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Effect of Postoperative Kinesio Taping on Knee Edema, Pain, and Range of Motion After Total Knee Arthroplasty and Anterior Cruciate Ligament Reconstruction

A Systematic Review and Meta-analysis of Randomized Clinical Trials

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Abstract

Background: Kinesio taping (KT) has been shown to be clinically effective in a wide range of musculoskeletal disorders. Despite evidence supporting KT, there still needs to be more certainty regarding its clinical worthiness in managing postoperative conditions. This study aims to assess the effect of postoperative KT on knee edema, pain, and range of motion (ROM) when added to routine physiotherapy after knee surgery.

Methods: In this systematic review and meta-analysis, MEDLINE, Embase, Scopus, Web of Science, and CENTRAL databases were searched from their inception to July 2023. Randomized controlled trials (RCTs) comparing routine physiotherapy with and without KT were included. Random-effect models were used to calculate the standardized mean difference (SMD), confidence interval, and heterogeneity (I^2).

Results: Sixteen RCTs on 842 operated knees were included. KT reduced knee edema in first week (SMD, -0.59, $p < 0.001$), 14th postoperative day (POD) (SMD, -0.78, $p < 0.001$), and 28 to 42 days postop (SMD, -0.66, $p < 0.001$). The KT demonstrated significant pain improvement in second week (SMD, -0.87, $p < 0.001$) and the fourth week (SMD, -0.53, $p < 0.001$). The KT groups demonstrated ROM improvement within second week (SMD, 0.69, $p = 0.010$) and in the 28th POD (SMD, 0.89, $p = 0.009$). Subgroup analysis demonstrated minimal heterogeneity in anterior cruciate ligament reconstruction (ACLR) cases. However, it did not show significant superiority regarding ankle, calf, or thigh edema and Lysholm scale.

Conclusion: This study suggests that adding KT to routine postoperative physiotherapy reduces pain and knee edema after total knee arthroplasty or ACLR. Low to very low certainty of evidence for all outcomes and the limited number of studies emphasize the need for more high-quality primary studies to explore the optimal method of KT application and its effectiveness in specific knee surgeries.

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Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSREV/B69).

Level of Evidence: Level I. See Instructions for Authors for a complete description of levels of evidence.

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The number of knee surgeries performed each year is growing[1]. In addition to total knee arthroplasty (TKA), which is the choice surgical method for knee osteoarthritis[2], after the increasing incidence of anterior cruciate ligament injury[3], open and arthroscopic anterior cruciate ligament reconstruction (ACLR) is more widely administered[4,5]. The main postoperative challenges are pain, limb edema, and imbalances between flexor and extensor muscle strengths[6-10]. Appropriate management of postoperative conditions is crucial for enhancing patient satisfaction and quality of life and controlling complications[11-13]. The more immediately these factors are handled, the more effectively the patient will cover functional activity[14]. Conventional postoperative rehabilitation protocols usually improve range of motion (ROM), muscle strength and functions, and control pain and edema[15]. These methods include limb elevation, cold pack application, isometric and isotonic exercises, and specific interventions such as manual lymphatic drainage (MLD)[16,17].

Kinesio taping (KT) is an elastic adhesive tape with a specific thickness and the ability to stretch up to 130% to 140% of its resting length[18]. The literature has shown that KT is a practical and safe method, which leads to increased muscle activity, correction of joint misalignment, activation of the pain-relieving mechanisms, elimination of edema and pain, and reduced muscle fatigue[19]. KT has been shown to be clinically effective in a wide range of musculoskeletal disorders such as low back pain[20], osteoarthritis[21], and sports injuries[22].

Previous randomized controlled trials (RCTs) investigated the effects of KT after orthopaedic surgeries[23-26]. However, the findings are controversial. For example, a 10-day KT application with lymphatic modification has been effective in controlling swelling, but its effect on postoperative pain in the first 3 days has not been demonstrated[25,27]. Other investigations suggested that in the first 1 to 2 weeks after ACLR and TKA, 10 to 28 days of KT application with lymphatic modification showed impacts such as pain alleviation, reduced edema, and improved ROM[23,24]. However, knee strength and balance were not altered by the immediate effects of KT[26].

Despite evidence supporting KT, there still needs to be more certainty regarding its clinical worthiness in managing postoperative conditions. To date, no systematic review has provided a complete summary of the existing high-quality trials investigating the postoperative effects of KT. Therefore, we performed a meta-analysis on RCTs to investigate KT's effect when added to conventional therapy in terms of reducing pain and edema and improving function in the early knee rehabilitation period.

Methods

This systematic review and meta-analysis was conducted and reported conformed to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines[28] (Supplementary Tables S4 and S5). Protocol of the present systematic review and meta-analysis has been registered with the International Prospective Register of Systematic Reviews under the registration code (CRD42023444343).

Study Design

In this study, the effectiveness of addition of postsurgical KT to the routine postop physiotherapy in the management of knee surgeries was investigated. The authors defined the PICO framework as follows:

P (Population): Individuals of any sex who underwent orthopaedic knee surgery composed of cruciate ligament reconstruction, meniscal repair, and hemiarthroplasty or total knee arthroplasty.

I (Intervention): Administration of Kinesio taping in addition to the routine postop physiotherapy.

C (Comparison): Patients taking routine postop physiotherapy, but not receiving any kind of taping method.

O (Outcome): lower extremity edema (i.e., thigh, knee, calf, and ankle edema), knee pain, knee ROM, and any orthopaedic outcome assessment scale (i.e., Lysholm score, Knee injury and Osteoarthritis Outcome Score [KOOS], and Knee Society Knee Score [KSS]).

Search Strategy

A combination of expert suggestions, Medical Subject Headings and Emtree databases, and screening of relevant articles' titles were used to determine the keywords related to knee orthopaedic surgery and KT. We generated separate search strings using relevant tags for each database, namely MEDLINE (through PubMed), Embase, Scopus, Web of Science, and Cochrane library and conducted searches from their initial launch until July 2023 (Supplementary Table S1). Furthermore, ClinicalTrials.gov and Google Scholar were searched for any potentially relevant studies and a review of gray literature. Also, we manually searched the bibliography of all selected articles.

