



The effect of cryotherapy on pain in patients with total knee replacement surgery: a meta-analysis

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Cryotherapy is used to reduce edema and pain after total knee replacement surgery. This study was conducted as a meta-analysis study to determine the effect of cryotherapy on pain in patients undergoing total knee arthroplasty. The words ‘total knee prosthesis,’ ‘pain,’ ‘cryotherapy,’ ‘cold application,’ and ‘orthopedic surgery’ were searched in Turkish and English in scientific articles in the last 20 years from Scopus, Science Direct, Google Scholar, Pubmed databases. As a result of the research, a total of 8.406 studies were identified. Funnel Plot, Rosenthal’s Secure N, and Orwin’s Secure N methods were used to demonstrate that the meta-analysis study was reliable and valid and to determine publication bias. The sample size of the studies included in the analysis was 1462. The total effect size was 2.929, with a lower bound of 1.641 and an upper bound of 5.223 at a 95% confidence interval. The study determined that patients who underwent cryotherapy in total knee replacement surgery had 2.9 times less pain than patients who did not undergo cryotherapy.

Keywords: total knee replacement, pain, cryotherapy, cold application, orthopedic surgery.

INTRODUCTION

It is observed that skeletal and muscular problems increase with the prolongation of life expectancy, and the number of total knee replacement surgeries is higher, especially as a result of obesity^{1,2}. Total knee replacement surgery is a surgical procedure allowing the joint to be reconstructed to relieve pain and movement limitation in patients and increase the knee’s function. Almost half of total knee replacement patients return to the clinic with complaints of pain after surgery. Managing pain after total knee replacement aims to prevent patients from suffering and improve their quality of life³. Pain is a universal condition felt in different parts of the body and causes physiological and psychological reactions causing pain to the patient. The pain felt after a successful surgery reduces the patient’s comfort and overshadows surgical success^{4,5}. Pain management is important for patient care, and nurses must be trained in pain management⁶. Another important issue is the application of non-pharmacologic methods used in treating postoperative pain and evaluating their effectiveness.

Cryotherapy, one of the non-pharmacologic methods, has become quite common in recent years. Cryo-

therapy is used to reduce edema and pain after total knee replacement surgery⁷. Cryotherapy is a non-pharmacological intervention widely used in various rheumatic joint diseases due to its effects on pain, inflammation, and edema. It is considered relatively safe, inexpensive, and easy to administer for healthcare professionals and patients. Moreover, it can be used alone or in combination with other treatments⁸. Cryotherapy is used as an adjunctive treatment method in many fields, such as orthopedics, traumatology, rheumatology, and neurology. It is reported in the literature that cryotherapy is effective in pain control and functional knee scores in preoperative and post-operative periods after total knee replacement⁹.

Cryotherapy is a method of cooling the tissue to reduce local metabolism. Today, cold application methods can be wet or dry, depending on the intended use. Wet cold application is performed with compresses soaked with ice or cold water, general or local cold water bath, and ice massage, while dry cold application is performed with ice packs and cold gel packs¹⁰. The study aimed to reveal the effect of cryotherapy on pain in patients with total knee replacement by meta-analysis.

MATERIALS AND METHODS

Research Question

– Does cryotherapy have an effect on pain in patients with total knee replacement surgery?

Scopus, Science Direct, Google Scholar, Pubmed, and Mendeley databases were utilized in the study. Studies published in the last 20 years and research articles were included in the study. Studies were excluded in the last 20 years, operations other than total knee replacement, and studies without research articles (Figure 1).

The licensed software “Comprehensive Meta-Analysis Academic/Non-profit Pricing (Version 3)” was used for data analysis. The data of all articles meeting the inclusion criteria and deemed appropriate for inclusion in the study were entered into the CMA software, and the heterogeneity status of the articles was evaluated. Effect sizes, study weights, 95% confidence intervals, and overall effect size of all studies were calculated under the random effects model in group analyses with $p < 0.05$ in the heterogeneity test and under the fixed effects model in group analyses with $p > 0.05$. “R.R. and OR” values were taken to evaluate the overall effect size in the analyses performed for binary data. “Cohen’s d” coefficient was used to compare means and calculate the overall effect size, and

this coefficient was converted to the OR coefficient to compare the effectiveness between sites. The statistical significance limit was accepted as $p < 0.05$ in evaluating the overall effect. The kappa statistic was used in the SPSS program for inter-rater agreement.

