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Clinical outcomes of Continuous Passive Motion vs. No Continuous Passive Motion for TKA patients, and its validity: A Comparative Study

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ABSTRACT
Purpose: To identify the necessity and post-operative usefulness of CPM for the recovery of knee joint function for patients post. Total knee arthroplasty (TKA).
Methods: It is a retrospective study with analysis of data and direct patient feedback. Data from all the patients that underwent TKA during a certain time period was collected. Out of 40 patients, 20 received CPM and 20 of them did not. Subsequently, the signs and symptoms that chiefly centered on range of motion of knee joint, pain, length of hospital stay or the time taken for gaining of normal pre-operative joint function was documented and analyzed.
Results: It was seen that CPM did not significantly alter the clinical recovery of TKA patients. The results of CPM and no CMP were similar.
Conclusion: Based on our findings, we found that following TKA, post-operative clinical maneuvers alone are enough for recovery. Thus we can conclude that routine practice or mandatory application of CPM is not necessary and does not influence the clinical outcome in patients undergoing TKA.
Keywords: Total knee arthroplasty (TKA) / Continuous passive motion (CPM) / Physical therapy (PT) / Range of motion (ROM) / Rehabilitation

I. INTRODUCTION

The concept of early rehabilitation following Total Knee Arthroplasty (TKA) or Total Knee Replacement (TKR) is not a new one. Continuous Passive Motion (CPM), and the possibility of its use after TKA to assist in achieving range of movement (ROM) is widely known in orthopedic medicine and physiotherapy. However, its use varies widely. In some hospitals it is not used at all; in some it is used only if the patients are unable to gain sufficient ROM by other means, while in others it is applied routinely to all patients who have undergone a TKA.

RB Salter came up with the concept of continuous passive motion, which has come to be known simply as "CPM". He derived this concept on the basis of a series of experimental investigations and well thought-out rationale. In 1960,Salter and Field[1] showed that immobilization of a rabbit knee joint under continuous compression, provided by either a compression device or forced position, resulted in pressure necrosis of the cartilage. Again, in 1965, Salter et al. [2]reported deleterious effects of immobilization on the articular cartilage of rabbit knee joints and the resultant lesion that they termed "obliterative degeneration of articular cartilage." Salter [3]believed that "The relative place of rest and of motion is considerably less controversial on the basis of experimental investigation than on the basis of clinical empiricism". He reasoned that because immobilization is obviously unhealthy for joints, and if intermittent movement is healthier for both normal and injured joints, then perhaps continuous motion would be even better. Because of the fatigability of skeletal muscle, and because a patient could not be expected to move his or her own joint constantly, he concluded that for motion to be continuous it would also have to be passive. He also believed that CPM would have an added advantage, namely that if the movement was reasonably slow, it should be possible to apply it immediately after injury or operation without causing the patient undue pain. This idea was based on the gate-control theory of pain by Melzack and Wall [4]that with competing afferent sensory stimulation, painful stimuli would be inhibited. The concepts, tested in patients since 1978, have proven to be feasible.[5] Over time, clinicians have adopted the use of CPM into their regular practice.

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Knee flexion range of motion (ROM) has usually been considered the primary outcome measure to evaluate both the short-term effectiveness (measured at the end of the hospital stay) and long-term effectiveness (measured 2–12 months after TKA).Most researches have shown that long-term CPM for knee flexion ROM is ineffective ; [6-15] however, there is still controversy regarding its short-term effectiveness. Studies have reported significant knee flexion ROM gains of between 7 and 22 degrees (relative to results for control groups)[6,10-18] or faster knee flexion recovery during the hospital stay.[12,16-20] However, in these studies, the duration of CPM applications varied from 10 hours to 24 hours per day and were performed during 2 to 7 days after TKA.[6,10,12-18] In the majority of these studies, subjects' knees in the control group were immobilized for 2 to 7 days, whereas subjects in the experimental groups received early postoperative CPM applications. [6,13,15] These experimental conditions vary from normal practice and thus their clinical significance is questionable. In addition, description and standardization of knee flexion measurements have been neglected in many experiments, and only a few studies have provided detailed methodology. [6,7,20-23] Other researchers [24,20-23,25,26] have concluded that CPM applications do not provide any additional gains in knee flexion at the end of the hospital stay. In a large proportion of these studies, knee flexion exercises in the control group began when CPM applications were initiated in the experimental groups. [7,21,25,26] However, either knee flexion ROM measurements were performed 11–22 days after TKA [24,19,20,23] or CPM application parameters were not applicable for actual practice. [9,11,25,27]

