

# A Comparison of Two Different Ways of Treating Knee Replacement Patients with Continuous Passive Motion (CPM)

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## ABSTRACT

*The purpose of this study was to compare the effect of CPM given for 3 hours a day for group A and CPM and CPM given for 10 hours a day for group B. Each group consisted of 15 subjects who had undergone knee replacement after suffering from osteoarthritis. The variable analysed was knee flexion recovery. The result showed no significant difference in the recovery periods between the two groups. The patients in group A obtained 90 degrees flexion of the knee not later than the patients in group B who received 10 hours CPM a day. The conclusion can be drawn that patients had no added benefit of staying on CPM for 10 hours a day compared to 3 hours a day.*

## INTRODUCTION

Osteoarthritis, which is the most common rheumatic disease has significant social and economic implications. Patients with osteoarthritis are typically in their middle or later years with the large weight-bearing joints (hips and knees) being most commonly affected<sup>10</sup>. Moreover, the primary complaint and the greatest cause of disability for these patients is pain localised to the affected joints which can severely reduce functional ability and undermine work performance.

Osteoarthritis of the knee should be regarded as the end result of abnormal mechanical inflammatory, metabolic, physiological or pathological factors. There are two obvious pathological processes in osteoarthritis, the progressive destruction of articular cartilage, and the formation of osteophytes at

the margins of the joint. Eventually this may lead to the bone being completely denuded of cartilage and thus the bone end by becoming exposed and eroded. New bone formation starts and may be responsible for some restriction of movement and pain<sup>11</sup>.

Despite the significant impact of osteoarthritis there is as yet no cure<sup>5</sup>. Much effort has been placed on reducing the pain accompanying the disease by means of different physical therapy modalities or by analgesic medication and nonsteroidal anti-inflammatory drugs<sup>11,17</sup>. However, prolonged medications may increase the risk of adverse reaction with the osteoarthritic patient especially if he has concomitant renal, cardiac or liver condition<sup>17</sup>.

Most people who suffers from osteoarthritis may never need a joint replacement. However, if a knee replacement does become necessary now the patient is in a better position than at any time in medical history owing to the recent

advancement in joint replacement and post operative care<sup>18</sup>.

Post-operative care following knee replacement has progressed further recently owing to the use of continuous passive motion (CPM). CPM is an electronically powered device which enables the patients joints to be moved through a set range at a set rate. Both the rate and range can be varied as required<sup>3</sup>.

The aim of CPM treatment is to prevent the effects of new collagen that are being laid down. Joint stiffness may be the end result when no stress is applied to these fibres. They will be deposited randomly and therefore cause resistance to joint movement<sup>21</sup>.

Rest followed by mobilisation has been the most common treatment after a knee replacement until the last few years. A plaster cast would be applied for 2-3 days, then an exercise program to increase the range of movement and muscle power. Today, it is accepted that joints will stiffen if they are not moved from the beginning<sup>6</sup>. Valuable time will then be spent on recovering and improving the range and muscle strength. Today many surveys show that by applying CPM straight after surgery better results will be achieved.

Clinical studies<sup>3,4</sup> comparing between the use of CPM and immobilisation reported that CPM cleared blood in haemarthrosis twice as fast as immobilisation. It also assists the return of blood and lymph by providing a pump action.

Postoperative observation on patients who received CPM after knee replacement and patients who received active exercises postoperatively demonstrated that the patients who received CPM required less analgesia 3-4 days postoperatively than the other group<sup>2</sup>.

The effect of CPM given for a minimum of 20 hours a day and a maximum of 5 hours a day was studied in two groups of patients who

had undergone knee replacement<sup>1</sup>. The result showed that patients who received CPM for 20 hours a day had an average knee flexion gain of 10.5 degrees from day 3 to 6, which was twice that for patients receiving 5 hours CPM a day. However, within the second week of treatment there was no significant difference between the two groups. The study also expected the pain to be reduced, swelling decreased and shorter hospital stay for patients who had longer duration of CPM. The result showed no significant difference between the two groups of patients in this respect.

Therefore, the aim of this study was to investigate if further reduction in the time of treatment with CPM would affect the treatment outcome differently than previous studies.

