

Effectiveness of Cryotherapy on Pain and Swelling After Total Knee Replacement

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Abstract: Total knee replacement surgery is the traditional method of surgical replacement of the damaged joint. Rehabilitation is usually affected with post arthroscopic pain and swelling. This study was aimed to assess the effectiveness of cryotherapy on pain and swelling after the arthroscopic surgery. A Randomized clinical research design has been applied, this study was carried out in orthopedic ward at Mansoura University Hospital. Purposive sample of all adult patients, willing to join our study, aged 20-60y were planned for total knee replacement for the duration of three months were included and randomly assigned into two groups. Cryotherapy used at the surgical site for study group 15-20 minutes 3 times a day in the 1st and 2nd post-operative day. For control group routine care was given. Results showed a reduction in the pain level among study group with significant difference between both group after 15 min and second day where P (0.001&0.000) respectively. A significant reduction in the muscle girth was detected in the last day for the study group, where P= (0.047). Conclusion, it was concluded that cryotherapy was significantly effective in management of post total knee replacement pain and swelling.

Key words: Arthroscopic Surgery • Cryotherapy • Pain • Swelling • Total Knee Replacement

INTRODUCTION

Total knee replacement (TKR) is one of the most common joint replacement surgeries. According to the American Academy of Orthopedic Surgeons, TKRs performed for nearly 581,000 each year and expected to reach almost 3.5 million by 2030 [1]. Total knee replacement surgery, or knee arthroplasty, is the traditional method of surgical replacement of the damaged parts of the joint with an implant or prosthetic, that functions in a similar way to the knee you were born with. Knee replacement surgery is one of the most successful orthopedic procedures ever [2].

The incidences of arthroscopic surgery continue to increase particularly in earning age group (19 to 60 years). Post arthroscopic pain and swelling predominantly disturb patients' recovery [3]. Immediate post-operative period is frequently linked with substantial complications including pain, bleeding and localized edema resulting

from tissue damage and the inflammatory response [4]. There are numerous treatment options and modalities implemented following a TKR, to improve the outcomes of the patient. In postoperative period, patients usually suffer severe Pain that delaying rehabilitation. Mobilization requires pain control, but narcotics related side effects can limit activity, resulting in longer hospital stays [5].

In spite of progress in anesthesia and multi-modal pain management, TKR remains a challenging procedure for many patients. This has led to the use of non-pharmaceutical management aides such as cryotherapy to address the immediate post-operative fears [6]. Cryotherapy and compression are some of the most commonly used modalities to address pain and swelling following TKR [7]. Reducing pain and early recovery of TKR patient should be the main concern of nursing care. Use of cold therapeutic devices or ice bags on surgical site to control swelling and pain are very useful [3].

Cryotherapy has been used to improve recovery after orthopedic surgery. Numerous cold therapeutic devices currently available but limited types can keep a fixed temperature during a prolonged time and consequently disapproved and replaced by cryotherapy devices to test the outcome of prolonged post joint replacement cooling on rehabilitation [8]. Cryotherapy used by many orthopedic surgeons as a standard practice that constricting blood vessels and decrease blood flow at the cellular level, limit cellular metabolism, reduce capillary permeability, inhibit inflammatory mediators release and prostaglandin synthesis, all of which play a role in acute inflammation and edema resulting in decrease peripheral nerve temperature and velocity of nerve conduction through the nerve synapse, consequently elevating the pain threshold in nerve fibers. It has become standard practice by many orthopedic surgeons [9].

Cryotherapy includes the application of ice bags or specialized devices to the surrounding skin of an injury or surgical site. There is evidence that range of movement can be increased and pain level reduced in patients managed with cryotherapy in the first few days after a total knee replacement without any serious complications [4]. So this study was aimed to assess the effectiveness of cryotherapy on pain and swelling after the arthroscopic surgery.

MATERIAL AND METHODS

Study Design: A randomized clinical research design was used.

