Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty (Review)

He ML, Xiao ZM, Lei M, Li TS, Wu H, Liao J

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[Intervention Review]

Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

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ABSTRACT

Background

Total knee arthroplasty (TKA) is a common form of orthopedic surgery. Venous thromboembolism (VTE), which consists of deep venous thrombosis (DVT) and pulmonary embolism (PE), is a major and potentially fatal complication after TKA. The incidence of DVT after TKA is 40% to 80% and the incidence of PE is approximately 2%. It is generally agreed that thromboprophylaxis should be used in patients who undergo TKA. Both pharmacological and mechanical methods are used in the prevention of DVT. Pharmacological methods alter the blood coagulation profile and may increase the risk of bleeding complications. When pharmacological methods cannot be used, the mechanical methods become crucial for VTE prophylaxis. Continuous passive motion (CPM) is through an external motorised device which enables a joint to move passively throughout a preset arc of motion. Despite the theoretical effectiveness and widespread use of CPM, there are still differing views on the effectiveness of CPM as prophylaxis against thrombosis after TKA.

Objectives

The aim of this review is to determine the effectiveness of continuous passive motion therapy for preventing thrombosis in patients after total knee arthroplasty (TKA).

Search methods

The Cochrane Peripheral Vascular Diseases Group searched their Specialised Register (last searched January 2011), CENTRAL (2011, Issue 1), MEDLINE (1948 to Week 2 January 2011) and EMBASE (1980 to Week 3 January 2011). In addition, the authors searched the reference lists of identified trials.

Selection criteria

Randomised controlled trials (RCTs) comparing the use of CPM with control in preventing DVT or PE after TKA. People aged 18 years and older who have undergone TKA were included in this review. We excluded studies of patients who presented with DVT at baseline. Both the experimental and control groups received similar postoperative care and therapy other than the CPM.

Data collection and analysis

Two review authors independently assessed the citations retrieved by the search strategies for reports of relevant RCTs. They independently selected trials that satisfied the inclusion criteria, extracted data and undertook quality assessment. Effects were estimated as risk ratios (RRs) or mean differences or standardised mean differences with 95% confidence intervals (CI). Meta-analyses were performed using a fixed-effect model for continuous variables. Where heterogeneity existed (determined by the I^2 statistic), a random-effects model was used.

Main results

Ten randomised controlled trials involving 764 participants met the inclusion criteria. Four studies with a total of 361 patients reported the incidence of DVT. In the CPM group (182 patients) 36 developed DVT (20%) compared to 28 (16%) the control group of 179 patients. The meta-analysis result showed no evidence that CPM had any effect on preventing VTE after TKA (RR 1.27, 95% CI 0.87 to 1.86). One trial (150 participants) did not find PE in any of the patients during hospitalisation or in the subsequent three months. None of the trials reported any deaths of the included participants.

Authors' conclusions

There is not enough evidence from the available RCTs to conclude that CPM reduces VTE after TKA. We cannot assess the effect of CPM on death because no such events occurred amongst the participants of these trials.

PLAIN LANGUAGE SUMMARY

Continuous passive motion therapy for preventing venous thromboembolism after total knee replacement (arthroplasty)

Total knee arthroplasty (TKA) is a common form of orthopedic surgery that can improve the quality of life for patients. Patients who receive joint replacement are particularly susceptible to developing deep vein thrombosis and pulmonary embolism following the surgery because of tissue damage, surgical stress and immobility and muscle weakness. Venous thromboembolism describes both deep venous thrombosis (DVT) and pulmonary embolism (PE), which is potentially fatal. The risk of DVT is greatest in the first week after surgery. Drug treatments to prevent venous thromboembolism include low-molecular-weight heparin, fondaparinux, or warfarin, which reduce blood clotting (coagulation). These drugs increase the risk of bleeding after TKA and associated complications such as infection and wound healing problems. Early mobilisation and mechanical methods are therefore of clinical interest. Continuous passive motion (CPM) uses an external motorised device to move the knee for the patient through a preset range of motion as part of postoperative management.

This review did not find enough evidence from randomised controlled trials to conclude that CPM reduces VTE. We included 10 trials involving 764 participants in our review. The incidence of DVT or venous thromboembolism was not clearly different in the CPM group compared with the control group of participants

The methodological quality of the included studies was variable. Sensitive methods such as venography or sonography were not always used to diagnose DVT and the CPM was applied differently across studies, varying in range of motion, duration of CPM per day and the number of days after the surgery.

BACKGROUND

Description of the condition

With the ageing of the population, the prevalence of degenerative joint diseases is increasing. In the United Kingdom, 10% of people aged over 55 years are affected by painful knee osteoarthritis (Peat 2001). Total knee arthroplasty (TKA) is a common form of orthopaedic surgery that can improve the quality of life for patients. Currently in the United States, more than 400,000 TKAs are performed every year, and this number is expected to reach

3.48 million by the year 2030 (Kurtz 2007).
Venous thromboembolism (VTE), which consists of deep venous thrombosis (DVT) and pulmonary embolism (PE), is a major and potentially fatal complication after TKA (Clayton 2008; Yoo 2009). Patients who receive joint replacement are particularly susceptible because of a variety of physiological and mechanical factors including 1. local vessel wall damage occurring during surgery from the operative procedure (Stamatakis 1977); 2. the blood becoming hypercoagulable from the sequelae of responses to surgical stress (Fedi 1999); and 3. venous stasis, which occurs as a consequence of hyperviscosity of the blood, prolonged immobility, and muscle weakness (Brander 2006).

Patients who undergo joint replacement often have a number of risk factors that increase the risk of VTE, including advanced age, obesity, prolonged immobilization, and accompanying disease such as varicose veins, haematological disease, rheumatoid arthritis, renal disease and cardiac insufficiency (Brander 2006; Chotanaphuti 2007; Memtsoudis 2009). Some patients who undergo TKA need drugs to treat their comorbidities and certain drugs such as estrogen or corticosteroids can increase a person's risk of DVT (Huerta 2007). The greatest risk for DVT is within the first week after surgery, but the risk remains increased for several weeks after the procedure. A number of studies showed that the occurrence of DVT or PE varies between 40% and 84% of patients undergoing TKA (Lynch 1988; Stringer 1989). Most of the thrombi formed are small and have little clinical consequence. Less than two out of 1000 patients develop clinical PE, with fatal PE occurring in one to seven of 1000 patients (Khaw 1993).

Description of the intervention

Because of the potentially life-threatening nature of these complications, numerous prophylactic measures have been recommended for these patients. Although pharmaceutical methods of preventing DVT, such as low-molecular-weight heparin, fondaparinux, or adjusted dose warfarin, are regularly used, thromboembolic complications still occur (Colwell 2006). In a Japanese study, the incidence of VTE was 29.5%, 26.1%, 12.5% and 9.1% in the edoxaban 5 mg, 15 mg, 30 mg and 60 mg treatment groups compared with 48.3% in the placebo group (Fuji 2010). Furthermore, opponents to prophylaxis emphasise the high costs of universal prophylactic anticoagulation, a large numbers of clinically-silent DVTs and chemoprophylaxis-related complications. There is substantial evidence in the literature that administration of anticoagulation chemoprophylaxis places patients at risk of bleeding after TKA. The occurrence of major bleeding complications after an elective total joint arthroplasty is regarded by most surgeons as unacceptable because of the potential for subsequent occurrence of more important complications such as infection, wound healing problems, functional disability and loosening of the joint, which have a high probability of compromising the surgical outcome.

Since the usefulness of routine postoperative chemoprophylactic treatment after TKA is divisive, early mobilisation and mechanical methods are of clinical interest. Continuous passive motion (CPM) is an external motorised device that enables a joint to move passively throughout a preset arc of motion. The biological concept of CPM was introduced by Salter in 1980 (Salter 1980).
The use of postoperative CPM for patients undergoing TKA was first reported in the 1980s. Proposed advantages include increased range of motion (ROM), which is important for mobility and activities of daily living in patients who have undergone TKA (Chen 2000); a decrease in the length of hospital stay; less postoperative pain; decreased requirement for physical manipulation; decreased cost compared with physiotherapy alone; and potentially a decrease in the rate of DVT.

How the intervention might work

The indications for CPM include total joint arthroplasty, articular cartilage defect, ligamentous reconstruction, osteoarthritis, release of contracture, intra-articular fracture and reflex sympathetic dystrophy (O'Driscoll 2000; Salter 2004). Although controversial, CPM has been used by many surgeons as part of the standard postoperative management of patients with TKA.The rationale for the application of CPM is that it stimulates venous and lymphatic flow (Lynch 1990; von Schroeder 1991) and maintains the range of the motion of the joint. Venous stasis due to the absence of muscular contraction in immobilised patients is an essential risk factor for VTE. The movement of the joint causes a measurable increase in the venous blood flow, producing the function of a physiological pump. This may lead to a better dispersal of activated blood components and dissolution of small thrombi attached to the venous wall.

Why it is important to do this review

Doctors generally agree that thromboprophylaxis should be used in patients who undergo TKA. Both pharmacological and mechanical methods are used in the prevention of DVT. Pharmacological methods alter the blood coagulation profile and may increase the risk of bleeding complications. Despite the theoretical effectiveness and widespread use of CPM, there are still differing views on the effectiveness of CPM as prophylaxis against thrombosis after TKA. The purpose of this systematic review was to objectively evaluate the effectiveness of using CPM in the prevention of VTE for patients after TKA.

OBJECTIVES

The aim of this review was to determine the effectiveness of continuous passive motion (CPM) therapy for preventing venous thromboembolism in patients after total knee arthroplasty (TKA).

METHODS

Criteria for considering studies for this review

Types of studies

We included only randomised controlled trials (RCTs) in this review.

Types of participants

People aged 18 years and older who had undergone TKA. We excluded studies of patients who presented with DVT at baseline.

Types of interventions

Any programmes of CPM used in the patients after TKA, whether combined with physical therapy or pharmacological prophylaxis.