## METHOD

Thirty patients suffering from osteo-arthritis of the knee who undergone a total knee replacement operation were involved in this study. All the patients were treated at the Orthopaedic Department of the Birmingham Nuffield Hospital (UK). The patients were randomly allocated into two groups. Group A included 15 patients (11 females and 4 males) and group B included 15 patients (9 females and 6 males). The average age of patients in group A was 67.5 years ranging between 53 and 74 years. Patients in group B were of an average age of 64.5 years and ranging between 47 and 76 years. All the patients suffered from osteoarthritis of the knee prior to the operation. None had any major complication during the operation. No attempts were made to control the technique used under the operation, prosthetic design or preoperative physical therapy evaluation. Prior to the operation every patient had received some sort of

physiotherapy input. Pain relief, muscle strengthening and general advice was the most common input.

Two different CPM settings were advocated in the treatment of the two groups of patients. Patients in group A received CPM treatment for 3 hours a day. Patients in group B received CPM treatment for 10 hours a day. The aim was to determine if patients receiving CPM for 10 hours a day would have an enhanced recovery more than the patients receiving CPM 3 hours a day. Subjects in both groups stayed on CPM continuously except when receiving physiotherapy treatment or going to the toilet.

A variety of protocols in applying CPM have been developed based on individual surgeon's experience, surgical response and the patients condition. In this study it was agreed to apply CPM on the second day of the operation. The CPM machine was set for each patient firmly on the bed so that it did not slide. Cover was applied for the well being of the patient. Before adjusting the arc of motion of the CPM the procedure was explained to the patient so that he or she understood what was happening in order not to resist the machine or panic. Also the time and duration on CPM was discussed with the patient before the treatment started.

The arc of motion for the joint was set and adjusted daily based on the existing active range of motion the patient could independ-

ently achieve and sometimes according to the patient's tolerance. The CPM was applied at the rate of one cycle per minute for the first half hour of the treatment to accommodate the patient and then increased to two cycles.

The progress of treatment for each patient was based only on assessing the active range of knee flexion. Measurements of the range of motion were taken daily before the application of CPM in order to adjust the arc of motion of the machine and after the patient had finished his daily CPM treatment. A standard manual goniometer was used for measuring the gain in the range of motion.

Each patient in addition to CPM was given other forms of physiotherapy such as active exercises for the involved and noninvolved limb, maintenance exercises and gait training with partial weight bearing. In addition to patients receiving pain relief drugs, cold application was occasionally used to relieve pain.

## RESULTS

The results of this study showed that patients in group A who received 3 hours CPM a day on average reached 90 degrees of flexion after 13 days of treatment. In comparison, patients in group B who received 10 hours CPM a day reached 90 degrees of knee flexion after 12 days of treatment ( see figures 1 to 4).

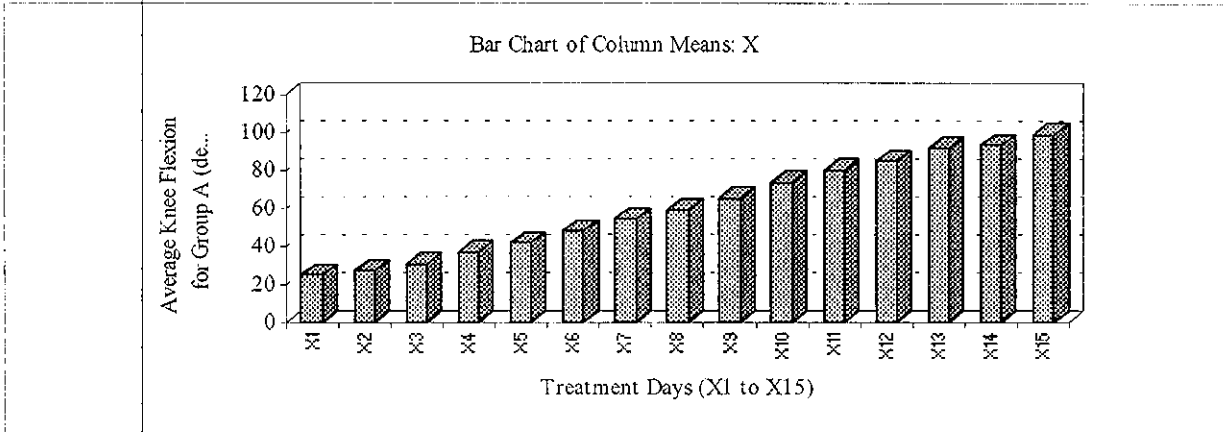


Figure (1): Progressive increase in the range of knee flexion along 15 days of 3 hours CPM treatment a day for patients in group A.