RESULTS

All 18 studies included in the meta-analysis, which evaluated the effect of cryotherapy on pain in patients with total knee replacement surgery, were research articles published in peer-reviewed journals. When the studies included in the study were evaluated: Descriptive: 1, Randomized-Controlled: 14, Prospective-Randomized-Controlled: 2, Prospective Case-Control: 1. The sample size of the studies included in the analysis is 1462. Sample numbers vary between 7 and 263. The average sample size is 81. The publication year of the studies is between 2002 and 2021. There are 1 study from 2002, 1 from 2003, 1 from 2006, 1 from 2012, 1 from 2013, 1 from 2014, 1 from 2015, 3 from 2016, 1 from 2017, 1 from 2019, 1 from 2020 and 4 from 2021.

As a result of the review of the articles, the “Joanna Briggs Institute MASTARI Critical Appraisal Tool for Descriptive/Case Series Studies” adapted into Turkish by Nahcivan and Secginli was used for the remaining 18 publications¹¹. The tool has a total of 9 items. For each study included in the scope of the review, the fulfillment of each feature included in the nine items in the form was examined, and an evaluation was made by giving 1 point if the relevant feature was met and 0 points if it was not met. These criteria allow for a general evaluation of the aims, sample characteristics, findings, and results of the studies. In the study, the articles belonging to all subgroups were independently reviewed by two researchers, and the articles with a score of 6 and above in the quality assessment were evaluated as high quality. According to the quality assessment score, an inter-coder agreement was found to be 87%. Kappa value < 0 is worse agreement than chance agreement; 0.01-0.20 is insignificant agreement; 0.21-0.40 is poor agreement; 0.41-0.60 is moderate agreement; 0.61-0.80 is good agreement; and 0.81-1.00 is very good agreement or 0.75 and above is excellent, 0.40-0.75 is fair-good and below 0.40 is poor agreement¹². The kappa value in this study (0.87) indicates a very good inter-coder agreement. (Table I)

Funnel plot, Rosenthal’s Safe N, and Orwin’s Safe N methods were used to demonstrate that the meta-analysis study was reliable and valid and to determine publication bias. The effect sizes of 18 studies examining

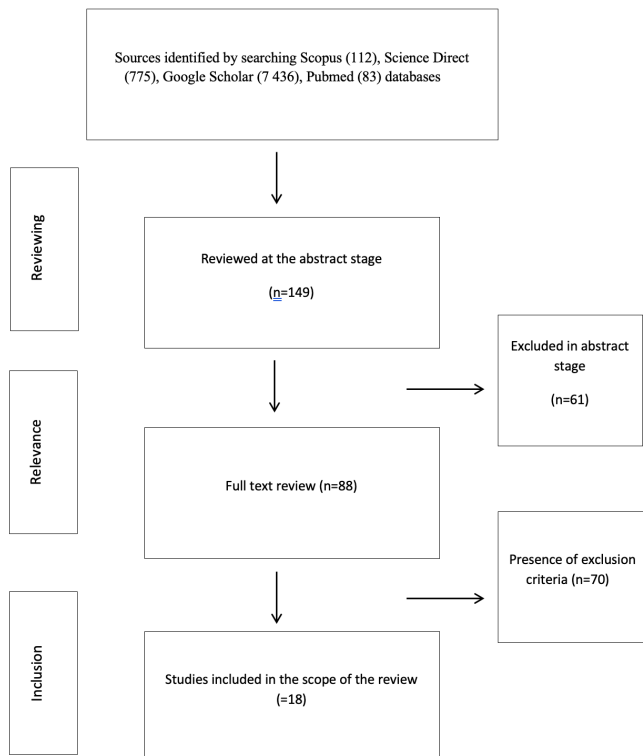


Figure 1. — Flow diagram.