Eligibility Criteria

Only randomized clinical trials (RCTs) were included in this study with no language or publication date restriction. The studies that initiated the KT intervention before surgery or later than 14 days after surgery were excluded. This decision was made to evaluate

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specifically the effect of adding KT to the immediate postsurgery physiotherapy protocol. In addition, the predefined exclusion criteria included studies that compared KT with other experimental interventions, those that did not assess the main outcomes of the current study, and those that recruited patients undergoing vascular surgery (However, no study was excluded according to these 2 predefined criteria). Case-control and observational studies, duplicate reports, letters, case reports, case series, and reviews were also excluded.

Study Selection and Data Extraction

Initial records were exported to EndNote version 20.0 software, which removed duplicates. Titles and abstracts were reviewed by 2 independent authors (A.A. and F.T.) to screen articles. The authors then retrieved the full text of potentially eligible studies and adopted articles according to predefined inclusion criteria. In cases of disagreement, the senior reviewer's opinion (S.S.) was considered for the final decision. Data extracted from the article consisted of details about study characteristics, study methodology, number and demographics of the enrolled patients, details of the intervention, follow-up duration, and method of outcome measurement.

Two independent authors entered the included studies data into a predesigned Excel form. If there were lacking data to meet our study objectives, we contacted the article's corresponding authors. PlotDigitizer online software was used for articles reporting data in the form of figures.

Outcomes of Interest and Definitions

This systematic review focused on several outcomes of interest, including intensity of pain (measured by Visual Analog Scale or Numerical Rating Scale), lower-limb edema (net thigh, knee, calf, and ankle circumference by centimeter or increase from the preoperation measurement), knee flexion ROM (angle degree), and any orthopaedic outcome assessment scale (i.e., Lysholm score, KOOS, and KSS).

Risk-of-Bias Assessment

For Included studies, second version of the Cochrane risk-of-bias tool was used for critical appraisal of the quality of studies[29]. Two independent authors applied the criteria stipulated by this tool for all included articles and made decisions on the basis of available data. When there was no risk of bias in any one of the areas, the total score was classified as "low." When more than one of the domains was judged as "some concerns" or "high," the end result was rated as "some concerns" or "high."

Certainty of Evidence

Two independent authors assessed publication bias, risk-of-bias assessments, inconsistency, imprecision, and indirectness and reported the level of evidence for each investigated outcome based on the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) guideline[30]. The certainty of evidence in this meta-analysis was reported as high, moderate, low, and very low.

Statistical Analysis

The meta-analysis was performed using STATA software (version 17). Forest plots have also been used to demonstrate the effect size. All outcomes were evaluated using the standardized mean difference (SMD). Because of differences in the study population, measurement of outcomes, and intervention procedure, high heterogeneity could be anticipated within the included reports. To address this issue, random-effect analyses were applied

The subgroup analyses were selected according to the follow-up time when the targeted outcome was assessed. We established cut-points to aggregate and assess edema during the first week, second week, and after 4 weeks based on the available data. For pain and ROM assessments, we pooled the available data during the first week, second week, at the fourth week, and after 6 weeks. In addition, we specifically evaluated the Lysholm score at the second week and after the fourth week. We also conducted additional subgroup analysis based on the type of surgery (TKA and ACLR/invasive knee arthroscopy [IKA]) to assess the outcomes in each population. On completing the data collection, limited studies reported outcomes using KOOS, KSS, or other orthopaedic outcome assessment tools; therefore, only the Lysholm score was included in the meta-analysis.

I^2 was applied to measure heterogeneity among results according to the Higgins classification[31]. The Egger[32] test and funnel plots were used to investigate small study effect and publication bias.

Results

Search Results

The starting search of the databases detected 482 articles implementing the search strategy. In addition, 15 studies were obtained from extra sources. Duplicates were removed using EndNote, and 39 particular studies were chosen for a full-text review. Based on the eligibility criteria, 23 studies were omitted for explanations as stated in Figure 1, and 16 articles were chosen to be included in the meta-analysis of this study[23-25,33-45] (Fig. 1).

Study Characteristics

Table I shows the baseline characteristics of studies included in the final analysis. Data were collected from 16 RCTs involving 842 patients, with 418 in the KT group and 424 in the control group. Eight studies were conducted on TKA cases[23,34,37,38,40-42,45], 7 studies focused on ACLR cases[24,25,33,35,39,43,44], and 1 study included patients undergoing IKA for meniscal repair, meniscectomy, or ligament repair[36].

The mean age of participants in ACLR studies was 26.3 to 64.5, with a male sex participant rate of over 62%. The mean age of participants in TKA studies ranges from 65.4 to 68.1, with a male sex participant rate of under 80%. Four studies added sham taping to routine physiotherapy in the control group[24,34,36,45], whereas the other 12 control groups underwent routine