II. MATERIALS AND METHODS

DATA COLLECTION

Data was collected from the patients undergoing Total Knee Arthroplasty who were admitted to our First Affiliated Hospital of Anhui Medical University Orthopedics Department from June 2014-November 2015. A total of 40 cases that underwent TKA followed by physical therapy or CPM with physical therapy were considered. 20 patients were on the CPM group and 20 on the non CPM group.

There were cased including osteoarthritis and rheumatoid arthritis. Cases were considered independent of the operative diagnosis. The indications for surgery in all the cases were pain and limitation of knee movement.

Implants from Zimmer and Aesculap were used, considering both; the cost of the implant, and the requirement of the patient.

PRE-OPERATIVE PREPARATION

Routine pre-operative investigations were done in all patients. These included chest x-ray, complete blood count (CBC), liver function test (LFT), renal function test (RFT), electrocardiogram (ECG) and serology. Color Doppler of the leg was also done in all cases preoperatively and on the 5th day of surgery. Patients were put on Low Molecular Weight Heparin (LMWH), at a dose of 400 IU intradermal (i/d) in once daily dose for 2 weeks or till discharge for anticoagulation starting from the day of surgery. Prophylactic antibiotics were started to diminish the chance of infection.

PHYSICAL THERAPY AND CONTINUOUS PASSIVE MOTION PROTOCOL

Physical therapy was done 3 times a day, lasting 20 minutes each time.

Day 0/ Day 1: Foot and ankle pump exercises, static quadriceps, turning in bed, sitting in bed

Day 2/ Day3/ Day 4: All of the above, walking with walker, commode chair training, ROM at edge of the bed

Day 5/ Day 6: All of the above, increasing the walking distance, increasing the bending at the edge of the bed

Day 7: All of the above, Climbing stairs, 2-5 steps

CPM machine was used for the CPM group in addition to the physical therapy. CPM was done 2 times a day each day for 30 minutes.

PAIN MANAGEMENT PROTOCOL

All the patients were put on intravenous infusion of 50mg Flubiprofen, twice daily for 3 days, followed by Cap Tramadol 100mg per oral BD or Cap Celecoxib 200mg per oral BD for 1 week. Intramuscular injection of 100mg Tramadol or intramuscular injection of Diclofenac Sodium was given SOS. It is pertinent to note that none of the patients under study required significantly high doses of analgesics.

PATIENT SELECTION AND EXCLUSION CRITERIA

Random patients with different diagnoses were selected and equally divided into two groups. One group had been advised CPM along with physical therapy while the other group was advised only physical therapy. The choice of CPM or no CPM was based on the surgeon's preference. Age or sex biases were not considered, however, the vast majority of patients were females in geriatric age group. All the patients with major cardio vascular, respiratory and renal problems were

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excluded. None of the patients had any co-existing morbidity which could potentially limit their movement. No cases of bilateral TKA were considered.

EVALUATION CRITERIA

For the evaluation of comparative effectiveness of CPM and physical therapy, 4 variables were considered: Pain, mid-patellar thickness, ROM in flexion and ROM in extension. These values were recorded at Day 1, Day 3, Day 5 and Day 7 (Day 0 being the day of surgery).