Table I. — Assessment details of all studies (n=18) that underwent quality assessment

Score												Total Score
Study No	Author Name-Date	Study Type	S1	S2	S3	S4	S5	S6	S7	S8	S9	
1	Barry et al. 2003 ¹⁴	Descriptive	1/1	1/1	1/1	1/0	1/1	1/1	1/1	1/1	0/1	8/8
2	Bech et al.2013 ¹⁵	Randomized Controlled	1/1	0/0	1/1	1/0	1/1	1/1	1/1	1/1	0/0	8/8
3	Chen et al. 2020 ¹⁶	Randomized Controlled	1/1	0/0	1/1	1/1	1/1	1/1	1/1	1/1	1/1	8/8
4	Desteli et al.2015 ¹⁷	Randomized Controlled	0/1	0/0	1/1	1/1	1/1	1/0	1/1	1/1	1/0	7/7
5	Hugo et al. 2021 ¹⁸	Randomized Controlled	0/1	1/0	1/1	1/1	1/1	1/1	1/1	1/1	1/1	8/8
6	Kullenberg et al. 2006 ¹⁹	Prospective Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/8
7	Kuyucu et al. 2015 ²⁰	Randomized Controlled	0/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	8/9
8	Mark et al. 2016 ²¹	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
9	Morsi 2002 ²²	Prospective and Randomized	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
10	Murgier et al. 2017 ²³	Prospective -Case-Control	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
11	Park 2021 ²⁴	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
12	Ruffilli et al.2015 ²⁵	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
13	Su et al. 2012 ²⁶	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
14	Thienpont 2014 ²⁷	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
15	Thijs et al. 2019 ²⁸	Double Blind-Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
16	Witting-Wells et al. 2015 ²⁹	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
17	Yüksel et al. 2021 ³⁰	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9
18	Zhong et al. 2021 ³¹	Randomized Controlled	1/1	1/1	1/1	1/1	1/1	1/0	1/1	1/1	1/1	9/9

the effect of cryotherapy on pain reduction in patients with total knee replacement surgery were evaluated according to the funnel scatter plot. In the funnel plot, if the effect sizes of individual studies are inside the funnel lines and symmetrically distributed, it does not cause publication bias; if the effect sizes of individual studies are outside the funnel lines and asymmetrically distributed, it causes publication bias¹². In line with this information, when Figure 2 is analyzed, it can be said that the effect sizes of the studies are distributed in the graph close to a symmetrical shape.

When Begg-Mazumdar and Egger tests for the bias indicators of the funnel plot were evaluated, these values were Begg-Mazumdar Kendall’s tau = 0.033, p=0.488 and Egger: bias = 2.347 (95% CI = 2.217 to 2.6.912), p=0.291. In this case, the p-value was greater than 0.05 (p=0.291>0.05). With the results of the analysis, it was determined that there was no bias. In addition, Rosenthal’s fail-safe number data, another test to determine study bias, supports the data in the funnel plot and is presented in Table II.

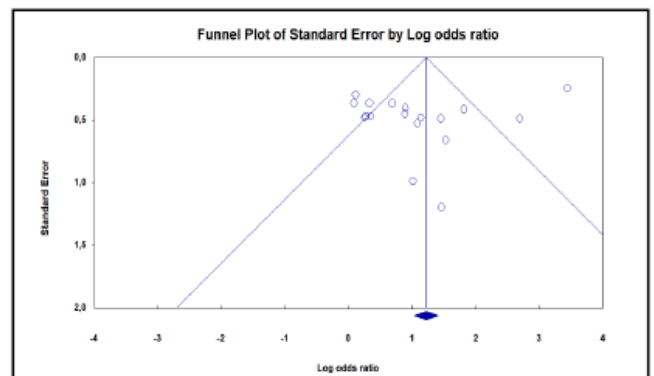


Figure 2. — Funnel Scatter Plot.