Types of outcome measures

Primary outcomes

1. Postoperative (up to one month after operation) proximal and distal (to the knee) DVT
2. Pulmonary embolism diagnosed by ventilation/perfusion (V/Q) lung scan, spiral computed tomography (CT), or pulmonary angiography
3. Death from all causes

Secondary outcomes

1. Major bleeding (fatal bleeding; bleeding which involved a critical organ, or required re-operation; or clinically overt bleeding outside the surgical site; haemoglobin decrease > 2 g/dL, or requiring transfusion of more than two units of blood)
2. Minor bleeding (did not meet any of the above criteria for intervention)
3. Adverse effects, such as knee haematoma, delayed healing and postoperative pain

Search methods for identification of studies

Electronic searches

The
Cochrane Peripheral Vascular Diseases (PVD) Group searched their Specialised Register (last searched January 2011) and the Cochrane Central Register of Controlled Trials (CENTRAL) part of *The Cochrane Library* at www.thecochranelibrary.com (2011, Issue 1). See Appendix 1 for details of the search strategy used to search CENTRAL. The Specialised Register is maintained by the Trials Search Co-ordinator and is constructed from weekly electronic searches of MEDLINE, EMBASE, CINAHL and AMED; and through handsearching relevant journals. The full list of the databases, journals and conference proceedings which have been searched, as well as the search strategies used, are described in the Specialised Register section of the Cochrane PVD Group module in *The Cochrane Library* (www.thecochranelibrary.com). In addition, the PVD Group searched Ovid MEDLINE (1948 to Week 2 January 2011) and EMBASE (1980 to Week 3 January 2011) using the strategies shown in Appendix 2 and Appendix 3.

Searching other resources

The authors searched the reference lists of identified trials. There was no restriction on language or publication status.

Data collection and analysis

Selection of studies

Two authors (He ML and Xiao ZM) independently screened the search results using the article titles and the abstracts (if available). The full text of the selected articles was retrieved and scrutinised to ensure that multiple publications from the same trial were included only once. The same authors (He ML and Xiao ZM) then independently selected articles for inclusion using a standardised form to assess the eligibility of trials. Disagreements were resolved through discussion with the third author (Lei M). The trial authors were contacted for clarification if it was unclear whether a trial was eligible for inclusion. Excluded trials along with the reasons for exclusion are listed. A kappa statistic was calculated for measuring agreement between the two authors making simple inclusion and exclusion decisions (Higgins 2008).

Data extraction and management

Two authors (He ML and Xiao ZM) independently extracted the data using standard forms. Any differences were resolved through discussion with the third author (Lei M). Attempts were made to obtain any missing data from the trial authors.

The following information was extracted from included studies:
• age;
• sex;
• thrombosis risk group to which participants belonged;
• type of CPM used;
• duration of application of CPM;
• incidence of DVT;
• incidence of PE;
• incidence of adverse events (knee haematoma, postoperative pain, etc);
• investigations used to make the diagnosis of thrombosis and adverse events.

Assessment of risk of bias in included studies

Two authors (He ML and Xiao ZM) independently assessed the risk of bias of each trial as described below and recorded the information in a table. We provided a narrative description in the text. We assessed the methods used to generate the allocation sequence and to conceal allocation as adequate, inadequate or unclear (Jüni 2001). We recorded who was blinded in each trial (for example participants, care providers, outcome assessors). We assessed the numbers of participants randomised into the trial and included in the analysis as adequate (if more than 90%), inadequate (if less than 90%) or unclear (if it was unclear how many participants were originally randomised into the trial). Disagreements were resolved by consensus and trial authors were contacted for clarification if the information was unclear. We assessed the risk of bias in each trial using the Cochrane Collaboration 'Risk of bias' tool (Higgins 2008).

Measures of treatment effect

For dichotomous outcomes we expressed the results as risk ratio (RR) with 95% confidence intervals (CI). For continuous scales of measurement we used the mean difference (MD), or the standardised mean difference (SMD) if different scales were used.
The RR was used to compare the risk of developing DVT in people receiving CPM compared with people who were not receiving CPM. A RR of 1 means there is no difference in risk between the two groups. An RR of < 1 means DVT is less likely to occur in the CPM group than in the control group. An RR of > 1 means DVT is more likely to occur in the CPM group than in the control group. If the 95% confidence interval for a RR crossed 1, we have interpreted this as no evidence of an effect of CPM.

Unit of analysis issues

We did not include studies with non-standardised designs, except multiple treatment groups.
In trials in this area, inclusion of multiple limbs per patient can introduce complexity. If studies were identified that included more than one limb per patient in their analyses, we planned to consider suitable methods to address this issue, as outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2008).

Dealing with missing data

Relevant missing data were obtained from the authors of trials, if possible. Evaluation of important numerical data such as the number of screened, eligible and randomised patients as well as intention-to-treat (ITT) and per protocol (PP) populations were carefully performed. Drop outs, losses to follow up and withdrawn study participants were investigated. Issues of last observation carried forward (LOCF), ITT and PP were critically appraised and compared with the specifications of primary outcome parameters and power calculations.
In the case of duplicate publications and companion papers of a primary study, we tried to maximise the yield of information by simultaneous evaluation of all available data. In cases of doubt, the original publication (usually the oldest version) obtained priority.

Assessment of heterogeneity

Heterogeneity amongst trials was investigated by: looking at whether a graphical plot of the CIs for the results of each study overlapped; and using the I^2 statistic (> 50% was considered substantial heterogeneity). We attempted to determine potential reasons for any heterogeneity found.

Assessment of reporting biases

We planned to analyse publication bias using the funnel plot method. We planned to assess the funnel plot asymmetry statistically. It was, however, important to realise that publication bias is only one of a number of possible causes of funnel plot asymmetry.

Data synthesis

We analysed the data using Review Manager 5.0 (RevMan 5). Results were combined unless clinical and methodological heterogeneity or statistical heterogeneity (non-overlapping CIs) made it unreasonable to do so. We pooled dichotomous data using the risk ratio and calculated the number needed to treat, when appropriate. If continuous data were summarised with arithmetic means and standard deviations, then we combined the data using the mean differences. Where continuous data were summarised using geometric means, we combined them on a log scale using the generic inverse variance method and reported them on the natural scale.
For time-to-event data, the hazard ratio was combined on the log scale using the generic inverse variance method. We presented all results with 95% CIs. The ITT principle was applied. If there was a discrepancy in the number randomised and the number analysed in each group, however, we calculated the percentage loss to follow up in each group and considered using a different type of analysis. We used a fixed-effect meta-analytic model unless there

was statistically significant heterogeneity between trials, in which case we used a random-effects model. If heterogeneity proved to be substantial, we considered it unwise to perform a meta-analysis.

Subgroup analysis and investigation of heterogeneity

We planned to conduct subgroup analysis to explore possible sources of heterogeneity (for example participants, interventions and study quality). Heterogeneity among participants could be related to age, outpatients and inpatients with DVT.

Sensitivity analysis

We planned to perform sensitivity analysis based on the four parameters of trial methodological quality. We planned to assess publication bias using the funnel plot or other corrective analytical methods depending on the number of included trials.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification.
See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification.

Results of the search

Following screening of the titles and abstracts, 64 potentially eligible reports of trials were identified. Of these, 10 reports of 10 trials were included in the review and 15 reports of 15 trials were excluded. The remaining reports were not relevant to this review.

Included studies

Brief descriptions of the included studies can be found in the table Characteristics of included studies.

On inspection of the full reports, 10 trials met the inclusion criteria (Alkire 2010; Bruun-Olsen 2009; Chen 2000; Denis 2006; Harms 1991; Johnson 1992; Lenssen 2008; Lynch 1988; Mclnnes 1992; Montgomery 1996). In the 10 included trials, CPM was administered from 2 to 24 hours a day for between 3 and 17 days. A total of 764 patients were randomised; 64% of the randomised patients were female. Treatments were initiated between the conclusion of the operation and the second postoperative day in all trials. All included studies were randomised controlled trials (RCTs).

Alkire 2010 described a RCT of 65 participants, with 33 in the experimental group and 32 in the control group. One patient in the experimental group was withdrawn from the study because of further need for revision not related to the study device. The study included 26 men and 38 women. The experimental group received CPM three times daily and physical therapy twice daily during their hospitalisation. The control group received physical therapy only twice daily. In the experimental group, patients received CPM three times daily for three days (postoperative day zero to postoperative day two) starting with flexion at 70° to 90° and increasing extension by 10° over four hours for a total of six hours per day. There were no reports of DVT in the study. There was no statistically significant difference in knee swelling or blood drainage but the standard deviations were not provided. In the study the incidence of PE or death was not described .

Bruun-Olsen 2009 described a RCT of 63 participants, with 30 in the experimental group and 33 in the control group. The study included 19 men and 44 women. The mean age was 69 years, with the range from 49 to 92 years. Patients in the experimental group received CPM and active exercises and the control group received active exercises only. In the experimental group, on the day of the operation the CPM machine was set at 70° to 100° for flexion and the knee was moved continuously two times for two hours. The next day the machine was set at 0° to maximum 100° flexion and the knee was kept in movement continuously three times for two hours. There were no statistical differences between groups for postoperative pain and knee swelling. In the study the incidence of DVT, PE or death were not described.

Chen 2000 included 51 participants, with 23 in the experimental group and 28 in the control group. The study included 15 men and 36 women. The experimental group received CPM for five consecutive hours per day plus physical therapy, whereas the control group received only physical therapy. The CPM machine was initially set from 0° of extension to 10° less than the measured passive knee flexion. Knee flexion was increased daily as tolerated by the patients. The differences in knee swelling between the two groups were not statistically significant. In the study there was no description of the incidence of DVT, PE or death.

Denis 2006 included 81 participants, with 26 in the experimental group 1, which received physical therapy and 35 minutes of CPM applications daily; and 28 in experimental group 2, which received physical therapy and 2 hours of CPM applications daily; and 27 in the control group, which received physical therapy only. One patient in experimental group 2 refused to continue so there were only 27 patients evaluated at discharge in experimental group 2. One patient in each group developed a knee haematoma and DVT occurred in one patient in experimental group 2. Scar bleeding was seen in one patient in the control group and two patients in experimental group 1. In the study there was no description of the incidence of PE or death. Experimental group 1 received only minimal exposure to CPM (just 35 minutes daily) and was therefore not included in the meta-analysis.