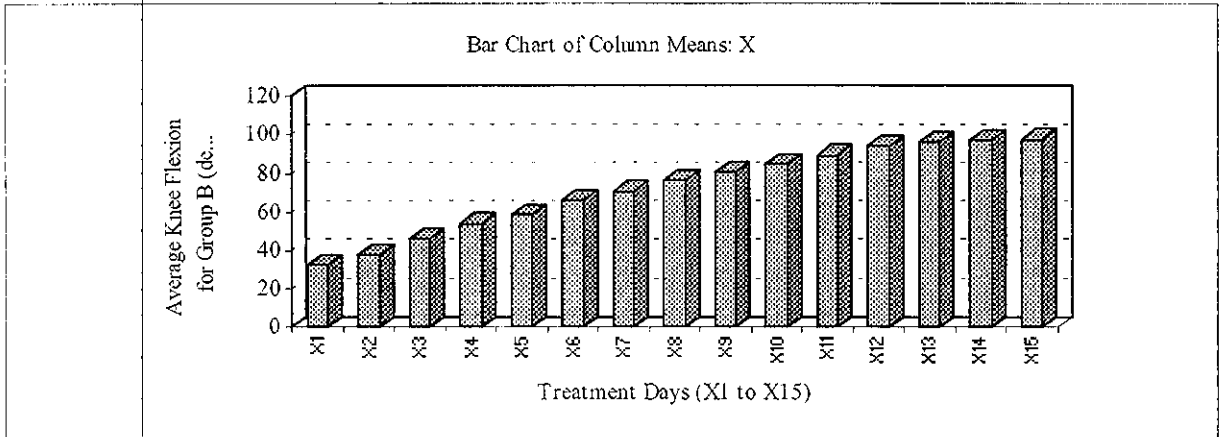


Figure (2): Progressive increase in the range of knee flexion along 15 days of 10 hours CPM treatment a day for patients in group B.

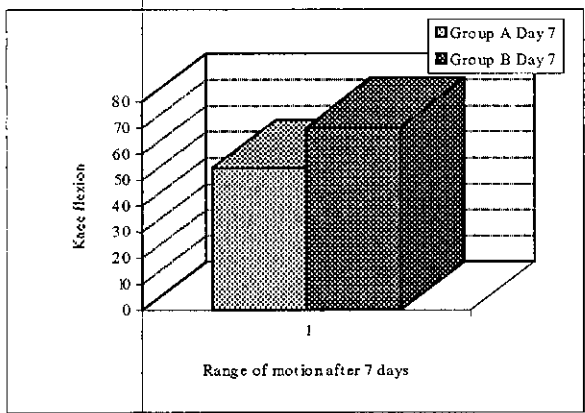


Figure (3): Histogram showing the range of knee flexion after 7 days of CPM.

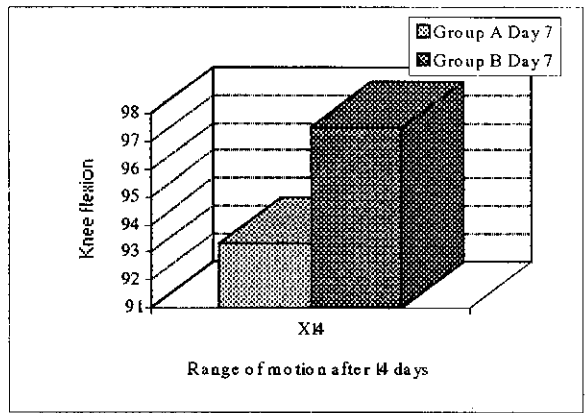


Figure (4): Histogram showing the range of knee flexion after 14 days of CPM.

Table 1 summarises the results and the statistical comparison between the two groups along 15 days of CPM treatment. From the table it can be observed that patients in group B had shown a significant gain in the range of knee flexion more than patients in group A. However, from day 13 statistical comparison between the two groups showed no significant difference in the range of flexion. In both groups the range of flexion exceeded 90 degrees after day 12.

