Postoperative Cryotherapy After Total Knee Arthroplasty

A Prospective Study of 86 Patients

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Abstract: A study of 86 patients undergoing total knee arthroplasty (TKA) was performed to evaluate the role of cold compression. The patients were treated with cold compression or epidural analgesia for 3 days after TKA. Pain was measured on a visual analog scale, and total consumption of analgesics was recorded. Range of movement (ROM) was recorded before TKA until 3 weeks postoperatively. Weight bearing, blood loss, and time in hospital were recorded. Visual analog scale scores and analgesic consumption were equal in both groups. Range of movement at discharge was 75° in the cold compression group vs 63° in the control group. By 3 weeks' follow-up, ROM was 99° vs 88°. Mean Hb values averaged 120 mmol/L in the cold compression group vs 109 mmol/L in the control group after surgery. Mean time in hospital of patients with cold compression averaged 4.8 days vs 6.2 days in the control group. The study shows that cold compression therapy improves the control of pain and might thus lead to improvement in ROM and shorter hospital stay. **Key words:** TKA, cold compression, Cryocuff, pain, mobilization.

Pain is a common element in the early postoperative phase of total knee arthroplasty (TKA). The pain is often severe and interferes with the postoperative regimen of mobilization and rehabilitation.

Cryotherapy is widely used as an emergency treatment of sports trauma and postoperatively after anterior cruciate ligament reconstruction. Cooling after soft tissue injury has been described since the time of Hippocrates [1], but studies on the effect of cryotherapy after TKA have been limited and controversial.

Local application of cold penetrates to a depth of 4 cm below the skin [2] and affects tissue metabolism by decreasing enzymatic function and producing vasoconstriction [3]. The reduction in blood flow decreases the local inflammatory response and edema formation [3]. The anesthetic effect of local cooling is produced by the slowing or elimination of pain signal transmission [4]. Furthermore, cold inhibits the stretch reflex and reduces muscle spasm [3]. Cold alone has a limited effect on swelling and may actually increase swelling as a result of cold-induced ischemic damage to blood vessels [5]. Simultaneous application of cold and compression is a better treatment. Compression acts synergistically with cold to reduce the blood flow [6] and edema formation. Furthermore, compression provides support to the soft tissues [7].

The objective of this study was to investigate the effect of long-term postoperative application of combined cooling and compression after TKA to

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improve perioperative care, to speed up mobilization, and to evaluate the efficacy of this treatment.

Material and Method

A prospective study of 86 consecutive patients undergoing unilateral TKA was performed to evaluate the role of cold compression. The patients were randomized into 2 groups. Randomization was obtained through the use of sealed envelopes. Group 1 was treated with cold compression for 3 days after TKA. Cold compression was applied with the Cryocuff (Aircast, Summit, NJ) The cuff covers the anterior part of the knee, leaves the patella free, and leaves the popliteal space free of pressure. The cuff is connected to a cooler containing 4 L of ice water and provides 30 mm Hg cold compression to the knee. Group 2 was treated according to the normal routine by the clinic: epidural analgesia (EDA) with ropivacain until postoperative day 3, then intravenously with nonsteroidal anti-inflammatory drugs and opioids.

Surgical Technique

Before surgery, all patients were premedicated with a mild sedative and paracetamol. During surgery, both groups received spinal anesthesia with morphine and ropivacain. All knees were approached through a midline anterior incision with a medial parapatellar arthrotomy. Total knee arthroplasty was performed with a tourniquet (300 mm Hg) applied for 75 minutes (60-90 minutes). Before skin closure, hemostasis was controlled using diathermy. No wound drainage was used postoperatively.

Cold Compression (Group 1)

After skin closure, the tourniquet was deflated and the Cryocuff was applied in group 1 and inflated with ice water. Rechilling was performed every 60 minutes by the nursing staff for 3 days (mean 60 hours) until the cold compression dressing was removed. Ice was changed in the canisters every fourth hour.

Regimen of Pain Treatment (Both Groups)

After completing the surgery, the EDA catheter with local anesthetics was administered in the control group. Pain was controlled regularly at least every second hour in all patients. Treatment with periorally administered tramadol (150 mg × 2) and paracetamol (1 g × 4) was started postoperatively. Breakthrough of pain was treated with ketobemidon (2.5-5 mg) intravenously.