Harms 1991 described a RCT of 113 participants, with 55 in the experimental group and 58 in the control group. The study included 16 men and 97 women. Patients in the experimental group

received CPM and a standardised exercise programme, whereas the control group received a standardised exercise programme only. The CPM started in the recovery ward, initially at 0° to 40° for the first 48 hours and increasing 10° flexion/day depending on tolerance. The CPM was provided for six hours per day, and finished when 80° of passive knee flexion was reached. There was no statistically significant difference in postoperative pain or blood drainage. In the study there was no description of the incidence of DVT, PE or death.

Johnson 1992 included 56 participants, with 26 in the experimental group and 30 in the control group. The mean age of the patients was 69 years (range 36 to 85 years), 23 were male and 33 female. The experimental group received CPM for the first seven postoperative days. Patients used the CPM machine for 20 hours per day for three days and then for 16 hours per day for four days. The initial range of motion was 0° to 40° and this was increased each day by 10° up to 90° on the sixth day. The control group was immobilised using a splint. Delayed wound healing occurred in eight cases; two were in the experimental group and six in the control group. In the study there was no description of the incidence of DVT, PE or death.

Lenssen 2008 included 60 participants, with 30 in the experimental group and 30 in the control group. The experimental group received CPM for four hours daily and physiotherapy for 17 consecutive days after surgery, whereas the control group received the same treatment during the in-hospital phase followed by physiotherapy alone in the first two weeks after hospital discharge. There was no statistically significant difference in postoperative pain. In the study there was no description of the incidence of DVT, PE or death.

Lynch 1988 included 150 participants; 75 of the same sex, age, obesity and history of hypertension were allocated to each group. In the study group, CPM commenced on postoperative day 3, initially at 0° to 30°, and was provided for 10 hours per day. This increased > 10° flexion/day as tolerated by the patient and continued at for least one week. The control group began to perform active assisted exercises of the knee on postoperative day 3. Venography was performed on each patient on the seventh postoperative day. The result was that PE did not develop in any of the patients during hospitalisation or in the subsequent three months. DVT was found in 34 participants in the study group and 28 in the control group. There was no statistical significance between the two groups in terms of the incidence of thrombosis, length of hospitalisation and the use of a tourniquet (used during operations to block the blood supply of the lower limb). In the study there was no description of the incidence of bleeding and death.

Mclnnes 1992 included 93 participants, with 48 in the study group and 45 in the control group. The participants were followed up for six weeks. CPM machines were programmed for rate and specified arc of motion beginning within 24 hours of surgery with the range increased daily, as tolerated, together with the standardised rehabilitation programme and compared with the standardised rehabilitation programme alone. The CPM group had one patient with DVT. Use of CPM increased active flexion and decreased swelling and the need for manipulations but did not significantly affect pain, active and passive extension, quadriceps strength, the incidence of thrombosis or length of hospital stay. Eleven patients had delayed wound healing problems that included wound haematoma (five patients), wound drainage at 24 to 48 hours (three patients), heel decubitus (one patient), wound healing problems in the contralateral total knee replacement (one patient); and delayed healing (one patient). The concrete details were not provided. In the study there was no description of the incidence of bleeding and death.

Montgomery 1996 included 60 participants, with 30 in the experimental group and 30 in the control group. The study included 12 men and 48 women. In the experimental group, CPM was applied for three hours three times daily, seven days a week. The therapy was initiated on the first postoperative day and continued until discharge. The range of motion was adjustable and it was increased until the patient experienced pain. The CPM group sustained less postoperative knee swelling but there were no differences in postoperative pain between the groups. Three patients had superficial wound complications, one patient had DVT and one patient had a myocardial infarct. They were excluded from the study. In the study there was no description of the incidence of DVT, PE or death.

Excluded studies

The reasons for exclusion can be found in the Characteristics of excluded studies table.

Ten studies (Gose 1987; Kim 2009; Kusswetter 1991; Lotke 1991; Lynch 1990; Maloney 1990; Pope 1997; Ververeli 1995; Vince 1987; Xu 2001) were not RCTs. There were no clinical outcomes relevant to this review in two studies (Beaupré 2001; Davies 2003) that had the same participants so they were excluded. London 1999 compared two groups: patients using a conventional CPM machine versus using CPMlite, which is a new design of CPM machine; this study was also excluded. Rader 1998 was excluded because the CPM treatment was for the ankle. Lenssen 2003 was excluded because of data errors.

Risk of bias in included studies

A graphical representation of risk of bias can be found in Figure 1 and Figure 2.

Figure 1. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

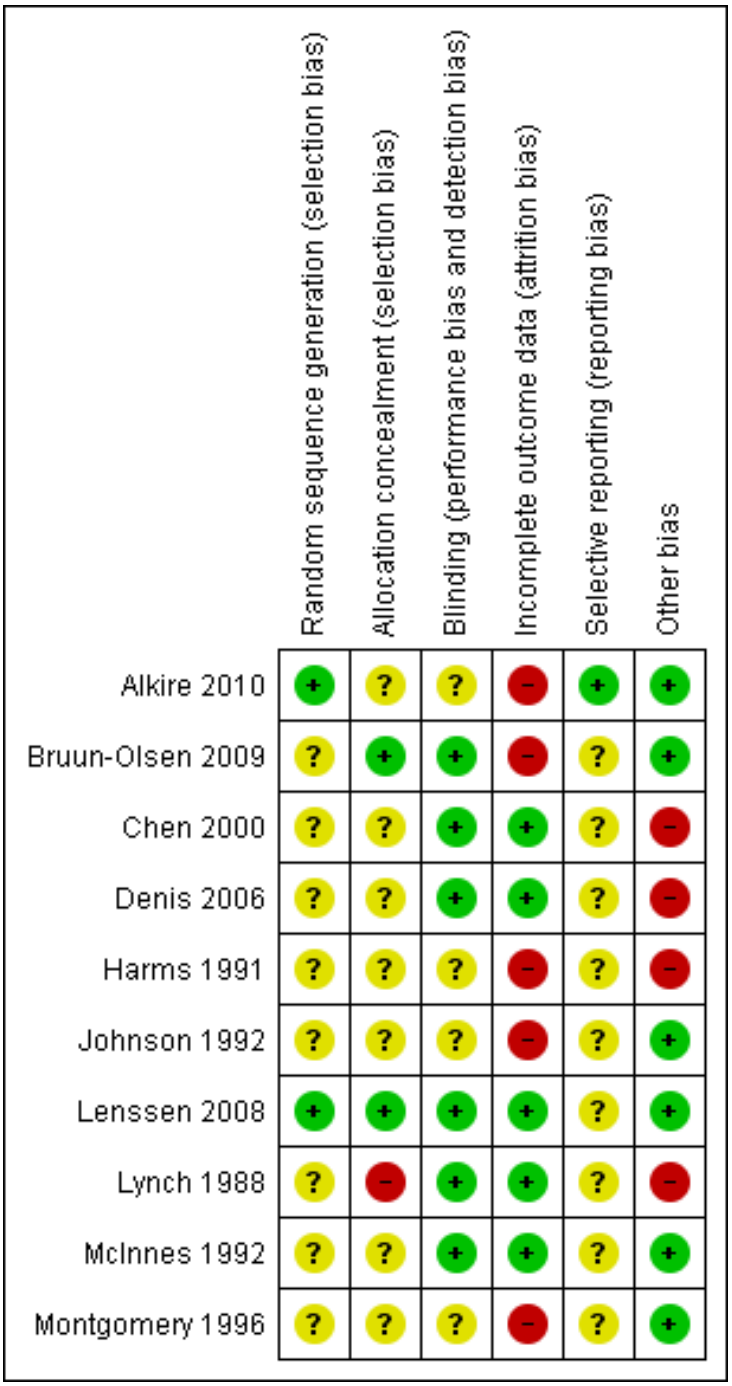
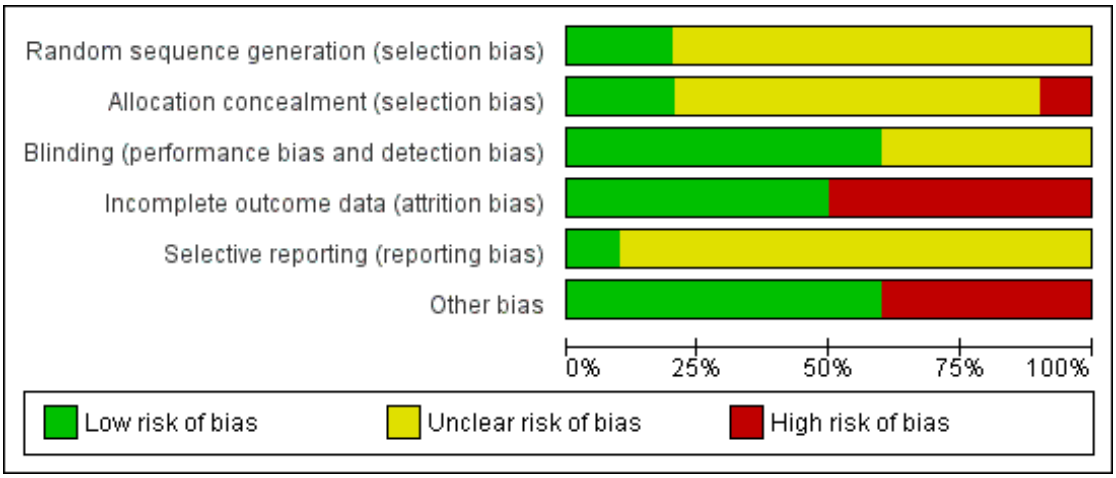


Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

Only two studies (Alkire 2010; Lenssen 2008) reported how the randomisation sequence was generated. Only two studies (Bruun-Olsen 2009; Lenssen 2008) reported allocation concealment. The other studies did not describe randomisation or allocation concealment.

Blinding

Six studies (Bruun-Olsen 2009; Chen 2000; Denis 2006; Lenssen 2008; Lynch 1988; Mclnnes 1992) used single blinding. The remaining included studies did not report blinding.