**Table (1): Results of CPM treatment in group A and B.**

Treatment days	Mean flexion range		Unpaired t	Probability
	Group A	Group B		
1	24.3 (04.2)	32.5 (10.1)	-2.39	< 0.025
2	26.8 (03.4)	37.3 (11.4)	-2.94	< 0.005
3	30.5 (05.5)	46.1 (13.7)	-4.10	< 0.0005
4	36.6 (07.3)	53.6 (14.2)	-40.1	< 0.0005
5	41.5 (08.0)	58.4 (12.5)	-4.34	< 0.0005
6	84.0 (09.3)	66.1 (11.4)	-4.58	< 0.0005
7	54.5 (10.0)	70.5 (12.4)	3.70	< 0.005
8	58.9 (10.1)	75.9 (13.3)	-3.82	< 0.0005
9	65.1 (11.7)	80.1 (13.3)	-3.28	< 0.005
10	73.9 (11.6)	84.6 (12.7)	-2.34	< 0.025
11	80.0 (12.3)	89.4 (13.0)	-1.96	< 0.025
12	85.1 (12.2)	93.9 (11.7)	-2.00	< 0.05
13	91.5 (11.4)	96.0 (10.6)	-1.09	NS
14	93.3 (08.9)	97.5 (09.9)	-1.07	NS
15	99.0 (09.4)	97.8 (09.9)	+0.24	NS

N.S = not significant

## DISCUSSION

The results of this study showed that patients who have undergone knee replacement and received CPM for 10 hours a day in conjunction with other forms of physiotherapy treatment had a significant increase in the range of knee flexion for 12 days of treatment in comparison to those who received CPM 3 hours a day. However, after treatment no significant difference in the range of motion was observed between the two groups of patients. Both group of patients have exceeded

90 degrees of flexion toward the end of two weeks. These results contradict with the expectation that an increase in time spent on CPM would further increase the range of knee flexion and shorter hospital stay.

Basso and Knapp<sup>1</sup> compared the effects of CPM given for a minimum of 20 hours a day and a maximum of 5 hours a day in two groups of patients who had undergone knee replacement. The results showed that patients who received 20 hours CPM a day had an increase in the range of flexion twice the amount of those who received 5 hours a day.

These results were obtained from treatment day 3 to 6. However, at the end of treatment there were no significant difference between the range of flexion in the two groups of patients. The authors also expected the pain to be reduced, effusion decreased and a shorter hospital stay for patients who had a longer duration of CPM. Their results showed no significant difference between the two groups in respect to pain, effusion and hospital stay.

The results in this study and those of Basso and Knapp<sup>1</sup> correspond when linking time dosage on CPM to knee flexion achievement. When looking at the amount of flexion that was achieved by group A and group B in this study after 7 days of treatment, there is a marked difference. Group B had reached an average of 70.5 degrees of knee flexion while group A had reached an average of 54.5 degrees. When taking into account the physiological and psychological benefits of being able to increase the range of motion in the knee joint there is a possibility that a longer duration of CPM in the first week has its role. Even, if the result toward the end of the treatment period is not significant still there is a difference. If patients are increasing their movement by a greater number of degrees each day, it will give them a more positive view and enhance their efforts further. Salter et al.<sup>20</sup> and Campbell<sup>2</sup> reported that CPM was most effective during the first 5-7 days when it prevented the formation of adhesions and the laying down of fibrous tissues. Basso and Knapp<sup>1</sup> also identified an important trend linking physiotherapy treatment to length of hospital stay. They suggested that the hospital stay tended to be shorter if more physiotherapy treatment was received in the first 6 days after surgery. Therefore the optimum treatment programme should include CPM for a longer period of time as an adjunct to physiotherapy

treatment during the first week. A study<sup>9</sup> on the role of cold compression dressings in the post operative treatment of knee replacement showed that cold compressions provided significant benefits. Not only did blood loss, swelling and pain decrease, but also there was early increase in range of motion. These are all the same factors that CPM are working to improve. Therefore, CPM in conjunction with cold compression in early stages may influence even better results for knee replacement patients. Later on, physiotherapy treatment such as active and passive movement, gait training, transfers and stairs should generally increase while CPM dosage decreases<sup>1,3</sup>.