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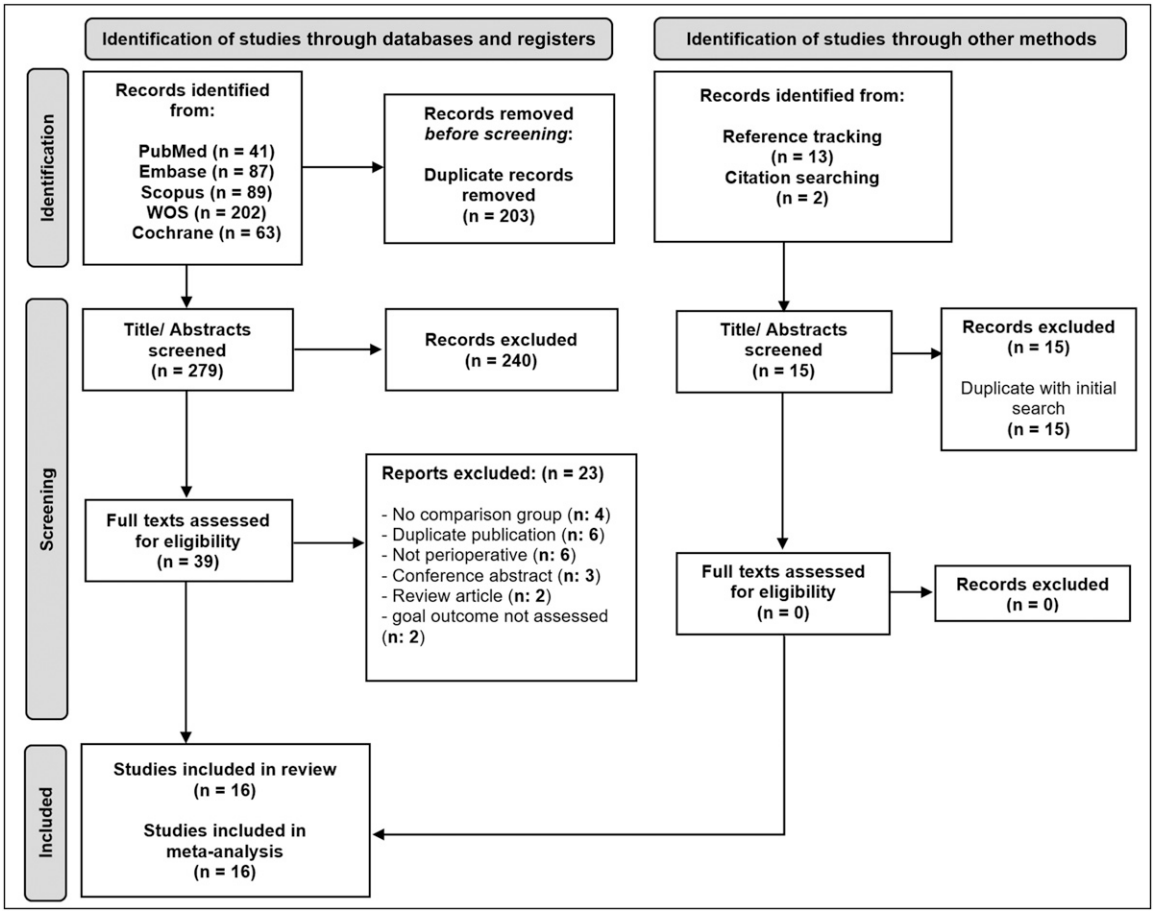

Fig. 1

PRISMA 2020 flow diagram for study selection. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses, and WOS = Web of Science.

physiotherapy without any additional taping treatment.

Main Outcomes

Figure 2 presents the outcomes of a meta-analysis comparing knee edema across 3 subgroups based on outcome assessment timing. In the first subgroup (3 to 8 days postop [PO]) knee edema significantly favored the KT intervention (SMD, −0.59, 95% confidence interval [CI], −0.85 to −0.33, $p < 0.001$). In addition, the KT intervention exhibited significant superiority in knee edema at the 14th day postoperation (SMD, −0.78, 95% CI, −1.11 to −0.46, $p < 0.001$) and during the 28- to 42-day postoperation period (SMD, −0.66, 95% CI, −0.91 to −0.40, $p < 0.001$). The magnitude of the difference in the results indicates a medium-to-large clinical significance and statistical significance at all the time points.

Figure 3 displays the forest plot illustrating disparities in pain across 3 subgroups. Notably, the KT group demonstrated statistically and clinically significant pain improvement through pooled analysis in 2 subgroups: 8 to 14 days PO (SMD, −0.87, 95% CI, −1.42 to −0.33, $p < 0.001$) and the 28th postoperative day (POD) (SMD, −0.53, 95% CI, −0.82 to −0.25, $p < 0.001$). Although the KT group exhibited favorable differences in pain within the remaining 2 subgroups, these distinctions were not statistically significant for the 3 to 8 days PO or the 42nd POD subgroups ($p = 0.434$ and $p = 0.523$, respectively).

Figure 4 provides a subgroup analysis depicting the variation in knee flexion ROM through pooled analysis. The findings reveal that the KT groups exhibited a notable increase in ROM in comparison with the control groups during 2 specific intervals: 8 to 14 days postoperation (SMD, 0.69, 95% CI, 0.16-1.22, $p = 0.010$) and the 28th POD (SMD, 0.89, 95% CI, 0.22-1.57, $p = 0.009$). However, these distinctions did not attain statistical significance within the subgroups evaluated at 3 to 7 days PO or 42 to 90 days PO ($p = 0.078$ and $p = 0.779$, respectively).

Secondary Outcomes

Figure 5 depicts the forest plot illustrating variations in Lysholm scale scores across 2 subgroups (14th POD and 28 to 42 days PO). The results suggest that the application of KT did not yield a significant difference in Lysholm scale scores within either of the 2 subgroups (all $p > 0.05$).

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TABLE I Baseline Features of the Included Randomized Controlled Trials*