Incomplete outcome data

Two studies (Alkire 2010; Harms 1991) did not provide standard deviations for the measures of postoperative pain. In Bruun-Olsen 2009, deceased patients were excluded from the study. Johnson 1992 did not mention the age and gender of participants in the treatment groups. In Montgomery 1996 a patient with DVT was excluded from the study.

Selective reporting

It would appear that all of the included studies reported on all of their intended outcomes. We did not, however, have access to any of the study protocols to confirm this.

Other potential sources of bias

Surgical experience

Some surgeons may have been more experienced with TKA than the others. Operations performed by surgeons with different level of experience might influence the outcome of VTE.

Appropriateness of the statistical analyses

The appropriateness of the statistical analyses methods was assessed. The statistical methods in all of the included studies were considered as appropriate for the data analyses.
Additionally, all trials were small trials that are themselves associated with risks of bias.

Other bias

Some outcomes such as blood drainage and wound healing may be affected by patients' age or comorbidities, or both, and not just by whether or not the patients had received CPM.

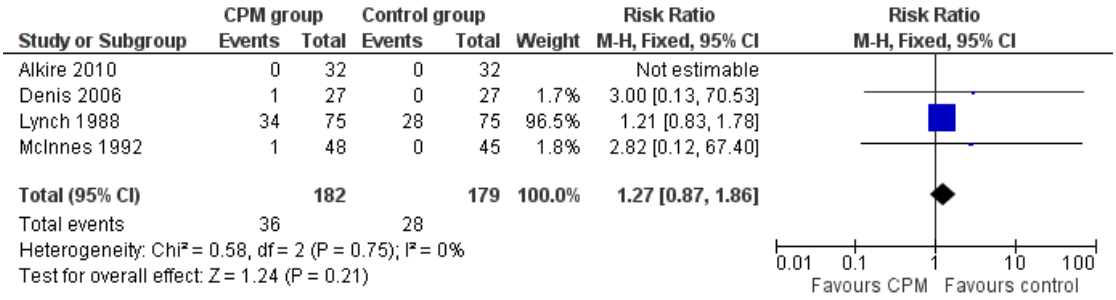
Effects of interventions

Primary outcomes

1. Proximal and distal DVT events

See Analysis 1.1 and Figure 3.

Figure 3. Forest plot of comparison: CPM group versus control group, outcome: 1.1 Incidence of DVT.



Four studies (Alkire 2010; Denis 2006; Lynch 1988; McInnes 1992) with a total of 361 patients reported the incidence of DVT and showed minimum heterogeneity in the meta-analysis (I^2 = 0). The meta-analysis showed no difference between the two groups (RR 1.27, 95% CI 0.87 to 1.86) and the effect was not statistically significant (P = 0.21). One patient in Montgomery 1996 was diagnosed with DVT but was excluded from the study by the study authors.

2. Pulmonary embolism

One study (Lynch 1988) reported that PE did not develop in any of the groups. Pulmonary embolism was not reported by the other studies (Analysis 1.2).

3. Death from all causes

There were no deaths reported in the included studies.

Secondary outcomes

1. Major bleeding

Major bleeding was not reported in the included studies.

2. Minor bleeding

One study (Denis 2006) reported one 'scar bleeding' with 'no significant difference' between treatment and control groups (RR 0.33, 95% CI 0.01 to 7.84; n = 54) (Analysis 1.3).

3. Adverse effects

(1) Knee haematoma

Denis 2006 reported two knee haematoma with 'no significant difference' between treatment and control groups (RR 0.33, 95% CI 0.01 to 7.84; n = 54) (Analysis 1.4).

(2) Blood drainage

Two trials with a total of 177 patients measured blood drainage (Alkire 2010; Harms 1991). Only one trial with a total of 113 patients provided useful data (Harms 1991). The mean difference was 42.00 mL (95% CI -104.35 to 188.35; P = 0.57) (Analysis 1.5).

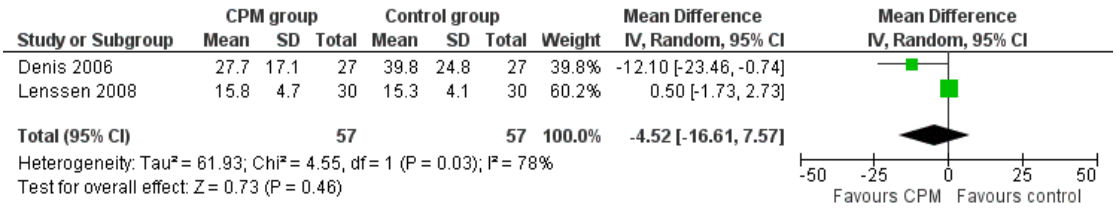
(3) Delayed healing

Two trials with a total of 149 patients reported delayed healing (Johnson 1992; McInnes 1992). Only one trial with a total of 113 patients provided useful data (Johnson 1992). The RR was 0.38 (95% CI 0.08 to 1.74; P = 0.22) (Analysis 1.6).

(4) Postoperative pain

See Analysis 1.7 and Figure 4.

Figure 4. Forest plot of comparison: CPM group versus control group, outcome: 1.7 Postoperative pain (WOMAC score).

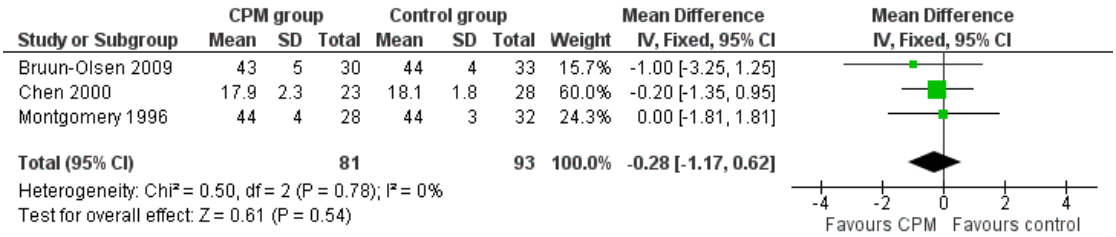


Six trials with a total of 443 patients reported postoperative pain (Bruun-Olsen 2009; Denis 2006; Harms 1991; Lenssen 2008; Mclnnes 1992; Montgomery 1996). Only two trials with a total of 114 patients provided useful data (Denis 2006; Lenssen 2008). In the former study (Denis 2006), the pain measured at discharge in the experimental group (mean ± standard deviation (SD)) was 27.7 ± 17.1), which was less compared with the control group (39.8 ± 24.8). Lenssen 2008 did not detect any difference in pain on day 17 between the groups. There was considerable between-study heterogeneity in estimates of effects (I^2 = 78%). An I^2 of 78% indicates a large degree of between-trial heterogeneity which might have been related to the fact that it is impossible to blind patients or clinicians when using physical interventions. Another reason for the large degree of heterogeneity could have been due to the measure of postoperative pain. This was particularly problematic for outcomes measured by reporting questionnaires.

(5) Knee swelling

See Analysis 1.8 and Figure 5.

Figure 5. Forest plot of comparison: CPM group versus control group, outcome: 1.8 Knee swelling (knee circumference (cm)).



Four trials with a total of 238 patients measured knee swelling (Alkire 2010; Bruun-Olsen 2009; Chen 2000; Montgomery 1996). Only three trials with a total of 114 patients provided useful data (Bruun-Olsen 2009; Chen 2000; Montgomery 1996). The mean difference was -0.28 (95% CI -1.17 to 0.62; P = 0.54).

With the data available, we could not conduct subgroup analyses evaluating any association of participants, interventions or study quality with outcome. In addition, we could not perform sensitivity analysis or assess publication bias.

DISCUSSION

Summary of main results

CPM therapy for preventing DVT after total knee arthroplasty (TKA)

Ten randomised controlled trials (RCTs) of 764 participants met the inclusion criteria. Four studies (Alkire 2010; Denis 2006; Lynch 1988; Mclnnes 1992) with a total of 361 patients reported the incidence of DVT after TKA with differing diagnostic criteria. In the CPM group of 182 patients, 36 developed DVT (20%) in comparison to the control group of 179 patients, where 28 (16%) had DVT. The results of this meta-analysis showed no evidence that CPM has an effect. The largest study, Lynch 1988,

was assigned most of the weight in the meta-analysis and therefore the result is driven by the outcomes of this study.

CPM therapy for preventing PE after total knee arthroplasty (TKA)

Only one of the included studies (Lynch 1988) reported the incidence of PE after TKA. Lynch 1988 reported no cases of PE in any of the patients either during hospitalisation or in the subsequent three months. The statistical power of the included studies on PE prevention by CPM therapy is weak and it is obvious that there is insufficient evidence to make a conclusion on CPM therapy for preventing PE after TKA.

CPM therapy for preventing minor bleeding or adverse effects after total knee arthroplasty (TKA)

There is inconclusive evidence for CPM on minor bleeding, knee haematoma, blood drainage, delayed healing, postoperative pain and knee swelling.

Overall completeness and applicability of evidence

The search strategy we designed for this review in order to locate all possible relevant studies included key electronic databases, including clinical trials registers, and we made contact with experts in the field. We included only randomised controlled studies in this review to restrict possible selection bias. The 10 included studies were not sufficient to evaluate the CPM therapy for preventing VTE after TKA. This was attributable to the lack of available data and the fact that is was impossible to gather missing data. Five studies (Harms 1991; Johnson 1992; Lynch 1988; Mclnnes 1992; Montgomery 1996) were conducted in the 1980s or 1990s. With the data available, we could not conduct subgroup analyses evaluating any association of participants, interventions or study quality with outcome.

Quality of the evidence

The quality of the evidence is summarised in Figure 1 and Figure 2.

1. The methodological quality of the included studies was variable. Among the included studies, only two studies (Alkire 2010; Lenssen 2008) provided randomisation methods. Two studies (Bruun-Olsen 2009; Lenssen 2008) performed allocation concealment. Six studies (Bruun-Olsen 2009; Chen 2000; Denis 2006; Lenssen 2008; Lynch 1988; Mclnnes 1992) described the blinding for patients and evaluators. Seldom did the original authors perform strict quality control on items such as sample size calculations and explanations of the inclusion criteria. Thus the results are weakened by the design and quality control.