III. RESULTS

There were total 40 patient admitted for Total Knee Arthroplasty. Among them, 36 were female patients and 4 were male. The age of the patients, including both the sexes, ranged from 57 to 84 years. The mean age was 67.7. Visual Analogue Score (VAS) was used as an indicator of pain, with 0 being the least and 10 being the most painful state.

Parameter	CPM	No CPM	p-value
Age (y) mean (SD)	67.8 (8.51)	67.2 (6.20)	0.54
Sex, M/F	3:17	1:19	0.686
Pain at rest #	1.55 (0.75)	1.6 (0.68)	0.798
ROM extension (degrees)	7.10 (11.16)	5.90 (10.43)	0.176
ROM flexion (degrees)	102.2 (15.59)	101.20 (20.98)	0.954
Mid patellar girth (cm)	37.20 (1.64)	38.25 (2.98)	0.093
Hemoglobin (gm/dl)	134.32 (14.5)	133.73 (16.97)	0.656
Hematocrit	41.23 (4.56)	40.36 (5.87)	0.934
HSS	53.0 (10.7)	49.0 (13.1)	0.082

Significant p <0.05; # Pain measured in VAS; HSS-Hospital for Special Scoring (Knee Score)

Table 1: Preoperative demographics of 2 groups and comparisons. This table shows the pre-operative demography of the cases under study. Even though the cases were chosen at random to avoid bias, both groups have comparable demographics with no significant statistical advantage of either group over the other.

		CPM Mean (SD)	No CPM Mean (SD)	p-value
Pain at rest (VAS)	Preoperative	1.55 (0.75)	1.60 (0.68)	0.798
	Day1	4.20 (0.89)	4.70 (1.12)	0.861
	Day3	2.70 (0.80)	3.50 (0.88)	1.000
	Day5	1.65 (0.74)	2.50 (1.27)	0.728
	Day7	0.40 (0.59)	0.85 (0.81)	0.312
ROM Flexion (degrees)	Preoperative	102.25 (15.59)	101.20 (20.98)	0.954
	Day1	32.25 (7.69)	33.75 (9.58)	0.117
	Day3	64.00 (11.98)	61.50 (9.47)	0.022*
	Day5	90.25 (8.95)	87.50 (6.97)	0.895
	Day7	104.00 (9.40)	102.50 (9.10)	0.328
ROM Extension (degrees)	Preoperative	7.10 (11.16)	5.90 (10.43)	0.176
	Day1	3.20 (5.17)	5.65 (2.97)	0.166
	Day3	2.55 (2.32)	4.05 (2.78)	0.526
	Day5	1.55 (1.82)	1.90 (2.63)	0.285
	Day7	0.200 (1.85)	0.15 (2.99)	0.251

*Significant p <0.05

Table 2: Comparison of Pain and ROM between the groups for all time intervals.

This table compares the Pain and ROM between the two groups. As we can see in the table above, the only parameter with a significant difference (as demonstrated by a P value of less than 0.05) was in the flexion range of motion, where the CPM group was shown to have an advantage over the no CPM group.

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		CPM Mean (SD)	No CPM Mean (SD)	p-value
Mid pat girth(cm)	Preoperative	37.20(1.64)	38.25(2.98)	0.093
	Day1	40.50(1.87)	41.75(3.27)	0.063
	Day3	39.85(1.78)	41.10(2.97)	0.183
	Day5	38.85(1.98)	40.20(2.94)	0.087
	Day7	38.55(1.76)	39.80(2.98)	0.040*
Drain (ml)		248.50(106.88)	299.00(113.78)	0.969
Length of Stay (Days)		9.95(3.95)	10.55(3.60)	0.352
Hemoglobin(gm/dl)	Preoperative	134.32(14.52)	133.73(16.97)	0.656
	Postoperative	112.49(10.46)	112.09(14.05)	0.841
Hematocrit	Preoperative	41.23(4.56)	40.36(5.87)	0.934
	Postoperative	32.73(4.93)	31.12(5.05)	0.426

