.4 ± 18.8	10	22.8%	9.30 (−5.19, 23.79)
Total		45		46	100.0%	10.35 (1.33, 19.36)

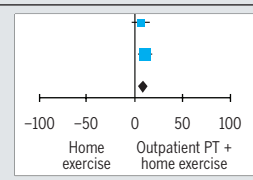


Abbreviations: CI, confidence interval; IV, instrumental variables estimation; PT, physical therapy.
**Review: physical therapy treatment on patients who have undergone arthroscopic partial meniscectomy. Comparison: outpatient physical therapy plus home exercise versus home exercise. Heterogeneity: $\tau^2 = 37.91$, $\chi^2 = 4.95$, $df = 2$ ($P = .08$), $I^2 = 60\%$. Test for overall effect: $Z = 2.25$ ($P = .02$).*

FIGURE 5. Meta-analysis of the outcome patient-reported knee function.

Knee Flexion Range of Motion*

	Outpatient PT Plus Home Exercise		Home Exercise			
Study	Mean ± SD	Total, n	Mean ± SD	Total, n	Weight	Mean Difference IV, Fixed (95% CI)
Kelln et al[24]	127.6 ± 12.3	15	121.3 ± 12.5	15	37.0%	6.30 (−2.57, 15.17)
Kirnap et al[25]	129 ± 10.2	20	118.2 ± 11.7	20	63.0%	10.80 (4.00, 17.60)
Total		35		35	100.0%	9.13 (3.74, 14.53)



Abbreviations: CI, confidence interval; IV, instrumental variables estimation; PT, physical therapy.
**Review: physical therapy treatment on patients who have undergone arthroscopic partial meniscectomy. Comparison: outpatient physical therapy plus home exercise versus home exercise. Heterogeneity: $\chi^2 = 0.62$, $df = 1$ ($P = .43$), $I^2 = 0\%$. Test for overall effect: $Z = 3.32$ ($P = .0009$).*

FIGURE 6. Meta-analysis of the outcome range of motion of knee flexion.

tion group (outpatient physical therapy plus home exercise) was found, with a mean difference of 9°. However, from a clinical point of view, this value does not reflect significant changes in functional activities.

Other studies included in this review found no differences between outpatient physical therapy alone as compared to home exercise,[21] and failed to find benefits of outpatient physical therapy.[22,23] As for early physical therapy, the results of 1 study do not appear to apply to current clinical practice because the group initiated the early physical therapy treatment only at 2 weeks postsurgery.[44] Leonard[29] showed that early physical therapy did not result in worse outcomes. This suggests that the traditional treatment of delayed time could be replaced by a safe and simple method that encourages the patient to walk and be discharged rapidly without causing harm to the final results. The author[29] suggested that physical therapy should be initiated at least 3 days after the surgery.

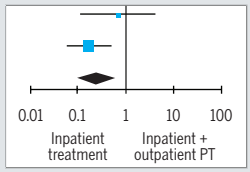
The results of the comparison of physical therapy to a control group (no intervention) have been in favor of physical therapy.[6] The results of studies[1,9,28,48] evaluating modalities alone have indicated that isokinetic training, EMG biofeedback, and electrical stimulation as adjuvants are effective for this type of patient.

Comparing inpatient physical therapy alone to inpatient plus outpatient physical therapy, no differences have been found between groups. When included in the meta-analysis (**FIGURE 7**), a difference was observed in favor of the inpatient group for the outcome of effusion present.[10,40] In these studies, the initial approach was to keep the patient in compressive bandages for at least 10 days, which may explain the absence of effusion at this stage of treatment. The authors suggested that for this type of patient, treatment during hospitalization alone is enough. However, the surgical procedures nowadays are minimally invasive, and patients are typically discharged home on the same day, making this suggestion impractical for clinical practice.