2. Due to the diversity of CPM programmes and their administration, data synthesis was seldom performed. Even for the trials using similar CPM programmes, the original authors rarely applied the same standard or period of follow up, making it difficult to carry out pooled analysis and to obtain synthesised outcomes of the different studies.

3. In two studies (Alkire 2010; Harms 1991) the standard deviations were not provided, so the results could not be included in the meta-analyses.

4. In Montgomery 1996, three patients had superficial wound complications, one patient had DVT and one patient had a myocardial infarct, but they were excluded from the study by the study authors.

Potential biases in the review process

A possible source of bias in the review process may be that not all relevant trials were identified, despite the extensive search of electronic databases and clinical registers. This may have occurred particularly when the trials were unpublished. Data presentation was also limited in all studies. We contacted authors of all included studies but they were unable to supply the necessary data. Meta-analysis was carried out only as a last resort after failure to obtain more data from trialists.

Agreements and disagreements with other studies or reviews

The rationale for the application of CPM is that it stimulates venous and lymphatic flow and maintains the range of the motion of the joint. Venous stasis due to the absence of muscular contraction in immobilised patients is an essential risk factor for DVT. The movement of the joint causes a measurable increase in the venous blood flow, producing the function of a physiological pump. This may lead to better dispersal of activated blood components and dissolution of small thrombi attached to the venous wall.

It has been suggested that CPM may decrease thromboembolic complications after TKA, but there are very few high quality RCTs available on the subject. Stulberg 1984 performed postoperative venography for 517 patients and found that the incidence of thrombosis in the calf is 46.2% and in the popliteal veins or thigh it is 10.7%. Vince 1987 performed venography routinely after TKA. They found a 75% incidence of calf thrombi in the control group and 45% incidence of calf thrombi in the CPM group. In a retrospective study, 8.1% of patients had DVT in the CPM group while 11.5% of patients had DVT in the control group (Gose 1987).

The data for the effect of CPM in preventing PE are not in agreement. Vince 1987 had no PE in either the control or CPM group, based on negative lung scans. Lynch 1990 showed that the incidence of (subclinical) PE as confirmed by lung scans was 6% in the

CPM group compared to 18% in the aspirin group. This suggests a protective effect from CPM.

We are not aware of other systematic reviews of CPM therapy for preventing VTE after TKA. The reviews published previously were mainly concerned with the influence of CPM on knee range of motion, length of hospital stay, function and incidence of manipulation under general anaesthesia following TKA (Brosseau 2004; Harvey 2010). This meta-analysis showed that CPM may not offer beneficial results for VTE prevention after TKA, supported by all four included studies (Alkire 2010; Denis 2006; Lynch 1988; Mclnnes 1992).

AUTHORS' CONCLUSIONS

Implications for practice

Most of the results were supported by only one or two studies of moderate quality. Thus, more trials of high methodological quality are needed before we can draw a reliable conclusion.

The effects of CPM on preventing VTE after TKA are too small to justify its use. Evidence suggests that CPM does not prevent VTE after TKA, however the quality of the evidence is low. Most of the results are supported by only a small number of studies, most of which are of poor quality. The systematic review will be updated if new full reports of relevant trials are obtained.

Implications for research

Future studies should be high quality, randomised controlled trials.This will help this systematic review to attain precise estimates of treatment effectiveness. Future studies should also strive to improve the quality of reporting of their trials. The use of concealed allocation and blinded assessors is particularly important for reducing bias. In addition, the incidence of DVT is generally underestimated due to subclinical events or DVTs displaying only minor symptoms and signs. Clinical information alone (history and physical examination) is insufficient for the diagnosis of DVT. Future studies should be aware of this and use more sensitive methods (such as venography or sonography) to diagnose DVT. In the included studies, a lot of variability exists in the application of CPM, such as the postoperative range of motion, duration of CPM per day and duration of CPM postoperatively. Future studies should address an optimal CPM dosage schedule to diminish bias.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Alkire 2010

Methods	**Design:** Randomised trial **Method of randomisation:** States "Those consenting were randomized into two groups, CPM and no-CPM, using a table of random numbers" **Method of allocation:** Not described **Blinding of outcomes assessors:** Not described
Participants	**Source population:** Between July 2006 and March 2008 **Sample size:** Study group: 33 Control group: 32 **Subject selection:** Inclusion: Patients with a diagnosis of rheumatoid or osteoarthritis and age greater than 18 years Exclusion: Patients with cognitive/sensory deficits; residing in skilled nursing facilities; non-English-speaking patients; with co-morbidities such as previous DVT requiring anticoagulants, weight more than 240 lb, and presence of other conditions such as diabetes, hypertension, stroke, diabetes, and/or lupus **Mean age:** Study group: 65.6 Control group: 66.9 **Gender (%):** Study group: 62.5% female Control group: 56.3% female
Interventions	**Type of CPM used:** Dannia ex 480 CPM apparatus. **Study group:** CPM + physical therapy. Patients in the study group received CPM three times daily for 3 days (POD0 - POD2), starting with flexion at 70° to 90° in the postanaesthesia care unit, increasing extension by 10 over 4 hours for a total of 6 hours per day **Control group:** Physical therapy. Both groups received physical therapy twice daily during their hospitalisation
Outcomes	**Outcomes included in this review:** 1. DVT (Diagnosis method: not reported) 2. Knee swelling 3. Blood drainage **Other outcomes:** Functional ability, stiffness, range of motion, length of stay, complications
Notes	One patient randomised to CPM was withdrawn from the study because of further need for revision not related to the study device. Therefore the CPM group consisted of 32 patients
Risk of bias	

Alkire 2010 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "Those consenting were randomized into two groups, CPM and no-CPM, using a table of random numbers."
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	High risk	Authors did not provide standard deviation.
Selective reporting (reporting bias)	Low risk	No indication of reporting bias.
Other bias	Low risk	No indication of other bias.

Bruun-Olsen 2009

Methods	**Design:** Randomised, single-blinded, controlled clinical trial. **Method of randomisation:** States: "the patients were randomly allocated into two groups..." **Method of allocation:** States: "the random allocation procedure was as follows: Seventy closed, opaque envelopes containing the specified treatment regime were prepared beforehand by the researchers, 35 for each group, and the physiotherapist concerned chose an envelope for each patient before starting the post-operative training" **Blinding of outcomes assessors:** States: "the physiotherapist who performed the measurements did not know which intervention group the patient belonged to"
Participants	**Source population:** Asker and Baerum General Hospital, University of Oslo, Norway, between October 2003 and March 2005 **Sample size:** Study group: 30 Control group: 33 **Subject selection:** Inclusion: Patients with good cognitive function and fluent spoken and written knowledge of Norwegian Exclusion: Patients with rheumatoid arthritis or prosthesis in the ipsilateral hip **Mean (SD) age:** Study group: 68 (10) Control group: 71 (10) **Gender (%):** Study group: 73% female Control group: 67% female

Interventions	**Type of CPM used:** Not described. **Study group:** CPM + active exercises. For the CPM programme, the patient lay in a supine position with the operated leg in the CPM machine. On the day of the operation the machine was set at 70° - 100° for flexion and the knee was moved continuously for two times 2 hours. The next day the machine was set at 0° to maximum 100° flexion, and the knee was kept in movement continuously for three times 2 hours **Control group:** Active exercises. The active exercises consisted of assisted and active flexion and extension of the hip/knee, active isometric contraction of the quadriceps, walking training using a high walker, rollator or crutches, and eventually climbing stairs on crutches
Outcomes	**Outcomes included in this review:** 1. Postoperative pain 2. Knee swelling **Other outcomes:** Active and passive knee flexion and extension, timed 'Up and Go' test, timed 40 m walking distance and timed stair climbing
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "the patients were randomly allocated into two groups..."
Allocation concealment (selection bias)	Low risk	States: "the random allocation procedure was as follows: Seventy closed, opaque envelopes containing the specified treatment regime were prepared before-hand by the researchers, 35 for each group, and the physiotherapist concerned chose an envelope for each patient before starting the post-operative training"
Blinding (performance bias and detection bias) All outcomes	Low risk	States: "the physiotherapist who performed the measurements did not know which intervention group the patient belonged to"
Incomplete outcome data (attrition bias) All outcomes	High risk	States: "Four patients, three women and one man, were not measured at three months. Two of them had died from heart and lung disease and two did not attend the follow-up consultation"
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.

Other bias	Low risk	No indication of other bias.

Chen 2000

Methods	**Design:** Prospective, randomised, single-blinded, controlled clinical trial **Method of randomisation:** Not described **Method of allocation:** Not described **Blinding of outcomes assessors:** States: "The measurements and recordings of all variables except length of stay were carried out by 1 of 2 physical therapists who were blinded to the patients' group assignments. Patients were asked not to tell the therapists to which group they belonged"
Participants	**Source population:** Kessler Institute for Rehabilitation, Inc., at Saddle Brook, New Jersey, from December 1996 to August 1997 **Sample size:** Study group: 23 Control group: 28 **Subject selection:** Inclusion: Patients with TKA who admitted to the study. Exclusion: (1) Bilateral TKA; (2) patient intolerant of the CPM machine; (3) significant wound drainage or wound infection; (4) TKA revision; or (5) weight $\geq$ 240 pounds **Mean age:** Study group: Not described Control group: Not described **Gender (%):** Study group: 73.9% female Control group: 67.9% female
Interventions	**Type of CPM used:** Not described. **Study group:** CPM + physical therapy. The CPM machine was set up within 24 hr of admission based on the range recorded by the treating therapist. The CPM machine was initially set from 0° of extension to 10° less than the measured passive knee flexion. Knee flexion was increased daily by the therapist as tolerated by the patients. Patients were placed in the CPM machine in the evening for 5 consecutive hours **Control group:** Physical therapy.
Outcomes	**Outcomes included in this review:** Knee swelling. **Other outcomes:** Passive knee flexion, passive knee extension.
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

Chen 2000 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	States: "The patients were randomly divided into 2 groups..." However, does not state how randomisation schedule was generated
Allocation concealment (selection bias)	Unclear risk	No description about the allocation sequence.
Blinding (performance bias and detection bias) All outcomes	Low risk	States: "the measurements and recordings of all variables except length of stay were carried out by 1 of 2 physical therapists who were blinded to the patients' group assignments"
Incomplete outcome data (attrition bias) All outcomes	Low risk	All the patients were followed up.
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	High risk	No description of mean age in each group.