First Author (Year)	Country and Surgery Type	Patient Characteristics: Sample Size (N) Mean Age (yr) Male (%)	KT Characteristics: Site Initiation Date Duration	Control Type	Evaluation Time	Reported Outcome of Interest
Balki (2016)[24]	Turkey, ACLR	KT: 15/CG: 15 KT: 28.6/CG: 27.7 KT: 100/CG: 100	Thigh + knee 4th POD 6 days	Routine physiotherapy and sham taping	9th, 14th, 30th, and 90th POD	Knee edema/ROM (knee)/pain/ Lysholm scale
Baltaci (2021)[33]	Turkey, ACLR	KT: 28/CG: 28 KT: 40.1/CG: 40.1 KT: 100/CG: 100	Knee 0 POD 3 days	Routine physiotherapy	1st, 2nd, and 3rd POD	Thigh, knee, and calf edema/ROM (knee)/pain
Cakmak (2023)[34]	Turkey, TKA	KT: 62/CG: 62 KT: 66.1/CG: 64.7 KT: 9.7/CG: 32.7	Thigh + knee 1st POD 7 days	Routine physiotherapy and sham taping	3rd and 10th POD	Knee and calf edema/ROM (knee)/pain
Chan (2017)[35]	Singapore, ACLR	KT: 30/CG: 30 KT: 27.4/CG: 26.3 KT: 73/CG: 80	Knee 1st POD 10 days	Routine physiotherapy	7th, 14th, 42nd POD	Knee edema/ROM (knee)/pain/ Lysholm scale
Donec (2014)[23]	Lithuania, TKA	KT: 40/CG: 49 KT: 66.8/CG: 68.1 KT: 12.5/CG: 16.3	Thigh + knee + calf 2nd POD 28 days	Routine physiotherapy	8th, 14th, 24th, and 28th POD	Thigh, knee, calf, and ankle edema/ ROM (knee)/pain
Gülenç (2018)[36]	Turkey, IKA	KT: 20/CG: 21 KT: 40.6/CG: 42.2 KT: 65/CG: 62	Thigh + knee + calf 2nd POD 22 days	Routine physiotherapy and sham taping	8th, 16th, 24th, and 42nd POD	Thigh, knee, calf, and ankle edema/ pain
Guney-Deniz (2023)[37]	Turkey, TKA	KT: 12/CG: 15 KT: 66.1/CG: 65.4 KT: 0/CG: 0	Thigh + knee + calf 2nd POD 2 days	Routine physiotherapy	3rd, 4th, 14th, and 42nd POD	Thigh, knee, calf, and ankle edema/ ROM (knee)/pain
Jarecki (2021)[38]	Poland, TKA	KT: 23/CG: 22 KT: 65.9/CG: 66.9 KT: 17/CG: 27	Calf 3rd POD 5 days	Routine physiotherapy	8th POD	Knee edema/ROM (knee)/pain
Labianca (2022)[39]	Italy, ACLR	KT: 26/CG: 26 KT: 28.5/CG: 29.2 KT: 100/CG: 100	Thigh + knee 2nd POD 28 days	Routine physiotherapy	14th and 28th POD	Knee edema/ROM (knee)/pain/ Lysholm scale
Laborie (2015)[25]	France, ACLR	KT: 28/CG: 29 KT: 29.2/CG: 32.6 KT: 75/CG: 80	Knee Operation room 3 days	Routine physiotherapy	1st, 2nd, and 3rd POD	Pain
Oktas (2018)[40]	Turkey, TKA	KT: 12/CG: 6 KT: 61/CG: 67 KT: 20/CG: 0	Knee 2nd POD 5 days	Routine physiotherapy	30th POD	Lysholm scale
Sobiech (2022)[41]	Poland, TKA	KT: 42/CG: 40 KT: 66.7/CG: 67.8 KT: 76/CG: 80	Calf 3rd POD 5 days	Routine physiotherapy	8th POD	ROM (knee)
Sulman (2020)[42]	Pakistan TKA	KT: 15/CG: 15 KT: 69.9/CG: 70.6 KT: 66/CG: 73	Thigh + knee 2nd POD 7 days	Routine physiotherapy	28th POD	Lysholm scale
Ural (2017)[43]	Turkey, ACLR	KT: 13/CG: 13 KT: 64.5/CG: 64.5 KT: 92/CG: 92	Thigh + knee 1st POD 28 days	Routine physiotherapy	14th and 28th POD	Thigh and knee edema/ROM (knee)/pain
	Brazil, ACLR	KT: 19/CG: 19	Knee		7th and 14th POD	Knee edema

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TABLE I (*continued*)

First Author (Year)	Country and Surgery Type	Patient Characteristics: Sample Size (N) Mean Age (yr) Male (%)	KT Characteristics: Site Initiation Date Duration	Control Type	Evaluation Time	Reported Outcome of Interest
Valladares (2023)[44]		KT: 29.2/CG: 29.4 KT: 95/CG: 95	2nd POD 14 days	Routine physiotherapy		
Yuksel (2022)[45]	Turkey, TKA	KT: 33/CG: 34 KT: 65.4/CG: 65.4 KT: 24/CG: 32	Thigh + knee + calf 1st POD 6 days	Routine physiotherapy and sham taping	6th and 90th POD	ROM (knee)/pain

*ACLR = anterior cruciate ligament reconstruction, CG = control group, IKA = invasive knee arthroscopy, KT = Kinesio taping, POD = postoperative day, ROM = range of motion, and TKA = total knee arthroplasty.

The Supplementary Figure S1 displays the forest plot depicting variations in ankle edema. The outcomes indicate that KT yielded no significant differences in ankle edema within any of the 3 subgroups (all $p > 0.05$).

The Supplementary Figure S2 presents the forest plot illustrating disparities in calf edema. The findings reveal a significant reduction in calf edema in the KT group within the subgroup assessed at 28 to 42 days PO (SMD, −0.60, 95% CI, −1.01 to −0.19, $p = 0.004$). However, no statistically significant differences were observed in the other 2 subgroups (all $p > 0.05$).

The Supplementary Figure S3 presents the forest plot illustrating disparities in thigh edema. The outcomes indicate that KT had no significant impact on thigh edema within any of the 3 subgroups (all $p > 0.05$).

Outcome Assessment Based on the Surgery

Table II presents a meta-analysis of outcomes at each time point performed in 3 populations: TKA, ACLR/IKA, and the previously discussed pooled population. In all subgroups, knee edema remained significantly lower in the KT group, and heterogeneity was minimized in the ACLR/IKA patients. Knee pain at the second week and knee ROM in the second week and fourth week similarly remained significantly lower in the KT group, with reduced heterogeneity in the ACLR/IKA patients. Differences in other outcomes remained statistically nonsignificant, or the number of studies in each subgroup was too low (1 or 2 studies) to assess for changes.

Publication Bias

Only ankle and thigh edema showed no evidence of a small study effect or publication bias. For all other outcomes, either 1 of the 2 or both issues were observed. Supplementary Table S3 provides a comprehensive summary of the small study effects and assessment of publication bias. For visual reference, Supplementary Figures S5 through S11 showcase the funnel plots.

Risk of Bias

Figure 6 presents a summary of the risk-of-bias assessment of individual articles. According to the nature and type of intervention that does not allow blinding in the methodology of included studies, 7 studies had a high risk of bias in the fourth domain of (measurement of the outcome). Overall, 1 study was evaluated as "low," 7 as "some concern," and 8 as "high" risk of bias. Because of the limited number of items for each subgroup, we included the studies in the meta-analysis regardless of their risk-of-bias score.