Assessment of Outcome (Both Groups)

Pain was measured regularly on a visual analogue scale (VAS) by the nursing staff and by a physical therapist (PT) during motion. Total consumption of analgesics in relation to patient body weight was recorded. Range of movement (ROM) for flexion and extension was recorded by the PT before the TKA on postoperative day 1 (POD 1), at discharge from hospital, and 3 weeks postoperatively. Weight-bearing beside the bed was recorded using 2 separate calibrated scales and registered as percent of patient body weight. Total time in hospital time was recorded.

Exclusion criteria included coagulopathies and preclosure tourniquet deflation. Statistical analyses were performed to determine significant differences between the groups.

Statistics

Pain data were analyzed using Wilcoxon signed rank test. Measurements of ROM were compared by paired *t* test.

Table 1. Cold Compression vs Control Treatment

	Group 1 (Cold Compression) (n = 43)	Group 2 (Standard Treatment [EDA]) (n = 40)
Age	68.1 ± 6	68.9 ± 6.8
Sex (female/male)	1.35/1	1.43/1
Pain (VAS)		
POD 1	2.1 ± 1.0	2.2 ± 0.8
POD 3	0.8 ± 0.9	1.2 ± 0.7
During exercise	3.4 ± 1.5	2.3 ± 1.7
Pain (mg morphine/kg per 24 h)	0.37 ± 0.11	0.43 ± 0.05
ROM		
POD 1	50.4 ± 8	51.4 ± 11.1
At discharge	75.1 ± 10.5	62.9 ± 12.8 (P = .0019)
3 weeks postoperative	98.9 ± 9.4	87.6 ± 7.8 (P = .0045)
Hemoglobin (mmol/L)		
Start	139.8 ± 10.4	140.3 ± 9.4
POD 1	120.2 ± 9.2	109.5 ± 9.4 (P = .042)
Weight bearing (% of body weight)	64.6 ± 13	65.4 ± 12.6
Care time (d)		
Total in hospital care time	4.8 ± 0.9	6.2 ± 1.5 (P = .00057)
Completed rehabilitation	4.3 ± 1.1	5.6 ± 1.2 (P = .002)

Results

Of 86 TKA patients randomly entered into the study, there were 45 in the control group and 41 in the cold compression group. The average age was 68 for cold compression and 69 for the control group, respectively. For full patient demographics, see Table 1.

One patient in the cold compression group and another in the control group developed deep vein thrombosis below the popliteal fossa. One knee in the cold compression group developed a superficial soft tissue infection of unclear origin. These patients were excluded.

No patient requested removal of the cold compression.

Visual analogue pain scores averaged 2 on POD 1, 3 during exercise, and 0 on time for discharge from hospital in the cold compression group. For the control group, the scores were 2 on POD 1, 2 during exercise, and 0 on discharge. Total morphine per kilogram administered in 24 hours averaged 0.37 in the cold compression group and 0.43 in the control group.

The total ROM before operation averaged 85° in the cold compression group and the same in the control group. Range of movement on POD 1 was 50° in the cold compression group and on POD 2 it was 51° in the control group. The weight load in the operated leg was 65% of body weight in both the cold compression group and the control group on POD 1. At discharge from hospital, ROM in cold compression knees was 75° and 63° (P = .0019) in the control group. By 3 weeks' follow-up, ROM was 99° in the cold compression group and 88° in the control group, respectively (P = .0045) (Fig. 1).

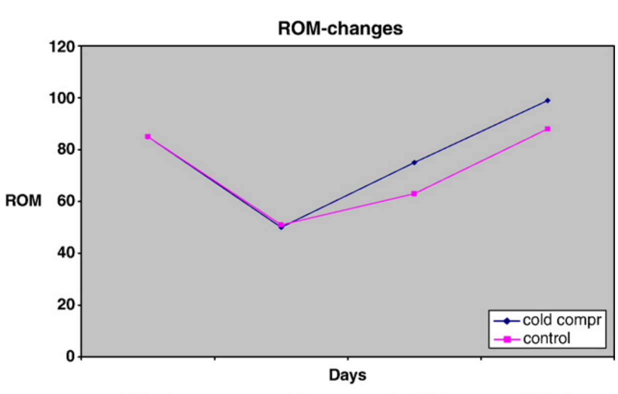

Fig. 1. Total ROM in the cold compression group and control group respectively from start, POD 1, 7, and 21.