Research Hypothesis:

H1: Total knee replacement patients who receive cryotherapy treatment will reduce post-operative pain and swelling.

H2: TKR patients who receive the cryotherapy will decrease affected knee circumference and improving knee ROM.

Setting: This study was carried out in the orthopedic ward at Mansoura University Hospital for a period of three months, from 1 October 2017 to 31 January 2018. Three days a week from 8.00 Am to 10.00 pm.

Sample: Purposive sample of all patients planned for total knee replacement surgery during a period of three months, based on the following criteria:

Inclusion Criteria: Adult patients from both sex, aged 20-60 years, agreed to participate in the study, performed knee surgeries, especially those with TKR. And cognitive intact to follow the instructions and willing to apply the cryotherapy at the postoperative stages.

Exclusion Criteria: Patients with a history of musculoskeletal disease, peripheral vascular disease and cold allergy were excluded from the study.

Instruments

Tool I: Demographic and Clinical Data Sheet: Developed by the researchers to obtain patient's demographics, diagnosis, relevant past medical history and medical condition includes pain, ROM, gait, muscle strength and circumferential measurements of the knee.

Tool II: Numerical Pain Scale: The 11-point numeric scale ranges from '0' representing no pain to '10' representing the other pain extreme (e.g. worst pain). Scores range from 0-10 points, with higher scores indicating greater pain intensity [10].

Tool III: Measurement of the Circumference of the Knee: Knee circumference at the mid-patella level with the knee in maximum extension will be measured by the researcher using measuring tape on the first day after surgery (Morning) and every morning after wound dressing until the patient was discharged and the results were recorded.

Content Validity: Tools were tested for content validity by jury of 5 expertise of medical- surgical nursing and the necessary modifications were done. Reliability testing was done using split half methods and Cronbach's alpha that measures the degree of reliability for the entire form. Both techniques showed high reliability of the final version of the tool (Alpha = .85).

A pilot study was conducted on 10% patients from each group after explain the nature and purpose of the study to test the feasibility and applicability of the tools, this number excluded from the total number of the study.

Ethical Consideration: Ethical approval from Faculty of Nursing ethics committee was obtained to carry out the study. An Official approval was obtained from hospital administrative authority to collect data. Aim of the study was explained to obtain patients' acceptance. The researcher emphasized participation was absolutely

voluntary. Anonymity, privacy, safety and confidentiality were assured as well as the right to withdraw from the study at any time and written consent was obtained.

Research Procedures

Preparatory Phase: Participants were explained about the purpose of the study and treatment procedures. A prior written consent ethical clearance was obtained. Detailed subjective assessment was done to ruling out criteria.

Implementation Phase: The researcher collected data from the patient medical record (Demographic and clinical data) from orthopedic ward at Mansoura University Hospital. All participants are orally educated about the significance of cryotherapy that used as standard practice by many orthopedic surgeons following physical therapy treatment to control inflammation, pain and edema in the knee joint.

For study group cryotherapy was applied at the surgical site over the single layer of crepe bandage for a period of 15-20 minutes at an interval of 2 hours three times a day during the 1st and 2nd day after surgery. Numerical rating scale was used to measure pain severity pre intervention and 15 minutes post intervention. Swelling was evaluated by inch tape at the mid patellar line in maximum knee extension in the 1st postoperative day before applying cryotherapy and post cryotherapy test was performed 2nd day post-surgery and recorded on the Knee Circumferences Record Chart. For control group, the routine care and follow up was performed in the 1st post operative day (1st time at morning and 2nd at the evening) and last one at the 2nd postoperative days without any intervention.

Evaluation Phase: Nurse's activity includes posttest assessment of pain and swelling which may or may not lead to improvement.

- Evaluate the improvement of pain by using numerical pain intensity rating scale after the cryotherapy by comparison between study and control group.
- To evaluate knee swelling, knee girth will be measured in studied groups to evaluate outcome. The circumference at mid-patellar line with maximum knee extension will be recorded on the Knee Circumferences Record Chart every day at the same time.