The quality of the RCTs included in this review, according to the Cochrane Collaboration[19] classification, was as follows: 13 studies were categorized as high risk of bias, 5 as moderate risk of bias, and no study as low risk of bias. In the analysis of 5 RCTs with better method-

Effusion Present*

Study	Inpatient Treatment Events, n	Inpatient Treatment Total, n	Inpatient Plus Outpatient Physical Therapy Events, n	Inpatient Plus Outpatient Physical Therapy Total, n	Weight	OR Peto, Fixed (95% CI)
Forster and Frost[10]	2	41	3	43	26.0%	0.69 (0.11, 4.17)
Seymour[40]	3	35	15	35	74.0%	0.17 (0.06, 0.49)
Total	5	76	18	78	100.0%	0.25 (0.10, 0.61)



Abbreviations: CI, confidence interval; OR, odds ratio; PT, physical therapy.
**Review: physical therapy treatment on patients who have undergone arthroscopic partial meniscectomy. Comparison: inpatient treatment versus inpatient plus outpatient physical therapy. Heterogeneity: $\chi^2 = 1.72$, $df = 1$ ($P = .19$), $I^2 = 42\%$. Test for overall effect: $Z = 3.01$ ($P = .003$).*

FIGURE 7. Meta-analysis of the outcome effusion present.

ological quality (assessed as moderate risk), their results showed that outpatient physical therapy in comparison to the control group (no intervention)[6] resulted in significant improvement. In addition, performing outpatient physical therapy plus home exercise was better than performing only home exercise,[24] and EMG biofeedback can be an important adjunct in the treatment of patients undergoing arthroscopic partial meniscectomy.[1]

Most of the studies included in this review did not perform allocation concealment or blinding of the assessor; only 2 studies performed analysis by intention to treat, and 17 studies did not have an acceptable compliance. Of the 25 studies evaluated, 7 were excluded because the authors did not randomize or their control group did not undergo arthroscopic partial meniscectomy. There were inconsistencies in the type of intervention, the duration and intensity of the treatment, and outcome measures, making it difficult to carry out meta-analysis. Many studies had small sample sizes. Due to these factors, the results presented here should be interpreted and used with caution.

This review had some limitations. The inclusion criteria were very broad and did not select for defined types of interventions, outcomes, specific lesions, or patients. Sixteen of the studies included in this review did not select the type of injury (traumatic or degenerative) as an inclusion criterion, impeding the separation of these conditions. Therefore, comparisons of meta-analyses may include both types of patients, which might create some bias. Another limitation was the inclusion of RCTs with a high risk of bias, as evidenced by the heterogeneity of the studies found in the meta-analysis. Also, a sensitivity analysis was not performed.

Implications for Practice

From a practical point of view, some suggestions can be made. Knee pain, lack of mobility, effusion, and thigh atrophy are the most common clinical findings after a partial arthroscopic meniscectomy procedure. The treatment should include outpatient care and a well-planned home exercise program. It should be performed at least 3 times a week[6,10,14,21,24,34,40,44,47,48] and start as soon as possible.[29] The treatment may contain the following interventions: early weight bearing, progressive knee mobilization exercises, quadriceps and hamstrings strengthening exercises (dynamic and isometric), sensory motor training, thermotherapy, and an early return to activities. It may use adjuvants such as neuromuscular electrical stimulation, EMG biofeedback, and isokinetics.

Implications for Research

The present review revealed some methodological flaws in the RCTs evaluated. The poor methodological quality found in the RCTs should be avoided and was due to factors such as small sample size, lack of standard outcome measures, and not using guidelines such as the CONSORT statement.[39] Another aspect to be considered is the assessment of compliance; for instance, it is necessary to know how many sessions each patient attended.

More RCTs with a high methodological quality should be conducted. One of the main implications resulting from this systematic review is the need for further research of the effectiveness of physical therapy after arthroscopic meniscectomy, with attention to the diagnostic criteria, whether acute or degenerative. We suggest an RCT conducted according to the guidelines of the CONSORT statement, with primary outcomes of patient-reported knee function, ROM, pain, quadriceps and hamstrings strength, and thigh circumference. Recommended secondary outcomes are effusion, gait, and time to return to work.

CONCLUSION

This review found that outpatient physical therapy associated with a home exercise program improved patient-reported knee function and ROM and reduced effusion in patients who had undergone partial arthroscopic meniscectomy. However, the results presented in this review are based on studies of moderate to high risk and should be interpreted with caution.

KEY POINTS

FINDINGS: The results of this review indicate that carrying out outpatient physical therapy associated with a home exercise program results in greater improvement in patient-reported knee function and ROM than just outpatient physical therapy. Furthermore, inpatient physical therapy alone reduces the likelihood of effusion.

IMPLICATIONS: For clinical practice, the treatment should include outpatient care and a well-planned home exercise program. It should be performed at least 3 times a week and start as soon as possible.

CAUTION: The studies included in this review were classified with a high to moderate risk of bias, so their results should be interpreted with caution.

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