Denis 2006

Methods	**Design:** Randomised clinical trial **Method of randomisation:** Not described **Method of allocation:** States: "Two strata were created for an equivalent distribution of subjects with and subjects without previous major surgery of the lower limbs in the 3 groups. One set of pre-numbered, sealed envelopes was prepared for each stratum, and subjects were assigned to the group specified in the envelope" **Blinding of outcomes assessors:** States: "Assessments were performed by 4 experienced physical therapists who were unaware of group assignment"
Participants	**Source population:** Centre Hospitalier Universitaire de Québec-Hôtel-Dieu de Québec, Canada. Between February 2001 and February 2003 **Sample size:** Study group 1: 26 Study group 2: 28 Control group: 27 **Subject selection:** Inclusion: Osteoarthritis, ambulatory, literate, primary TKA, those who have previous surgery occurred at least 12 months before the current TKA Exclusion:(1) medical conditions or diseases that could interfere with test performance, (2) collaboration or comprehension problems, (3) neuromuscular or neurodegenerative disease, (4) concurrent intervention during surgery that could interfere with outcomes (e.g. collateral ligament repair), (5) infection of the affected knee, and (6) any major health complication during the hospital stay (e.g. PE, heart attack, problems with scar healing)

	Mean (SD) age: Study group 1: 69.6 (6.7) Study group 2: 68.4 (7.4) Control group: 67.1 (7.6) **Gender (%):** Study group 1: 61.5% female Study group 2: 46.4% female Control group: 51.9% female **Number lost to follow up:** One patient in the study group2 refused to continue, only 27 patients in the study group2 evaluated at discharge
Interventions	**Type of CPM used:** Not described **Study group 1:** CPM + conventional physical therapy. Daily CPM session began on the second day after TKA until discharge or day 7 or 8. CPM was used for 35 minutes continuously in the evening, including a 5 minute warm-up period **Study group 2:** CPM + conventional physical therapy Daily CPM session began on the second day after TKA until discharge or day 7 or 8. CPM was used for 2 consecutive hours in the evening, including a 5 minute warm-up period **Control group:** Conventional physical therapy Conventional physical therapy was supervised by a physical therapist. On the first day after surgery, respiratory and circulatory exercises were encouraged. Isometric knee extensor muscle exercises were performed, and extension knee alignment was maintained in a splint. On the second day, the splint was removed. Active and passive knee flexion, abduction and adduction of the hip in the horizontal plane, and knee extensor muscle exercises were performed. Next, teaching for transferring and walking with the appropriate device was begun. Functional exercises with weight bearing were added on day 4. Management of stairs, if needed, was performed on day 6 or 7 before discharge. All subjects had to practice exercises and walk on their own in addition to the supervised sessions
Outcomes	**Outcomes included in this review:** 1. DVT (Diagnosis method: not reported) 2. Scar bleeding 3. Postoperative pain 4. Knee haematoma **Other outcomes:** Maximal active ROM in knee flexion, active ROM in knee extension, timed 'Up & Go' test (TUG) results, length of hospital stay, and WOMAC questionnaire scores
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	States: "all subjects were randomly assigned to one of the following...", However, does

Denis 2006 (*Continued*)

		not state how randomisation schedule was generated
Allocation concealment (selection bias)	Unclear risk	States: "Two strata were created for an equivalent distribution of subjects with and subjects without previous major surgery of the lower limbs in the 3 groups...", However, does not state how allocation concealment was generated
Blinding (performance bias and detection bias) All outcomes	Low risk	States: "assessments were performed by 4 experienced physical therapists who were unaware of group assignment"
Incomplete outcome data (attrition bias) All outcomes	Low risk	States: "CTL (n = 27) did not receive 75% of conventional physical therapy interventions: n = 3..."
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	High risk	One patient in the study group 2 refused to continue, only 27 patients in the study group 2 evaluated at discharge

Harms 1991

Methods	**Design:** Randomised controlled trial **Method of randomisation:** States: "A random allocation table was generated for the two patient groups(osteo-arthrosis and rheumatoid arthritis)" **Method of allocation:** States: "A random allocation table was generated for the two patient groups (osteo-arthrosis and rheumatoid arthritis). This procedure ensured that patients were equally likely to be assigned to CPMor non-CPM groups, and there was a similar distribution of both diagnoses in each group" **Blinding of outcomes assessors:** Not described
Participants	**Source population:** The Middlesex Hospital, University College Hospital and The Royal National Orthopaedic Hospital, Stanmore, UK **Sample size**: Study group: 55 Control group: 58 **Subject selection:** Inclusion: Osteo-arthrosis or rheumatoid arthritis; undergoing primary TKA; Stanmore, Kinemax or Insall-Burstein prosthesis; pre-operative mobility level: able to rise from a chair with armrests and seat pan height of 18 inches, walk 10 meters in two minutes with walking aid if appropriate, but no walking splintage, knee flexion contracture less than 40°; aged between 40 and 90 years Exclusion: Joint replacement revision; concurrent double joint surgery; other conditions

Harms 1991 (*Continued*)

	compromising the treatment regime **Mean (SD) age:** Study group: 69 (9) Control group: 71 (10) **Gender (%):** Study group: 78% female Control group: 93% female **Number lost to follow up:** None
Interventions	**Type of CPM used:** Kinetec 4000 CPM leg exercisers. **Study group:** CPM + standardised exercise programme CPM: started in recovery ward; range (0° - 40° of flexion for the first 48 hours); speed (2°/sec); increase (10° flexion/day depending on tolerance); duration (six hours daily, managed in back slab or splint while not on CPM); finish (when 80° of passive knee flexion reached) **Control group:** standardised exercise programme Standardised exercise programme for *s*tudy group and control group: twice each day; minimum of ten minutes knee-related treatment at each session Day One: patients managed in back slab or splint; quadriceps contractions, static progressing to straight leg raising (SLR); ankle exercises and glutei contractions Day Two: mobilise with back slab or splint. Day Three: active knee flexion; inner range quadriceps exercises; back slab removed except for mobilising Day Five: mobilise without back slab provided patients are able to SLR or have dynamic control of knee extension
Outcomes	**Outcomes included in this review:** 1. Wound drainage over the first 48 hours following surgery 2. Postoperative pain **Other outcomes:** Passive knee flexion ROM, active knee extension ROM, length of hospital stay, ease score, number of patients with complications, number of patients requiring outpatient physiotherapy
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "A random allocation table was generated for the...", However, does not state how randomisation schedule was generated
Allocation concealment (selection bias)	Unclear risk	No description about the generation of allocation sequence and process of recruiting the participants, therefore the allocation concealment is judged 'unclear'

Harms 1991 (*Continued*)

Blinding (performance bias and detection bias) All outcomes	Unclear risk	No description about the blinding.
Incomplete outcome data (attrition bias) All outcomes	High risk	The results of visual analogue pain scores were provided by graphical representation without standard deviation
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	High risk	States: "the distribution of the sexes was not even between CPM and non-CPM groups"

Johnson 1992

Methods	**Design:** Randomised trial **Method of randomisation:** Not described **Method of allocation:** Not described **Blinding of outcomes assessors:** Not described
Participants	**Source population:** Not described **Sample size**: Study group: 26 Control group: 30 **Subject selection:** Inclusion: Patients undergoing primary total condylar knee arthroplasty Exclusion: Preoperatively, the patients were assessed and matched for the presence of factors that might adversely affect wound healing such as diabetes, corticosteroid therapy and peripheral vascular disease, for their age, type of arthritis and presence of any previous scars around the knee **Mean age:** Study group: Not described Control group: Not described **Gender (%):** Study group: Not described Control group: Not described **Number lost to follow up:** None
Interventions	**Type of CPM used:** Not described. **Study group:** Received immediate post-operative CPM. Weight bearing was begun on the 3rd day, but no active knee flexion was allowed until the 7th day CPM was used for the first 7 post-operative days. Patients used the machine for 20 hours/day for 3 days and then for 16 hours/day for 4 days. The initial range of motion was 0 - 40° and this was increased each day by 10° up to 90° on the 6th day. The apparatus was removed on the 7th day **Control group:** Immobilised in a splint. Patients wore a splint over the bandages for 7 days. Straight leg raising exercises were performed twice daily. Weight bearing started

Johnson 1992 (*Continued*)

	on the 3rd postoperative day, but no active knee flexion was allowed until the 7th postoperative day as in the CPM group **Investigations used to make the diagnosis of wound healing problem:** All wounds were inspected regularly throughout the postoperative period. Failure of primary wound healing was considered to be present if aseptic wound dehiscence occurred, if an aseptic wound discharge continued after the 5th post-operative day or if infection confirmed by positive wound swab culture was present
Outcomes	**Outcomes included in this review:** Delayed healing. **Other outcomes:** Fixed flexion deformity, extension lag and flexion, superficial infection
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	States: "A randomised controlled trial was undertaken in 56 patients ..." However, did not state how randomisation schedule was generated
Allocation concealment (selection bias)	Unclear risk	No description about the generation of allocation sequence and process of recruiting the participants, therefore the allocation concealment is judged "unclear"
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No description about the blinding.
Incomplete outcome data (attrition bias) All outcomes	High risk	Age and gender in each groups were not reported.
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	Low risk	No indication of other bias.