Heterogeneity

The heterogeneity levels for knee edema ranged from $I^2 = 0\%$ to $I^2 = 74\%$, for knee pain ranged from $I^2 = 0\%$ to $I^2 = 89\%$, and for knee ROM from $I^2 = 0\%$ to $I^2 = 88\%$ (Figs. 2, 3, and 4). In addition, significant heterogeneity was observed among the studies that investigated ankle edema, calf edema, Lysholm scale, and thigh edema, as indicated by the results.

Certainty of the Evidence

Knee pain, knee ROM, and knee edema were rated as having low certainty of evidence according to the GRADE approach. For other outcomes, the certainty of evidence was assessed as low or very low (Supplementary Table S2).

Discussion

A comprehensive review of existing RCTs on the rehabilitative performance of KT after TKA, ACLR, and knee arthroscopy supported the beneficial effect of KT on alleviating postsurgical knee edema. Such a promising effect was observable from the first week after surgery and remained significant even in longer follow-ups (4-6 weeks). Swelling is one of the most prevalent complications after limb surgery. In the orthopaedic context, postsurgical edema formation is a contributing factor to surgical site infection, septic arthritis, and impaired wound healing[46,47]. Moreover, hemorrhage and fluid congestion impede rehabilitation programs by hampering the tissue distensibility around the joint and aggravating perceived pain and discomfort by patients. The main mechanism proposed for the antiswelling property of KT lies in the tension exerted by elastic tapes on the skin. KT have been shown to gently lift

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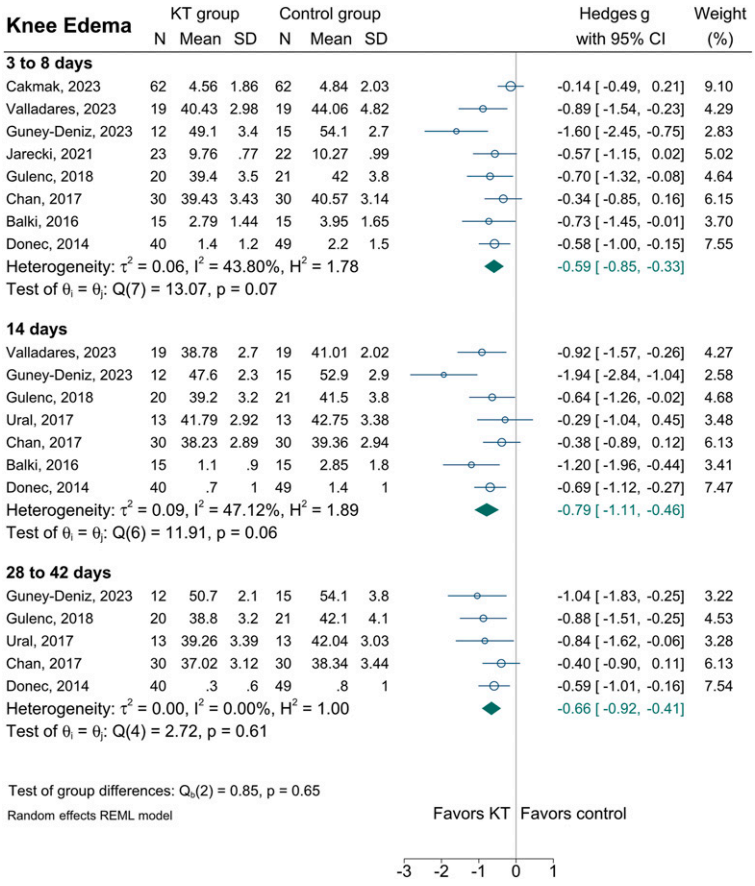

Fig. 2

Forest plots showing knee edema in 3 subgroups based on the time of outcome assessment. CI = confidence interval, KT = Kinesio taping, and REML = restricted maximum likelihood.

the skin and form convolutions beneath cutaneous soft tissues. This space-widening effect reduces the interstitial pressure, thus facilitating the uninhibited flow of congested lymphedema[48]. Decongestion approaches are broadly accepted in rehabilitation programs and include but are not limited to limb elevation, ice-packing, MLD, and compression stocking[49]. Compared with the above-mentioned modalities, KT is associated with advantages in terms of patients' compliance, lower needs for physiotherapy sessions, and low cost, making it a potential adjunct tool in rehabilitation programs. Compared with multilayer bandaging, which is another conventional decongestive lymphatic therapy, KT has the added benefit that patients can take a shower without peeling off the tape[50]. The beneficial effect of KT on managing postoperative edema is not restricted to extremity procedures. In line with our study results, a systematic review of the efficacy of KT in mitigating postsurgical edema in various types of surgery also indicated a visible effect after 7 days of follow-up[48]. Considering that swelling is an acute consequence of knee surgery, we speculate that immediate administration of KT after surgery would yield more promising results in managing edema. Nevertheless, it should be noted that applying KT in operative rooms may be challenging, accounting for the care of incision sites and sterility concerns. In our study, we could not perform subgroup analysis based on the time of KT initiation because of different administration times and various treatment durations. This highlights the demand for future clinical trials comparing the efficacy of KT on interested outcomes at different time windows. This will shed light on the golden time for KT application.

Among patient-centered outcomes, pain plays a pivotal role in the patient's satisfaction with surgery, adherence to rehabilitation treatments, and quality of life. Our results favor KT in ameliorating pain in patients with knee surgery. KT revealed significant pain reduction from the second week postop and remained in significant level in the longer follow-up (fourth week). These findings concur with studies highlighting the effect of KT on pain reduction[51,52]. In the second week, KT reduced pain significantly, suggesting that it accelerates the pain reduction effect of traditional modalities when used in conjunction with them. However, only 3 RCTs used KT for 4 weeks or longer. Lim et al., in their meta-analysis, demonstrated that KT as an adjunct to exercise therapy was associated with better pain management among patients with chronic (>4-week) musculoskeletal pain[53]. As a result, it is fair to expect that future RCTs with a longer period of KT application will show a significant pain reduction effect after 2 weeks. Along with reducing