Before TKA, the mean Hb value was 140 mmol/L in both groups. The day after surgery, the Hb values averaged 120 mmol/L in the cold compression group and 109 mmol/L in the control group.

Mean time in hospital averaged 4.8 days in the cold compression group and 6.2 days for the control group, respectively (P < .001).

For detailed results, see Table 1.

Discussion

The benefits of cold therapy in the total management of orthopedic patients include pain control and decreased edema which allows for earlier rehabilitation [8]. The compression minimizes hemarthrosis, whereas the cold improves patient comfort. Earlier studies have shown less swelling [9], less pain [10], and improved ROM [3]. Our present study supports these findings.

Minimizing hemarthrosis and pain control facilitate mobilization [11]. Our study showed 1.4 days shorter mean time in hospital for patients with cold compression. The clinical importance of the improvements in ROM seen in the cold compression group is questionable. Early gains in ROM achieved through continuous passive motion machines have not been shown to affect ultimate ROM [12]. However, the PT in our study noticed that patients in the cold compression group gain better control of their quadriceps muscle coordination. This leads to better movement of the knee joint with a maximum extension deficit of 10° and thereby more rapid rehabilitation.

No differences in ROM on the first postoperative measurement were seen between the groups, but measurements in later postoperative phases showed improved ROM in the cold compression group, indicating insufficient muscle control early postoperatively and improved control in later phases and probably less swelling in the cold compression group.

When the EDA catheter was removed in patients in the control group, the step between "no pain" and relatively "intense pain" was steep and was difficult for the patient to control, thus leading to more muscle spasm in the quadriceps, more pain, lesser ROM, and slower mobilization. Pain development in patients with cold compression was faster even during the first postoperative period and was easier to control for the patient and the nursing staff.

The positive effects we found with cryotreatment may be explained by faster mobilization which facilitates better muscle control with decreased pain, increased ROM, and decreased swelling. Joint effusion results in quadriceps inhibition by reduced afferent activity of intracapsular receptors followed by quadriceps weakness [13]. The reduction in swelling is followed by increased ROM [13].

The data on pain relief are difficult to interpret because of variations in patient pain threshold. The high analgesia consumption and VAS values demonstrate this variability. There were no differences in pain reduction between EDA and cold compression measured with VAS and use of analgesics. An advantage of the cold therapy is that no vasomotor or bladder check has to be made in patients with cold compression as in the case of EDA. Less pain using cold compression was seen in some studies [13,14], but other studies have reported different results [15,16] with no significant pain reduction or reduction in narcotic requirements.

The observed significant increase in ROM led to successful short-term rehabilitation. Early mobilization with full weight-bearing is the most effective way to prevent deep leg vein thrombosis [13]. Better joint motion using cold compression persisted throughout the study, although only minor differences were seen 3 weeks postoperatively.

Mean hospital time of patients with cold compression averaged 4.8 days. For patients in the control group, the mean hospital time in our study was 6.2 days. In other studies, mean hospital length of stay averages 6.5 days [17]. The postoperative hospital stay was also significantly shorter for cold therapy in previous studies [18]. Our present data show that patients using cold therapy achieved independent ambulation more than 1 day sooner than TKA control patients.

In the present study, we have registered as well the day of patient discharge from hospital as the day when postoperative rehabilitation was completed. Because some patients stay in the hospital even after completing the rehabilitation program, the actual time to rehabilitation may be shorter.

The use of cold compression is cost effective in TKA. The list price of the cold compression device used in this study is 50 euros. Twenty-four hours of orthopedic hospital care costs 325 euros. The nursing time taking care of the cryo-compressive dressings averages with the time controlling patients with EDA catheters.

In this study, the knees were rechilled every 60 minutes. The advantageous effects of cold compression would probably have been better if the TKA had a continuous-flow cooling device applied. Continuous-flow cold therapy is advantageous after TKA because it provides better results in all areas compared [19]. After this study, the technique of continuous flow is now used in our practice.

The evidence from our study shows that combined cold compression therapy controls pain, improves ROM, may speed up the time for mobilization, and may thereby shorten the hospital stay.

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