RESULTS

Table 1 shows the demographic characteristics of study and control groups. It can be seen that the mean

age of the study and control groups was 51.880 ± 6.173 and 48.960 ± 6.464 respectively. As regards to gender, female patients represented 60% of the study group and 68% of the control group. Moreover, 80% and 84% of the study and control groups were married. Concerning level of education, 48 & 40% of the study and control group respectively had secondary education. Regarding occupation, 44 & 60% of the study and control group was manual work respectively. There weren't any significant differences between studied groups regarding demographic characteristics.

Table (2) shows health relevant data among the study and control groups. It can be noticed that, right total knee replacement was the most shared diagnosis in the study (52%) and control (64%) group. Concerning family history, there is no family history, in most of the study and the control group (84% and 72% respectively). Concerning relevant past medical history, it was noticed that more than half of the study (56%) and control (52%) group had no relevant past medical history. Regarding body mass index, nearly half of the study and control groups were overweight (40 and 44% respectively). While 48% and 40% of the study and control groups respectively were obese. No significant difference between studies groups regarding health relevant data.

Table (3) shows Comparison between Pain level pre and post cryotherapy of the studied groups. It is clear that the pre cryotherapy was no significant between the studied groups ($P= 0.220$). Posttest 1(15 minutes after the cryotherapy), a significant difference ($P=0.001$) was noted between studied groups regarding pain severity with a mean value of 6.640 ± 0.700 for the study group compared to 7.320 ± 0.690 for the control group. Posttest 2 was conducted at the second day after cryotherapy, showed significant decrease ($p = 0.000$) in pain severity (4.960 ± 0.840) in study group compared to control group (6.987 ± 0.945).

Table (4) illustrates the comparison between muscle girth of the affected leg in the studied groups pre and post cryotherapy. No statistical significant difference were noticed between the studied groups before cryotherapy and in the 2nd day after cryotherapy, where $P=(0.829)$ & (0.279) respectively. While the decrease in the mean value of swelling from 29.160 to 25.200 in study group and 29.440 to 28.404 in control group. With significant difference was detected in the muscle girth in the last day for the study group, where $P=(0.047)$.

Table 1: Demographic characteristics of the studied groups (N: 50).

Variables	Study group		Control group		Total		Pearson Chi-Square X2 test (P)
	No=25	%	No=25	%	No=50	%	
Age (in years)							
20≤40	2	8.0	2	8.0	4	8.0	21.000
40≤50	8	32.0	13	52.0	21	42.0	(0.279)
50≤60	15	60.0	10	40.0	25	50.0	
Mean ± SD	51.880 ±6.173		48.960 ± 6.464				
Sex							
Male	10	40.0	8	32.0	18	36.0	0.347
Female	15	60.0	17	68.0	32	64.0	(0.556)
Marital status							
Married	20	80.0	21	84.0	41	82.0	0.136
Widow	5	20.0	4	16.0	9	18.0	(0.713)
Educational level							
No formal education	2	8.0	5	20.0	7	14.0	6.087
Read& write	4	16.0	2	8.0	6	12.0	(0.298)
Primary school	2	8.0	4	16.0	6	12.0	
Secondary school	12	48.0	10	40.0	22	44.0	
Associate degree	5	20.0	2	8.0	7	14.0	
Baccalaureate	0	0.0	2	8.0	2	4.0	
degree& above							
Occupation							
Manual	11	44.0	15	60.0	26	52.0	
Technical	6	24.0	3	12.0	9	18.0	7.015
Professional	0	0.0	1	4.0	1	2.0	(0.135)
House wife	4	16.0	0	0.0	4	8.0	
Employee	4	16.0	6	24.0	10	20.0	
Medical payment							
Totally reimbursed	20	80.0	16	64.0	36	72	1.587
Partially reimbursed	5	20.0	9	36.0	14	28	(0.208)

Table 2: Health relevant data of the studied groups (N: 50).