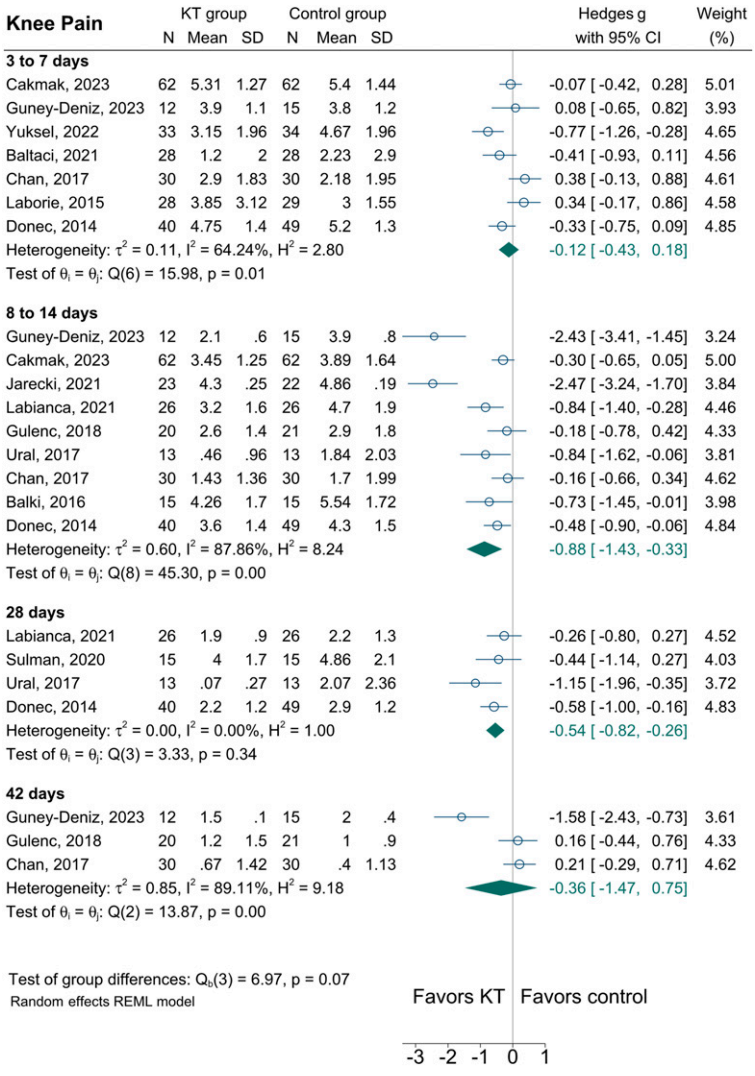

Fig. 3

Forest plots showing knee pain in 4 subgroups based on the time of outcome assessment. CI = confidence interval, KT = Kinesio taping, and REML = restricted maximum likelihood.

interstitial pressure and irritation of neurosensory by microscopically lifting the skin, another purported mechanism for reducing pain by KT is that tension applied by tapes activates cutaneous mechanoreceptors and inhibits the ascendance of nociceptive signals through the spinal cord, conforming to the principles of the gate control theory of pain[54]. Most studies in our review did not compare the KT effect on pain control with the placebo group, which in this case would be sham taping. In a systematic review by Montalvo et al., the authors reported that 4 of 5 placebo-controlled trials on the efficacy of KT in pain reduction in the context of musculoskeletal injuries revealed significant pain reduction for both KT and placebo[54]. Accounting for one of the proposed mechanisms of pain reduction by KT, sham taping may not literally act as a placebo because it may imitate mechanoreceptors' activation effects. Nonetheless, it warrants further studies to broaden our understanding of the KT pain alleviation mechanisms and the potential contribution of the placebo effect.

Our review demonstrated that KT was associated with improved ROM initiated in the second week of surgery and became most prominent in the fourth week. As was previously discussed, KT had significant effects on mitigating swelling and pain in the second week after surgery, which directly influenced functional recovery and improved ROM. Contrary to conventional tapes, KT provides muscle support without restriction on joint motion because it can stretch up to 50% of its length[55]. It needs to be made apparent whether the improved ROM observed in our results arose from improved muscle strength. Muscle strength recovery after knee surgery is cardinal for achieving joint stability, balance, and agility in patients. Although collated evidence endorses negligible muscle strength improvement in healthy individuals, this notion was contradicted by isokinetic muscle strength improvement after KT in patients with knee osteoarthritis[56,57]. Apart from muscle strength, 1 limiting factor for regaining ROM after knee

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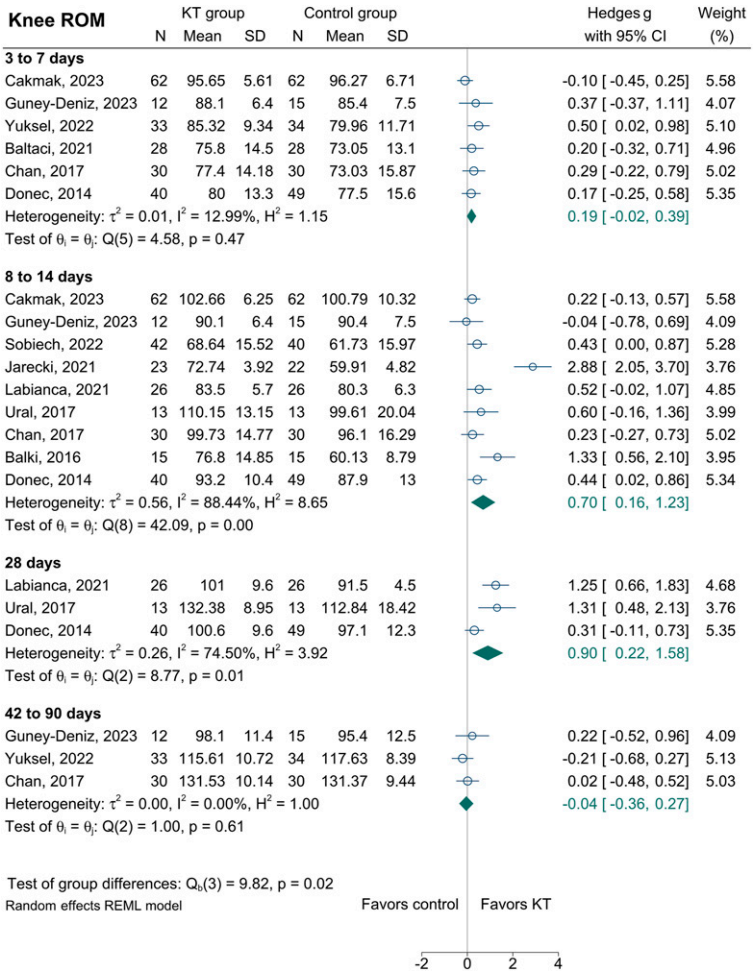