When Table 2 is analyzed, the fail-safe number obtained from this meta-analysis is 522 based on the Rosenthal method. In order for the statistical significance value of p=0.000 to be p>0.05, in other words, 522 studies with an effect size value of zero are required for the meta-analysis result to lose its significance. In other words, for the findings of this

Table II. — Graphic Table Showing Publication Bias of Studies

Begg and Mazumdar Rank Collections	
Kendall's S Statistics (P-Q)	53.00000
Kendall's tau without continuity correction	
Tau	0.0346
z-value for tau	2.0075
P-value (1-tailed)	0.2235
P-value (2-tailed)	0.4469
Kendall's tau with continuity correction	
Tau	0.33987
z-value for tau	0.196964
P-value (1-tailed)	0.24440
P-value (2-tailed)	0.48880
Egger's regression intercept	
Intercept	2.34765
Standard error	2.15351
%95 lower limit (2-tailed)	2.21757
%95 upper limit (2-tailed)	6.91288
t-value	1.09015
Df	16.00000
P-value (1-tailed)	0.14590
P-value (2-tailed)	0.29179
Classic fail-safe N	
Z-value for observed studies	10.72715
The P-value for observed studies	0.00000
Alpha	0.05000
Tails	2.00000
Z for alpha	1.95996
Number of observed studies	18.00000
Number of missing studies that would you bring p-value to > alpha	522.00000
Orwins fail-safe N	
Odds ratio in observed studies	2.9290
Creterion for a 'trivial' odds ratio	1.00000
Mean odds ratio in missing studies	1.00000
Criterion must fall between other values	

meta-analysis consisting of the data of 18 studies to be considered invalid, there must be at least 522 studies in the literature with values opposite to the present findings. The 18 studies included in the study were all the studies that could be accessed according

to the inclusion criteria from all studies conducted on the research question in the national and international literature. In this case, it can be stated that there is no publication bias as a result of the meta-analysis.

A heterogeneity test was applied to determine the effect of cryotherapy on pain in patients with total knee replacement in the included articles. As a result of the heterogeneity test, the p-value was found to be less than 0.05 ($p=0.000<0.05$), and the Q (139.795) value was greater than the value corresponding to 17 df (degrees of freedom) in the χ^2 table (χ^2 (0.95) =8.672 for df=17). As a result of the individual studies included in the analysis, it was determined that the studies examined in the meta-analysis application had a heterogeneous structure. In addition, as a result of the Z-test calculations performed for statistical significance, $Z=3.636$ was found. I2 statistic value was calculated as highly heterogeneous with 87.83%. Based on the calculations, the distribution of effect sizes was evaluated according to the random effects model ($p<0.05$) (Table III).

In Figure 3, the results of the meta-analysis of 18 studies that examined the effect of cryotherapy on pain in patients with knee prostheses and included in the study were shown with a forest plot. The mean effect size value (Odds Ratio) was positive (+2.929), indicating that the treatment effect was in favor of the experimental group. This result indicated that the effect size of cryotherapy on pain in patients with knee prostheses was statistically significant with a value of 2.929 (W.A; 1.641-5.226; $p=0.000$), which was above the odds ratio of +1. According to this result, it was determined that the pain of patients with knee prosthesis and cryotherapy was 2.9 times less (95% Confidence Interval) than those without cryotherapy.

DISCUSSION

Total knee replacement surgery is a surgical procedure allowing the joint to be reconstructed to relieve pain and limitation of movement in patients and increase the function of the knee. Almost half of total knee replacement patients return to the clinic with complaints of pain after surgery. Managing pain after total knee replacement aims to prevent patients from suffering and improve their quality of life³. Pain is a universal condition felt in different parts of the body and causes physiological and psychological reactions that cause pain to the patient. Pain stimulates individual pathological insults in the body, possibly allowing avoidance of the offending pathogen or stimulus. However, when the signal is abnormal and chronic, the

Table III. — Heterogeneity test results for the effect of cryotherapy on pain in patients with knee prosthesis