Lenssen 2008

Methods	**Design:** Randomised controlled trial **Method of randomisation:** States: "Blocked and concealed randomisation with a block size of four ensured equal distribution of patients over the two treatment groups" **Method of allocation:** States: "A randomised controlled trial, with blinded treatment allocation, assessment and analysis, was carried out..." **Blinding of outcomes assessors:** States: "The outcome assessor was blinded for the treatment procedure"
Participants	**Source population:** The Maastricht University Hospital, the Netherlands, between April 1st 2005 and June 30th 2006 **Sample size**: Study group: 30 Control group: 30 **Subject selection:** Inclusion: Patients had less than 80° of RoM 4 days after surgery, were able to understand and speak Dutch, were not suffering from mental disabilities and were resident within the 'Maastricht Heuvelland' region Exclusion: Patients who needed to stay in hospital for more than five days after surgery or showed relevant co-morbidity influencing mobility (e.g. claudication, other prosthesis) or were operated upon by minimally invasive surgery. Patients older than 80 years were also excluded **Mean (SD) age:** Study group: 64.1 (8.1) Control group: 65 (9.1) **Gender (%):** Study group: 60% female Control group: 70% female **Number lost to follow up:** None
Interventions	**Type of CPM used:** Not described. During the in-hospital period, all patients received a standardised physiotherapy programme, involving 20 minutes of PT and four hours of CPM use daily for four days. CPM was used for two consecutive hours, twice daily. At the end of the in-hospital period, all patients were randomly assigned to one of the following groups: **Study group:** CPM (4 hours daily) + physiotherapy for two weeks after surgery **Control group:** Patients received physiotherapy alone in the first two weeks after hospital discharge From 18 days to three months after surgery, both groups received standardised physiotherapy until patients and therapists were satisfied with their overall functioning
Outcomes	**Outcomes included in this review:** Postoperative pain. **Other outcomes:** Functional status, range of motion, perceived effect, postoperative medication use, satisfaction with treatment, satisfaction with treatment result, adherence to treatment protocols and use of CPM, quantity, duration and nature of PT intervention
Notes	
Risk of bias	

Lenssen 2008 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "Blocked and concealed randomisation with a block size of four ensured equal distribution of patients over the two treatment groups..."
Allocation concealment (selection bias)	Low risk	States: "Blocked and concealed randomisation with a block size of four ensured equal distribution of patients over the two treatment groups..."
Blinding (performance bias and detection bias) All outcomes	Low risk	States: "A randomised controlled trial, with blinded treatment allocation, assessment and analysis, was carried out..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	All the patients were followed up.
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	Low risk	No indication of other bias.

Lynch 1988

Methods	**Design:** Randomised controlled trial **Method of randomisation:** Not described **Method of allocation:** Not described **Blinding of outcomes assessors:** Assessor blinding was made
Participants	**Source population:** University Hospital, London, Ontario, from December 1985 to November 1986 **Sample size**: Study group: 75 Control group: 75 **Subject selection:** Inclusion: Primary unilateral TKA , diagnosis not described. Exclusion: History of DVT, refused to have a venographic examination **Mean (range) age:** Study group: 70 (35 - 82) Control group: 68 (47 - 84) **Gender (%):** Study group: 42% female Control group: 35% female **Number lost to follow up:** None.

Lynch 1988 (*Continued*)

Interventions	**Type of CPM used:** Kinetec 3080 CPM. **Study group:** CPM + physiotherapy. CPM was set from 0° - 30° for the first 24 hours, and then it was increased daily by 10° or more when the patient could tolerate. The patients used the machine for as long as they could tolerate it each day. The patients continued to use the machine for at least one week, or longer if the knee had not gained 90° of flexion **Control group:** Physiotherapy. Patients began to perform active assisted exercises of the knee on the third postoperative day, under the supervision of one physiotherapist **Investigations used to make the diagnosis of thrombosis:** Venography was performed on each patient on the seventh postoperative day. Pulmonary embolism judged either clinically or venographically
Outcomes	**Outcomes included in this review:** 1. DVT (Diagnosis method: venography) 2. PE
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "the 150 patients were serially randomised and allocated to...." However, did not state how randomisation schedule was generated
Allocation concealment (selection bias)	High risk	No description about the generation of allocation sequence and process of recruiting the participants, therefore the allocation concealment is judged "not used"
Blinding (performance bias and detection bias) All outcomes	Low risk	States: "Venography was performed on each patient on the seventh postoperative day. A standardized technique was used, always by the same radiologist, who was unaware of the patient's protocol for mobilization...."
Incomplete outcome data (attrition bias) All outcomes	Low risk	150/150 were present at follow up.
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	High risk	Age and gender composition was balanced among groups. Compliance assessment was not men-

Lynch 1988 (*Continued*)

		tioned.

Mclnnes 1992

Methods	**Design:** Randomised controlled single-blind trial **Method of randomisation:** Not described **Method of allocation:** Not described **Blinding of outcomes assessors:** Assessor blinding was made
Participants	**Source population:** Brigham Multipurpose Arthritis Center, Boston, Mass. Between 1988 and 1990 **Sample size:** Study group: 48 Control group: 45 **Subject selection:** Inclusion: Osteoarthritis or rheumatoid arthritis, primary TKA Exclusion: (1) had cognitive or sensory deficits; (2) did not understand or speak English; (3) were undergoing another surgical procedure prior to or during the TKA; or (4) weighed 136 kg or more **Mean (SD) age:** Study group: 65.7 (1.6) Control group: 70.2 (1.3) **Gender (%):** Study group: 65% female Control group: 64% female **Number lost to follow up:** None
Interventions	**Type of CPM used:** Sutter CPM 9000 or Sutter CPM 2000 machines. **Study group:** CPM + standard care. CPM commenced postoperative day 0. Provided "as much as possible". Increased daily as tolerated. Continued at least one week **Control group:** Standard care. Standard care for study group, control group Commenced postoperative day 1. Provided daily. Included unspecified ROM exercises, gait, training, transfer training, education, moist heat, strength and ROM exercises **Investigations used to make the diagnosis of thrombosis:** clinically or venographically
Outcomes	**Outcomes included in this review:** 1. DVT (Diagnosis method: not reported) 2. Postoperative pain 3. Delayed wound healing **Other outcomes:** Active and passive knee range of motion, quadriceps strength at postoperative day 7, length of hospital stay, active and passive range of motion and function at 6 weeks after operation, complications
Notes	Eleven patients who had delayed wound healing problems included wound haematoma (five patients), wound drainage at 24 to 48 hours (three patients), heel decubitus (one patient), wound healing problem in contralateral total knee replacement (one patient);

Mclnnes 1992 (*Continued*)

	and delayed healing (one patient). But the concrete details were not provided

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "The remaining 103 eligible patients were randomised into two groups"... . However, does not state how randomisation schedule was generated
Allocation concealment (selection bias)	Unclear risk	No description about the generation of allocation sequence and process of recruiting the participants, therefore the allocation concealment is judged 'unclear'
Blinding (performance bias and detection bias) All outcomes	Low risk	States: "All postoperative data except self-rated pain and function were collected by a physical therapist not involved with the subject's care and blinded to whether the patient was using CPM. Blinding was accomplished by removing the patients from the CPM machine and transporting them to another location for measurements. Patients were asked not to mention use of CPM."
Incomplete outcome data (attrition bias) All outcomes	Low risk	93/93 were present at follow up
Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	Low risk	Age and gender composition was balanced among groups.

Montgomery 1996

Methods	**Design:** Randomised trial **Method of randomisation:** Not described **Method of allocation:** Not described **Blinding of outcomes assessors:** Not described
Participants	**Source population:** Not described **Sample size:** Study group: 28 Control group: 32 **Subject selection:**

Montgomery 1996 (*Continued*)

	Inclusion: Gonarthrosis/knee osteoarthritis, had an uncemented PCA (porous-coated anatomic) prosthesis Exclusion: Not described. **Mean (SD) age:** Study group: 74 (5) Control group: 76 (6) **Gender (%):** Study group: 85.7% female Control group: 75% female
Interventions	**Type of CPM used:** Kinetec machine. **Study group:** CPM + active physical therapy. CPM was applied for 3 hours three times daily, 7 days a week. The range of motion was adjustable and it was increased until the patient experienced pain. The speed varied between 2 and 6 minutes per cycle and it was also adjusted up to the levels of pain **Control group:** Active physical therapy. Active physical therapy, which was initiated on the first postoperative day and continued until discharge, implied active and passive motion exercises of the knee, assisted by a physiotherapist 30 minutes twice daily, 5 days a week. Self-training was encouraged and instructions in proper walking technique were given
Outcomes	**Outcomes included in this review:** 1. Knee swelling 2. Postoperative pain **Other outcomes:** Length of hospital stay, Knee flexion at discharge
Notes	Three patients had superficial wound complication, one patient had DVT and one patient had myocardial infarct. They were excluded from the study

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	High risk	States: "8 patients were excluded from the study, 6 patients assigned to the CPM group-inadequate CPM program (3) , immobilization because of a superficial wound complication..."

Selective reporting (reporting bias)	Unclear risk	No description of the protocol was registered.
Other bias	Low risk	No indication of other bias.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Beaupré 2001	No relevant clinical outcomes.
Davies 2003	Uses the same participants as Beaupré 2001. No relevant clinical outcomes.
Gose 1987	Design: not RCT.
Kim 2009	Design: not RCT, states: "Randomization of the knees for the postoperative rehabilitation protocol was determined by the operation days of the surgeon, which were every Monday and Thursday)
Kusswetter 1991	Design: not RCT.
Lenssen 2003	Data error: in table 2, in the CPM group, it states: "n = 20, Gender (male/female): 6/15", in the PT group, it states: "n = 20, Gender (male/female): 7/12"
London 1999	Comparison: one protocol of CPM versus another protocol of CPM
Lotke 1991	Design: not RCT.
Lynch 1990	Design: not RCT.
Maloney 1990	Design: not RCT.
Pope 1997	Design: not RCT.
Rader 1998	Intervention: CPM for the ankle.
Ververeli 1995	Design: not RCT.
Vince 1987	Design: not RCT.
Xu 2001	Design: not RCT.