Fig. 4

Forest plots showing knee flexion ROM in 4 subgroups based on the time of outcome assessment. CI = confidence interval, KT = Kinesio taping, REML = restricted maximum likelihood, and ROM = range of motion.

surgery is the psychological fear of reinjury and pain named kinesiophobia[58]. Kinesiophobia is one of the main targets of rehabilitation programs, especially for athletes, to improve functional recovery after orthopaedic surgeries[59]. Similarly, a study by Gholami et al. reported diminished fear of movement measured by the Tampa Fear Scale after KT among athletes after ACLR surgery[60]. In addition, Hoffman et al.

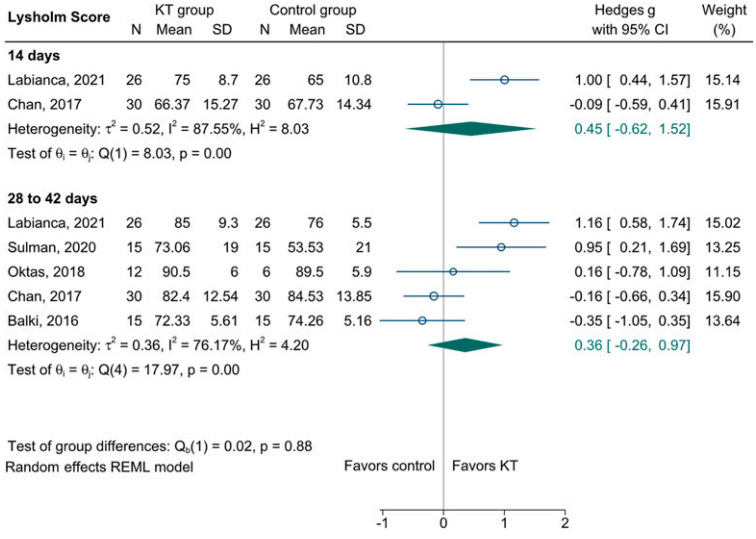

Fig. 5

Forest plots showing Lysholm Knee Scoring Scale in 2 subgroups based on time of assessment. CI = confidence interval, KT = Kinesio taping, and REML = restricted maximum likelihood.

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TABLE II Subgroup Analysis Based on the Type of Surgery*

Outcome	Assessment Timepoint	Surgery Type	N (Studies)	I^2 (%)	SMD (95% CI)	p Value
Knee edema	3 to 8 days	Pooled result	454 (8 RCTs)	43	**−0.59 (−0.85 to −0.33)**	**<0.001**
		TKA	285 (4 RCTs)	75	**−0.62 (−1.14 to −0.10)**	**0.018**
		ACLR or IKA	169 (4 RCTs)	0	**−0.61 (−0.91 to −0.31)**	**<0.001**
	14 days	Pooled result	311 (7 RCTs)	47	**−0.79 (−1.11 to −0.46)**	**<0.001**
		TKA	116 (2 RCTs)	83	**−1.25 (−2.46 to −0.03)**	**0.043**
		ACLR or IKA	195 (5 RCTs)	8	**−0.64 (−0.94 to −0.34)**	**<0.001**
	28 to 42 days	Pooled result	243 (5 RCTs)	0	**−0.66 (−0.92 to −0.41)**	**<0.001**
		TKA	116 (2 RCTs)	0	**−0.68 (−1.06 to −0.31)**	**<0.001**
		ACLR or IKA	127 (3 RCTs)	2	**−0.63 (−0.99 to −0.28)**	**<0.001**
Knee pain	3 to 7 days	Pooled result	480 (7 RCTs)	64	−0.12 (−0.43 to 0.18)	0.434
		TKA	307 (4 RCTs)	51	−0.29 (−0.63 to 0.04)	0.094
		ACLR or IKA	173 (3 RCTs)	64	0.10 (−0.39 to 0.60)	0.676
	8 to 14 days	Pooled result	494 (9 RCTs)	87	**−0.88 (−1.43 to −0.33)**	**0.002**
		TKA	285 (4 RCTs)	94	**−1.36 (−2.52 to −0.19)**	**0.022**
		ACLR or IKA	209 (5 RCTs)	30	**−0.50 (−0.84 to −0.17)**	**0.003**
	28 days	Pooled result	197 (4 RCTs)	0	**−0.54 (−0.82 to −0.26)**	**<0.001**
		TKA	119 (2 RCTs)	0	**−0.54 (−0.90 to −0.17)**	**0.003**
		ACLR or IKA	78 (2 RCTs)	69	−0.65 (−1.52 to 0.20)	0.137
	42 days	Pooled result	128 (3 RCTs)	89	−0.36 (−1.47 to 0.75)	0.523
		TKA	27 (1 RCT)	—	—	—
		ACLR or IKA	101 (2 RCTs)	0	0.18 (−0.19 to 0.57)	0.339
Knee ROM	3 to 7 days	Pooled result	423 (6 RCTs)	13	0.19 (−0.02 to 0.39)	0.078
		TKA	207 (4 RCTs)	36	0.18 (−0.10 to 0.47)	0.223
		ACLR or IKA	216 (2 RCTs)	0	0.24 (−0.11 to 0.60)	0.187
	8 to 14 days	Pooled result	535 (9 RCTs)	88	**0.70 (0.16 to 1.23)**	**0.010**
		TKA	367 (5 RCTs)	95	0.75 (−0.22 to 1.73)	0.132
		ACLR or IKA	168 (4 RCTs)	45	**0.60 (0.18 to 1.02)**	**0.005**
	28 days	Pooled result	167 (3 RCTs)	74	**0.90 (0.22 to 1.58)**	**0.009**
		TKA	89 (1 RCT)	—	—	—
		ACLR or IKA	78 (2 RCTs)	0	**1.26 (0.78 to 1.75)**	**<0.001**
	42 to 90 days	Pooled result	154 (3 RCTs)	0	−0.04 (−0.36 to 0.27)	0.779
		TKA	94 (2 RCTs)	0	−0.08 (−0.48 to 0.31)	0.682
		ACLR or IKA	60 (1 RCT)	—	—	—
Thigh edema	3 to 8 days	Pooled result	157 (3 RCTs)	93	−1.12 (−2.48 to 0.23)	0.104
		TKA	116 (2 RCTs)	89	−1.63 (−3.34 to 0.67)	0.060
		ACLR or IKA	41 (1 RCT)	—	—	—
	14 days	Pooled result	183 (4 RCTs)	87	−0.65 (−1.54 to 0.24)	0.154
		TKA	116 (2 RCTs)	93	−1.11 (−3.08 to 0.84)	0.265
		ACLR or IKA	67 (2 RCTs)	0	−0.27 (−0.74 to 0.19)	0.252
	28 to 42 days	Pooled result	183 (4 RCTs)	81	−0.10 (−0.82 to 0.61)	0.776
		TKA	116 (2 RCTs)	87	−0.30 (−1.48 to 0.88)	0.619
		ACLR or IKA	67 (2 RCTs)	81	0.12 (−0.98 to 1.23)	0.822
Calf edema	3 to 8 days	Pooled result	281 (4 RCTs)	92	−0.66 (−1.58 to 0.27)	0.165
		TKA	240 (3 RCTs)	95	−0.72 (−2.07 to 0.62)	0.294
		ACLR or IKA	41 (1 RCT)	—	—	—
	14 days	Pooled result	157 (3 RCTs)	91	−1.15 (−2.39 to 0.10)	0.072
		TKA	116 (2 RCTs)	92	−1.49 (−3.46 to 0.47)	0.136