*Significant p <0.05

Table 3: Comparison of Mid patellar girths, Drains (hemovac), Length of stay (LOS), Hemoglobin (Hb) and Hematocrit (Hct) within groups. Here we list the comparative difference of our other key parameters of evaluation i.e. mid patellar girth, drain from the surgical site, length of hospital stays, hemoglobin and hematocrit among the two groups.The only parameter with a significant difference (as demonstrated by a P valve of less than 0.05) was in the mid patellar girth on the seventh day, with CPM group having a significant advantage over the no CPM group.

IV. DISCUSSION

There have been contrasting views on the usefulness of CPM following Total Knee Arthroplasty, and the same exists in our hospitals, with some surgeons preferring the use of CPM, while some opting against it. During the course of this research, it was found that the use of Continuous Passive Movement machine offered only limited benefit over the use of physical therapy. Significant advantages of CPM, as shown by significant p values, were present only in 3rd post-operative day for ROM in flexion and in 7th post-operative day for knee swelling (mid-patellar girth).

PAIN AT REST

One of the key parameters for evaluation of benefit of use of CPM, pain at rest, was not demonstrated to be significantly lower in either of the groups. Pain at rest was lower in the CPM group preoperatively, and that trend continued till the seventh post-operative day with CPM group reporting lower pain levels as evaluated by VAS. But on none of the days was the difference in pain significant demonstrable by a p value less than 0.05.

ROM DURING FLEXION

The primary complaint of the patients, who eventually undergo TKA i.e. limited range of motion of knee during flexion, was an important parameter for evaluation of benefit of use of CPM over physiotherapy. The CPM group had an overall (insignificant) advantage over the no CPM group preoperatively in flexion ROM. On the first day of surgery, the no CPM group reported a better flexion ROM, while on the subsequent days; the CPM group reported a better flexion ROM. However, the only significant advantage the CPM group had over the no CPM group was on the third post-operative day, when the CPM group had flexion ROM of 64^0 as compared to flexion ROM of 61.5^o in no CPM group, which amounts to a p value of 0.022 (less than 0.05, therefore significant).

ROM DURING EXTENSION

Like ROM flexion, ROM during extension is an important parameter to measure the success of rehabilitation following TKA. Ideally, ROM of knee during extension should be as low as possible to lower the chances of recurvatum deformity.

During the course of our study, we found that use of CPM provided no significant advantage over physiotherapy for extension ROM. The CPM group had a greater extension lag preoperatively. Following surgery, the no CPM group showed a greater extension ROM, albeit insignificant when measured statistically by calculation of p value. The trend continued till the fifth post-operative day, but on the seventh post-operative day, no CPM group again had an advantage over the CPM group.

KNEE SWELLING (MID PATELLAR GIRTH)

Knee swelling is an objective parameter for monitoring the progress of rehabilitation following TKA and thus was considered as one of the key parameters for this study. Following the trend of other parameters, measurement of mid patellar girth was unable establish CPM as having a greater role during the rehabilitation process. The CPM group had lower mean mid patellar girth preoperatively and the trend continued in the post-operative period with CPM group reporting lower mid patellar girths on each of the days of measurement. However, the only significant difference in mid patellar girth quantifiable by a p value lower than 0.05 was on the seventh post-operative day. CPM group had a mean mid patellar girth of 38.5 cm while no CPM group had a mean mid patellar girth of 39.8 cm.

While the CPM group showed better outcome in every indicator considered for this study, the benefits were marginal at best. Considering gain in range of motion only, the benefit of CPM over only physical therapy can be considered non-existent. However, if we also consider pain and mid patellar girth, there seems to be slight albeit sure advantage of CPM over only physical therapy.

Conflict of Interest: The authors declare that they have no conflict of interest.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Compliance with ethical standards

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