Characteristics of studies awaiting assessment *[ordered by study ID]*

Aubriot 1993

Methods	Unable to obtain full text. Unable to determine if eligible.
Participants	
Interventions	
Outcomes	
Notes	

Scheidhauer 2003

Methods	Unable to obtain full text. Unable to determine if eligible.
Participants	
Interventions	
Outcomes	
Notes	

Sosin 2000

Methods	Unable to obtain full text. Unable to determine if eligible.
Participants	
Interventions	
Outcomes	
Notes	

DATA AND ANALYSES

Comparison 1. CPM group versus control group

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incidence of DVT	4	361	Risk Ratio (M-H, Fixed, 95% CI)	1.27 [0.87, 1.86]
2 Incidence of PE	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 Minor bleeding	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.1 Scar bleeding	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4 Knee haematoma	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Blood drainage	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
6 Delayed healing	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Postoperative pain	2	114	Mean Difference (IV, Random, 95% CI)	-4.52 [-16.61, 7.57]
8 Knee swelling	3	174	Mean Difference (IV, Fixed, 95% CI)	-0.28 [-1.17, 0.62]

Analysis 1.1. Comparison 1 CPM group versus control group, Outcome 1 Incidence of DVT.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 1 Incidence of DVT

Study or subgroup	CPM group n/N	Control group n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Alkire 2010	0/32	0/32		0.0 [0.0, 0.0]
Denis 2006	1/27	0/27		3.00 [0.13, 70.53]
Lynch 1988	34/75	28/75		1.21 [0.83, 1.78]
McInnes 1992	1/48	0/45		2.82 [0.12, 67.40]
Total (95% CI)	**182**	**179**		**1.27 [0.87, 1.86]**

Total events: 36 (CPM group), 28 (Control group)

Heterogeneity: Chi?? = 0.58, df = 2 (P = 0.75); I?? =0.0%

Test for overall effect: Z = 1.24 (P = 0.21)

Test for subgroup differences: Not applicable

Analysis 1.2. Comparison 1 CPM group versus control group, Outcome 2 Incidence of PE.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 2 Incidence of PE

Study or subgroup	CPM group n/N	Control group n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Lynch 1988	0/75	0/75		0.0 [0.0, 0.0]

Analysis 1.3. Comparison 1 CPM group versus control group, Outcome 3 Minor bleeding.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 3 Minor bleeding

Study or subgroup	CPM group n/N	Control group n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
1 Scar bleeding				
Denis 2006	0/27	1/27		0.33 [0.01, 7.84]

Analysis 1.4. Comparison 1 CPM group versus control group, Outcome 4 Knee haematoma.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 4 Knee haematoma

Study or subgroup	CPM group n/N	Control group n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Denis 2006	1/27	1/27		1.00 [0.07, 15.18]

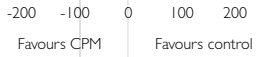
Analysis 1.5. Comparison 1 CPM group versus control group, Outcome 5 Blood drainage.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 5 Blood drainage

Study or subgroup	CPM group N	Mean(SD)	Control group N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Harms 1991	55	592 (352)	58	550 (439)		42.00 [-104.35, 188.35]



Analysis 1.6. Comparison 1 CPM group versus control group, Outcome 6 Delayed healing.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 6 Delayed healing

Study or subgroup	CPM group n/N	Control group n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Johnson 1992	2/26	6/30		0.38 [0.08, 1.74]

Analysis 1.7. Comparison 1 CPM group versus control group, Outcome 7 Postoperative pain.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

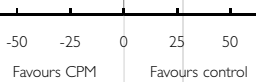
Outcome: 7 Postoperative pain

Study or subgroup	CPM group N	Mean(SD)	Control group N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Denis 2006	27	27.7 (17.1)	27	39.8 (24.8)		39.8 %	-12.10 [-23.46, -0.74]
Lenssen 2008	30	15.8 (4.7)	30	15.3 (4.1)		60.2 %	0.50 [-1.73, 2.73]
Total (95% CI)	**57**		**57**			**100.0 %**	**-4.52 [-16.61, 7.57]**

Heterogeneity: Tau?? = 61.93; Chi?? = 4.55, df = 1 (P = 0.03); I?? =78%

Test for overall effect: Z = 0.73 (P = 0.46)

Test for subgroup differences: Not applicable

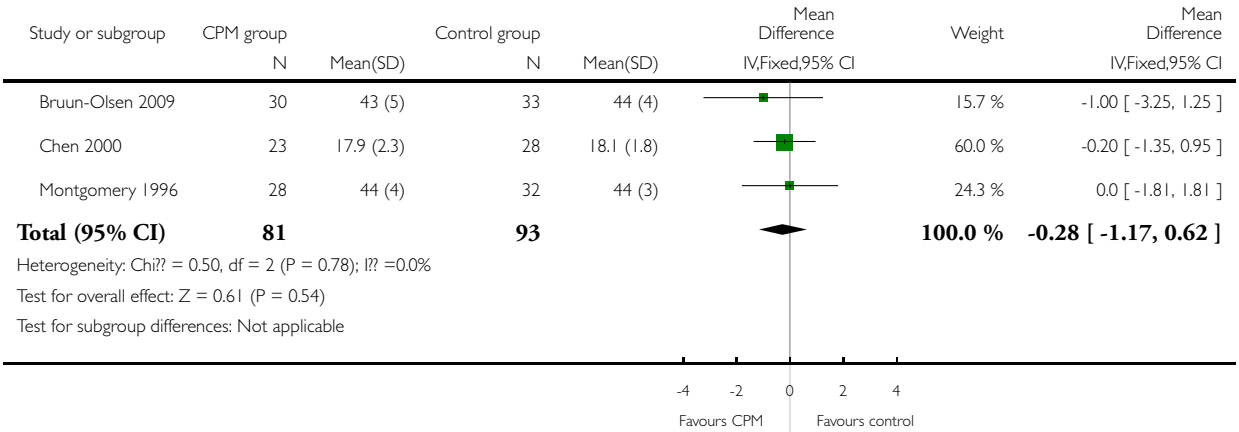


Analysis 1.8. Comparison 1 CPM group versus control group, Outcome 8 Knee swelling.

Review: Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty

Comparison: 1 CPM group versus control group

Outcome: 8 Knee swelling



APPENDICES

Appendix 1. PVD group CENTRAL search strategy

#1	MeSH descriptor Arthroplasty, Replacement, Knee explode all trees	1091
#2	MeSH descriptor Knee Prosthesis explode all trees	460
#3	MeSH descriptor Knee explode all trees with qualifier: SU	147
#4	(knee* and (replace* or arthroplast* or prosthe* or endoprosthe* or implant))	2510
#5	tka	283
#6	MeSH descriptor Motion Therapy, Continuous Passive explode all trees	99
#7	MeSH descriptor Exercise Therapy, this term only	3890

(*Continued*)

#8	MeSH descriptor Exercise Movement Techniques, this term only	64
#9	physical NEXT therap*:ti,ab	1375
#10	physiotherap*:ti,ab	2358
#11	continuous near3 motion	209
#12	cpm:ti,ab	206
#13	gait NEXT therap*:ti,ab	8
#14	exercis* near3 therap*:ti,ab	972
#15	kinesioth*.ti,ab	7918
#16	(#1 OR #2 OR #3 OR #4 OR #5)	2653
#17	(#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15)	15603
#18	(#16 AND #17)	168

Appendix 2. MEDLINE search strategy

1 Arthroplasty, Replacement, Knee/ (8243)
2 Knee Prosthesis/ (6938)
3 Knee/su [Surgery] (1992)
4 (knee and (replace$ or arthroplast$ or prosthe$ or endoprosthe$ or implant)).ti,ab. (16192)
5 tka.ti,ab. (1994)
6 or/1-5 (20209)
7 exercise movement techniques/ or exercise therapy/ or motion therapy, continuous passive/ (20631)
8 physiotherap$.ti,ab. (10510)
9 (physical adj3 therap$).ti,ab. (10859)
10 (continuous adj3 motion).ti,ab. (667)
11 cpm.ti,ab. (3647)
12 ((gait or exercise) adj3 therap$).ti,ab. (3398)
13 kinesioth$.ti,ab. (71)
14 or/7-13 (44960)
15 6 and 14 (580)

Appendix 3. EMBASE search strategy

Database: EMBASE <1980 to 2011 Week 03>
Search Strategy:

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1 kinesiotherapy/ (18162)
2 dynamic exercise/ (1595)
3 movement therapy/ (973)
4 passive movement/ (1585)
5 exp physiotherapy/ (39981)
6 (physical adj therap$).ti,ab. (12638)
7 physiotherap$.ti,ab. (16587)
8 cpm.ti,ab. (4317)
9 (gait adj3 therap$).ti,ab. (169)
10 (exercis$ adj therap$).ti,ab. (1893)
11 (therapeutic adj3 exercis$).ti,ab. (1251)
12 passive motion.ti,ab. (1000)
13 or/1-12 (77494)
14 exp knee arthroplasty/ (19004)
15 exp knee prosthesis/ (4809)
16 (knee$ and (replace$ or arthroplast$ or prosthe$ or endoprosthe$ or implant$)).ti,ab. (21527)
17 tka.ti,ab. (2504)
18 knee/su [Surgery] (3889)
19 or/14-18 (28942)
20 13 and 19 (1313)

HISTORY

Protocol first published: Issue 1, 2010

Review first published: Issue 1, 2012

CONTRIBUTIONS OF AUTHORS

Mao Lin He and Zeng Ming Xiao: responsible for searching for trials and data extraction, quality assessment, and development of review.

Ming Lei, Ting Song Li, Hao Wu and Jun Liao: analysis and interpretation of data, quality assessment, development of review.

Mao Lin He: contributed to contacting the original authors for missing data and data input.

DECLARATIONS OF INTEREST

None known

SOURCES OF SUPPORT

Internal sources

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the protocol, we planned to extract DVT events diagnosed by venography or sonography, but some studies (Alkire 2010; Denis 2006; Mclnnes 1992) just described DVT events without reporting how they were diagnosed. Therefore, in this review, we extracted DVT events without restrictions on how they were diagnosed.

In the protocol we planned to consider superficial vein thrombosis as an adverse event. After obtaining further advice we decided that superficial vein thrombosis is not an adverse event resulting from CPM and therefore we did not include superficial vein thrombosis in the assessment of adverse events.

INDEX TERMS

Medical Subject Headings (MeSH)

Arthroplasty, Replacement, Knee [*adverse effects]; Motion Therapy, Continuous Passive [*methods]; Pulmonary Embolism [*prevention & control]; Venous Thromboembolism [*prevention & control]; Venous Thrombosis [*prevention & control]

MeSH check words

Humans