Items	Study group		Control group		Total		Pearson Chi-Square X2 test (P)
	No=25	%	No=25	%	No=50	%	
Diagnosis & present condition							
Right total knee replacement	13	52.0	16	64.0	29	58.0	0.739
Left total knee replacement	12	48.0	9	36.0	21	42.0	(0.567)
Family history of orthopedic disease.							
Yes	4	16.0	7	28.0	11	22.0	0.496
No	21	84.0	18	72.0	39	78.0	(0.248)
Relevant past medical history.							
Preexisting conditions	9	36.0	10	40.0	19	38.0	0.09
Injuries	2	8.0	2	8.0	4	8.0	(0.956)
No	14	56.0	13	52.0	27	54.0	
Body mass index							
Normal weight	3	12.0	4	16.0	7	14.0	0.457
Over weight	10	40.0	11	44.0	21	42.0	(0.513)
Obese	12	48.0	10	40.0	22	44.0	
Mean± SD	29.682±2.126		29.109±3.036				

Table 3: Comparison between Pain level pre and post cryotherapy of the study and control groups

Variables	Study group			Control group			Independent t test (p) ^a	Independent t test (p) ^b	Independent t test (p) ^c
	Before cryotherapy Mean ± SD	15 min after cryotherapy Mean ± SD	2 nd day after cryotherapy Mean ± SD	Morning of 1 st post operative day Mean ± SD	Evening of 1 st post operative day Mean ± SD	2 nd post operative day Mean ± SD			
pain scale	8.120±0.665	6.640±0.700	4.960±0.840	8.360±0.700	7.320±0.690	6.987±0.945	1.242(0.220)	3.458(0.001)*	9.329(0.000)*
Friedman test (p) ¹	44.598 (0.000)*			24.295 (0.000) *					

Friedman test (p)¹: comparing the level of pain in each group.

Independent t-test (p) a: comparing studied groups before cryotherapy.

Independent t t-test (p) b: comparing studied groups 15 min after cryotherapy

Independent t-test (p) c: comparing studied groups 2nd day after cryotherapy.

* Significant, at p ≤ 0.05

Table 4: Comparison between muscle girth of the affected leg in the studied groups pre and post cryotherapy

Variables	Study group			Control group			Independent t test (p) ^a	Independent t test (p) ^b	Independent t test (p) ^c
	Before cryotherapy Mean ± SD	2 nd day after cryotherapy Mean ± SD	Last day after cryotherapy Mean ± SD	1 st post operative day Mean ± SD	2 nd post operative day Mean ± SD	3 rd post operative day Mean ± SD			
Muscle girth	29.160±4.180	27.880±4.352	25.200±4.330	29.440±5.465	29.360±5.179	28.404±5.465	0.217(0.829)	1.094(0.279)	2.036(0.047)*
Friedman test (p) ¹	47.574 (0.000) *			23.570 (0.000) *					

Friedman test (p)¹: comparing muscle girth in each group.

Independent t-test (p)^a: comparing studied groups before cryotherapy.

Independent t t-test (p) b: comparing studied groups 2nd day after cryotherapy

Independent t-test (p) c: comparing studied groups last day after cryotherapy.

* Significant, at p ≤ 0.05

Table 5: Comparison between muscle strength of the studied groups post cryotherapy

	Study group		Control group		Pearson Chi-Square Muscle strength X2 test (p)
	No=25	%	No=25	%	
- Sever weakness	0	0	1	4	
- Poor ROM	0	0	10	40	
- Average weakness	14	56	11	44	15.931
- Slight weakness	11	44	3	12	(0.001)*

Table (5) illustrates Comparison of muscle strength between the studied groups post cryotherapy. It was noticed that, in the study group 56 & 44% of the patients were average muscle weakness and slight muscle weakness respectively, while 40 & 44% of patients in the control group were poor ROM and average weakness respectively. So there was a significant improvement in muscle strength in the study group after cryotherapy. There were statistically significant differences between the studied groups P= (0.001).