Ritter and Gondolf<sup>14</sup> compared CPM with active exercises and found no differences in movement and swelling. But the CPM group who had done no active exercises generally had more quadriceps lag, tighter hamstrings and weaker knees than the exercise group. It would then appear that CPM does not have much value on its own since the range gained passively will not be maintained unless it can be performed actively.

When determining the success of a knee replacement and its post operative treatment, knee flexion is not the only measure of success. Long term results indicate that the pain should be less, functional range of movement (0-100 degrees) and that the gait pattern shows no correlation to the type of prosthesis implanted<sup>15</sup>.

Since most studies show a decrease in days spent in hospital it seems that CPM has a role to play. When considering the results of this study and Basso and Knapp<sup>1</sup> where no significant difference in the knee flexion gain was observed. Most studies however, state that a minimum of 2 hours a day should be sufficient to produce the desired result. This could have great influence on the economical

issue. If the CPM machine could be distributed amongst patients on the ward, fewer machines would be required. Coutts et al.,<sup>3</sup> reported that recovery rate was improved by decreasing post operative pain, enhancing wound healing and increasing range of motion by the time of discharge. Since CPM increases the range of motion the physiotherapist can concentrate on muscle strengthening and functional activities, which is the most important part of the treatment programme.

The trend nowadays in most countries is towards hospital trusts where each hospital is responsible for its own costs. Coutts et al.,<sup>3</sup> reported that a CPM machine costs about two thousands Sterling pounds plus ongoing repair and maintenance costs. Lake and Moore<sup>8</sup> stated that the most effective regime could be developed. As reported in this study and Basso and Knapp<sup>1</sup> a shorter duration of CPM is as effective as a longer duration. Therefore, the need for CPM machines would be reduced because the machine can be used on several patients. This will not only satisfy us as physiotherapists but also the administration of the hospital who do not have to spend thousands of pounds on CPM machines. Harms and Engstrom<sup>7</sup> stated that CPM together with physiotherapy treatment decreased costs because of shorter length of stay, less out patients physiotherapy treatment required, fewer complications and reduced need for manipulation under anaesthetic. So most surveys state that the use of CPM decreases the cost per patient and that the patient benefits from a regime in which CPM is used.

## CONCLUSION

The results of this study have demonstrated that CPM dosage of shorter duration is as effective as CPM of longer duration. This implicates a better distribution of CPM machines on the hospital ward since 3 hours dosage a day showed no significant difference in range of motion at the end of hospital stay from a dosage of 10 hours CPM a day. However, when looking at shorter post operative effects, patients who received 10 hours CPM dosage had reached after one week an average of 70.5 degrees of knee flexion compared to 54.5 degrees in patients who received 3 hours CPM a day. That leads to the assumption that CPM of longer duration is most beneficial during the first week postoperatively. Also, several studies by many authors have reported that long CPM use increases range of motion significantly and also reduces pain within 7 days postoperatively. Therefore it can be assumed that the decrease in pain and increase in range of movement may work together in improving the psychological state of the patient and thus also affect the progress of physical strength and function. This assumption would have a possible implication particularly with patients who had undergone surgery for other reasons than knee replacement.

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### المختصر العربي

## مقارنة بين طريقتين لتمارين مرضى استبدال مفصل الركبة

### باستخدام جهاز التحريك السلبي المتواصل

إن الغرض من هذه الدراسة هو مقارنة تأثير جهاز التحريك السلبي المتواصل لمجموعة (أ) لمدة ثلاثة ساعات يوميا وأخرى مجموعة (ب) لمدة عشرة ساعات يوميا . وكل مجموعة تتكون من خمسة عشر شخصا أجرى لهم تغيير مفصل الركبة بعد خشونة مزمنة بهم هذا التقييم مدى ثنى الركبة . وأوضحت النتائج أنه لا توجد اختلافات في النسب في فترة الشفاء لدى المجموعتين . المرضى في المجموعة (أ) وصلوا إلى ٩٠° في ثنى الركبة في نفس التوقيت لدى المجموعة (ب) التي استخدمت عشر ساعات . والمحصلة تفيد أنه لا جدوى ترجى من استخدام جهاز التحريك السلبي المتواصل لمدة عشرة ساعات يوميا مقارنة بثلاثة ساعات يوميا .