continued

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TABLE II (*continued*)

Outcome	Assessment Timepoint	Surgery Type	N (Studies)	I^2 (%)	SMD (95% CI)	p Value
		ACLR or IKA	41 (1 RCT)	—	—	—
	28 to 42 days	Pooled result	157 (3 RCTs)	32	**−0.61 (−1.02 to −0.20)**	**0.004**
		TKA	116 (2 RCTs)	38	−0.51 (−1.04 to 0.04)	0.054
		ACLR or IKA	41 (1 RCT)	—	—	—
Ankle edema	3 to 8 days	Pooled result	157 (3 RCTs)	0	−0.12 (−0.43 to 0.19)	0.449
		TKA	116 (2 RCTs)	0	−0.21 (−0.57 to 0.14)	0.250
		ACLR or IKA	41 (1 RCT)	—	—	—
	14 days	Pooled result	157 (3 RCTs)	35	−0.22 (−0.63 to 0.18)	0.283
		TKA	116 (2 RCTs)	0	**−0.40 (−0.77 to −0.43)**	**0.028**
		ACLR or IKA	41 (1 RCT)	—	—	—
	28 to 42 days	Pooled result	157 (3 RCTs)	0	−0.09 (−0.40 to 0.22)	0.552
		TKA	116 (2 RCTs)	0	−0.22 (−0.59 to 0.13)	0.216
		ACLR or IKA	41 (1 RCT)	—	—	—
Lysholm score	14 days	ACLR or IKA	112 (2 RCTs)	87	0.44 (−0.62 to 1.52)	0.413
	28 to 42 days	Pooled result	190 (5 RCTs)	76	0.35 (−0.25 to 0.96)	0.255
		TKA	48 (2 RCTs)	41	0.60 (−0.15 to 1.37)	0.119
		ACLR or IKA	142 (3 RCTs)	86	0.22 (−0.70 to 1.15)	0.636

*ACLR = anterior cruciate ligament reconstruction, CI = confidence interval, IKA = invasive knee arthroscopy, N = number of participants, RCT = randomized clinical trials, ROM = range of motion, SMD = standardized mean difference, and TKA = total knee arthroplasty. Bold numbers indicate statistically significant difference.

Fig. 6

Summary of Cochrane risk-of-bias assessment tool 2.

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supported the incomparable effect of KT over placebo on the kinesiophobia of patients with musculoskeletal pain[61]. Altogether, KT could be an ancillary tool in physiotherapeutic programs to improve ROM after knee surgery by reducing pain, swelling, kinesiophobia, and possibly enhancing muscle strength.

We acknowledge that our study is subject to sort of limitations that one should note when interpreting the results. Respecting the quality of included studies, based on our judgment, 8 of 16 included studies considered to have a high risk of bias. Moreover, the determination of the level of evidence for the investigated outcomes was indicative of a low level of evidence. All the clinical trials included in our review compared KT efficacy when added to other types of physiotherapeutic modalities, which varied among studies. Through our review, we encountered various KT appliance techniques (e.g., tension, site, and direction), recurrency of use, duration, and different time of administration respecting the postsurgical period that may contribute to the heterogeneity of results. This underlines the demand for future studies to provide the most efficacious protocol for administering KT in rehabilitation programs after orthopaedic surgeries, along with patients' perspectives on it.

Conclusion

The findings of this study suggest that adding KT to routine postoperative physiotherapy reduces pain and knee edema in patients who have undergone TKA or ACLR. Notably, these effects demonstrated minimal heterogeneity in ACLR cases. However, it is essential to acknowledge that the certainty of the evidence for all outcomes was rated as low to very low. In addition, the number of studies in each surgery group was limited. Therefore, there is a strong need for more high-quality primary studies to investigate the optimal method of KT application and explore its effectiveness in specific knee surgeries. This would contribute to a more robust conclusion regarding whether KT should be recommended as an addition to routine physiotherapy modalities or not.

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Appendix

Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSREV/B70). This content was not copyedited or verified by *JBJS*.

Data Sharing Statement

All data relevant to the study are included in this article or available in the supplemental file. The authors ensure that no patient-identifiable data are available.

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