DISCUSSION

The purpose of our research was to evaluate the effectiveness of cryotherapy on pain and swelling after total knee replacement. It is apparent from the present study that the mean age of the study and control groups was 51.880 ±6.173 and 48.960 ± 6.464 respectively. As regards to gender, female patients were more prevalent in both groups, represented 60% of the study group and

68% of the control group. This finding is in congruence with a similar study conducted by Batarfi *et al.* [11] who reported that 77 patients were participated in this study 59 of them were females (76.6%). Also, Kazan & Gorgulu [12] reported that 38% were aged 30-51 years, with mean age 38.2 y. This is in contrast with Kazan and Gorgulu [12] reported that, patients who participated in the study comprised 21 women and 39 men. Also, Edwin&Tad, [13] who reported that male patients were more prevalent in study group (54%) and control group (51%) and the mean age was 64 y.

Regarding pain level, the results illustrates that no significant difference was detected between the studied groups (P= 0.220) before cryotherapy. A decrease in pain level was prominent with a mean value of 6.640 ±0.700 for the study group and 7.320 ±0.690 for the groups after 15 minutes of cryotherapy, with significant difference between the studied groups (P=0.001). A significant decrease in pain severity in study (4.960 ±0.840) and control group (6.987 ±0.945) was noticed at the second

day after cryotherapy, with a statistical significance difference between the two groups $p = 0.000$. This finding is in accordance with Sadoghi *et al.* [14] who reported that pain in the numeric rating scale score was significantly lower in the treatment group on the 2nd post-operative day ($p = 0.034$). Also, Minmini *et al.* [16] reported that, the level of pain scores in patients who received cryotherapy were decreased at a statistically significant level, by slowing down the nerve conduction and blood flow, resulting in, less usage of analgesics. Also, Minmini *et al.* [16] reported that, the mean pain score decreased in study group from 4.90 to 2.50 ($p = 0.0005$) and in control group from 4.85 to 3.70 ($p = 0.04$). This is in contrast with Scharf [17] who reported that; cryotherapy was not effective in pain and bleeding control except for considerably reduced flexion at 6 weeks in the advanced cryotherapy group.

Regarding muscle girth measurements of the affected leg in studied group's pre and post cryotherapy. No statistical significant difference between studied groups were noticed before cryotherapy and 2nd day after cryotherapy, where $P = (0.829) \ \& \ (0.279)$ respectively. While the decrease in the mean value of swelling from 29.160 to 25.200 in study group and 29.440 to 28.404 in control group. with significant difference was detected in the muscle girth in the last day for the study group, where $P = (0.047)$. This results accordance with Minmini *et al.* [16] who reported decrease in mean swelling value from 35.54 to 31.39 ($p = 0.007$). Also in the same line with Shah and Elkins [18] who reported that the difference between the girth measurements on day 1 and day 13 revealed that there was overall reduction in edema by $\frac{3}{4}$ inch to $1 \frac{1}{4}$ inches. This is in contrast with Sadoghi *et al.* [14] who reported no statistically significant differences between studied groups regarding girth measurements and consumption of analgesics. No adverse effects were observed in both study groups and Waterman *et al.* [19] who reported that Circumferential knee measurements had no statistically significant differences between or within the two groups across any time intervals.

Regarding muscle strength, a statistically significant difference ($P = 0.001$) was noticed between studied groups regarding muscle strength improvement after cryotherapy. In the study group 56 & 44% of patients were with average muscle weakness and slight muscle weakness respectively. While 40 & 44% of patients in control group were poor ROM and average weakness respectively. This results come in the same line with meta-analysis of the effects of cold application on

healing after orthopedic surgery by Adie *et al.* [20] and Block [21] they found that range of motion in minimally affected by cryotherapy in the early postoperative period.

CONCLUSIONS

It can be concluded that cryotherapy is an effective method for reducing pain, swelling and improve muscle strength after total knee replacement.

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Limitations: The most important limitation of our study is the small numbers of the patients in 3 months therefore we increase the collection data time to four months.

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