Effect size and 95% interval				
Model	Number Studies	Point Estimate	Lower Estimate	Upper Limit
Fixed	18	3.388	2.790	4.114
Random	18	2.929	1.641	5.226
Test Of Null (2-Tail)				
Model	Z-Value	P-Value		
Fixed	12.313	0.000		
Random	3.636	0.000		
Heterogeneity				
Model	Q-Value	Df (Q)	P-Value	I-Squared
Fixed	139.795	17	0.000	87.839
Random				
Tau-Squared				
Model	Tau Squared	Standard Error	Variance	Tau
Fixed	1.309	0.561	0.337	1.144
Random				

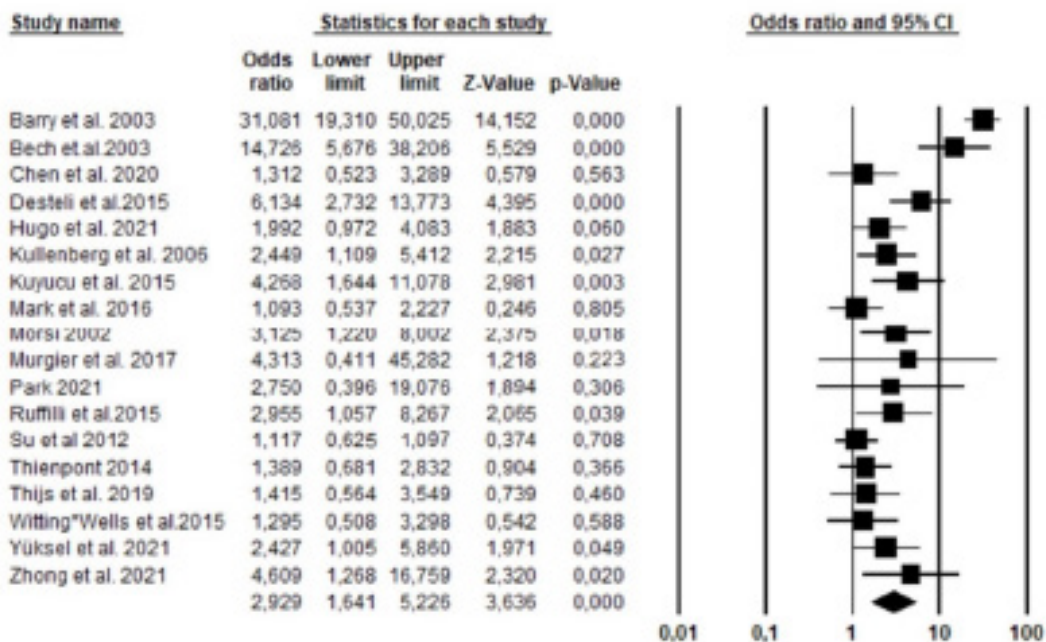


Figure 3. — Forest graph of the effect of cryotherapy on pain in patients with knee prosthesis

sensation of pain becomes harmful to the individual, both physically and psychologically¹³. The pain felt after a successful surgery both reduces the patient’s comfort and overshadows the surgical success^{4,5}. Cryotherapy is used to reduce edema and pain after

total knee replacement surgery⁷. Cryotherapy has been found to be effective in pain control and functional knee scores in preoperative and postoperative periods after total knee replacement⁹.

The role of the nurse in pain management after total knee replacement surgery is quite high. The nurse alleviates the pain and increases the patient's comfort by applying nonpharmacologic methods and pharmacologic methods. In pain management, cryotherapy is an effective method for both reducing the sensation of pain and making the patient feel better. Patients who undergo cryotherapy can mobilize early and move comfortably and safely with reduced pain in the postoperative period. Thus, the emotional state of the patients is also positively affected.

CONCLUSION

As a result of the study, it was determined that the pain of patients with total knee prostheses who underwent cryotherapy was 2.9 times less than those who did not undergo cryotherapy. This study determined that the application of cryotherapy was important in relieving patients' pain. Further studies on the application of cryotherapy in patients with total knee arthroplasty are recommended.

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