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Effectiveness of continuous passive motion protocol as an adjunct to standard physiotherapy protocol for post-operative rehabilitation in Total Knee Arthroplasty (TKA) cases

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***Abstract*---**Osteoarthritis (OA) of the knee is a relatively prevalent disorder, and prevalence rises with age. Total knee replacement

surgery (TKA) is a frequent operation that has significantly improved the quality of life for millions of people with symptomatic knee OA. TKA postoperative care has been discussed regarding the utility of CPM; it has been shown to speed up the recovery of full range of motion, shorten hospital stays, lessen discomfort, speed up wound healing, and lower the risk of DVT. The current study was conducted to compare Effectiveness of CPM protocol as an adjunct to Standard Physiotherapy protocol in Post-operative Rehabilitation of TKA cases. From July to December 2021, three affiliated hospitals hosted the randomised controlled study, which included patients who had complete knee arthroplasty surgery. After surgery, patients were randomly allocated to one of two groups: From the first surgical day till discharge, Group A got twice daily PT and continuous passive motion (CPM), while Group B only received the usual physiotherapy programme from the first postoperative day. Evaluation of the results took place the day after discharge. The participants in the 2 groups' baseline outcome measurement characteristics were comparable. There was no discernible difference in the results between the two groups in the knee flexion and extension range of motion as well as the strength at the time of discharge. There was no statistically significant difference in the pain or ease in ADLs also.

***Keywords*---**CPM, Continuous Passive Motion, Standard Physiotherapy, Total Knee Arthroplasty, TKA.

1. Introduction

To the greatest extent possible, normal musculoskeletal function must be restored as a core tenet of all orthopaedic treatment. The maximising of the knee's functional capacity may be a better way to express the notion of functional restoration with relation to joint replacement surgery for knees with severe degenerative arthrosis. [1] Total knee arthroplasty is a durable and reliable procedure, but proper patient and prosthesis selection are key for optimal results. Over the past 15 years, it has evolved significantly with respect to design and technique.[2] Total knee arthroplasty aimshelp make the joint more flexible, stable, and pain-free.It's critical to restore has a good range of motion, especially in flexion, for everyday tasks.According to estimates, good walking requires 65° of flexion, going downstairs requires 90°, and getting up from a low chair requires 105°. Suitable and thorough restoration is essential for successful TKA, with pain-free function and improved quality of life being the ultimate goals. Knee range of motion (ROM) is a key indicator.[3] Numerous disorders affecting the synovial joints, including full-thickness abnormalities in articular cartilage, acute septic arthritis, and hemarthroses, have been recommended to be treated with continuous passive motion (CPM). Neochondrogenesis has also been demonstrated to be induced in free intraarticular periosteal autografts. Good compliance, a comparatively low level of pain, the preservation of range of motion, and a lower incidence of complications are among the positive results that are purported. In light of this, CPM has been promoted for the postoperative care of total knee arthroplasty (TKA).[3, 4]

In the late 1970s, RB Salter proposed the idea of CPM in biology. According to Salter 6, "On the basis of experimental study, the relative location of rest and of motion is substantially less disputed than on the basis of clinical empiricism." In light of the fact that immobility is obviously bad for joints and that both healthy and injured joints benefit from occasional movement, he reasoned that continuous motion would really be even better. He came to the conclusion that passive motion was also necessary for continuous motion due to the fatigability of skeletal muscle and the impossibility of a patient moving their own joint continuously.[5] He also thought that CPM would have a further benefit, namely that It ought should be feasible. to use it right away following an accident or procedure without inflicting the patient with unnecessary discomfort if the movement was somewhat slow.The idea that joint motion would promote articular cartilage repair and regeneration served as the main inspiration for the development of CPM and subsequent research. [5, 6] Rex et el. stated that CPM improved collagen tissue repair and mobility restoration after TKA.Studies have shown substantial increases in knee flexion range of motion (ROM) of 7 to 22 degrees and quicker recovery of knee flexion throughout the hospital stay.[7]

Long continuous passive motion (CPM) devices are widely utilised in conjunction with physiotherapy to aid with the postoperative recovery process. Numerous studies that used various CPM protocols have produced contradictory results about how it affects knee range of motion. Some studies9–10 have showed that the addition of CPM improves early postoperative knee ROM, whereas other research have shown no change. [8] The variations in CPM methods, sample sizes, and study design may be to blame for this discrepancy. However, it is evident that long-term usage of CPM has little impact on knee ROM. [9]

TKA is quite expensive in our resource-constrained nation, where patients are responsible for covering their own medical costs. The advantage realised by using CPM postoperatively enhances this cost, which is debatable, casting doubt on its efficacy. The current study's objective was to to evaluate how CPM affected knee flexion range of motion utilising the standard hospital protocol.

2. Materials and Methodology

2.1 Study Design:
Randomized Control Trial

2.2 Study Setting:
Benazir Bhutto Hospital, Rawalpindi.
District Headquarter Hospital, Rawalpindi.
Holy Family Hospital, Rawalpindi.

2.3 Sample Size:
40 patients (n=20 in each group)

2.4 Sampling Technique:
Non-probability Convenient sampling followed by Lottery-style random allocation.

2.5 Inclusion Criteria:

- Male/Female
- Age= 20-70 years
- Identified knee OA cases
- Patients anticipating TKA
- Patients who underwent significant lower-limb surgery, such as TKA or contralateral TKA, or patients who had surgery at least a year earlier than TKA.

2.6 Exclusion Criteria:

- Any illnesses/conditions
- issues with patient comprehension or collaboration
- Neuromuscular/degenerative diseases
- affected knee infection
- Underlying major health complication during hospital stay

2.7 Data Collection Procedure:

40 patients from the three affiliated institutions of Rawalpindi Medical University—Benazir Bhutto Hospital, District Headquarters, and Holy Family Institutions—participated in the experiment. The sample was divided into two groups, each with 20 members: an experimental group and a control group. Before beginning treatments, a pre-intervention evaluation was carried out using data collection methods. There were 20 patients in each of the two postoperative regimens: one without CPM and the other with CPM. Each patient received the same course of physiotherapy care in both groups, with CPM being administered to those in the experimental group for one to two hours each day. Prior to, one week after, and three months after surgery, patients were examined.

2.8 Intervention

- **Standard Physical Treatment:** From the first postoperative day, standardized physical treatment included bed-to-chair movement, walker ambulation, and twice-daily isometric and isotonic quadriceps strengthening exercises.
- **Continuous Passive Motion:** It began at 0° and increased by 10° each day till discharge. A resident who was blind to the intervention conducted the outcome evaluation on the day of discharge, which is typically the seventh to tenth day after hospitalization.

3. Results

The topic of my study was Effectiveness of CPM protocol as an adjunct to Standard protocol of Physiotherapy for Post-Operative Rehabilitation in TKA cases. The research participants were distributed into two groups. The experimental group received the daily standard physiotherapy session along with one to two hours of CPM. The control group received only the standard physiotherapy session also given by the same therapist.

The physiotherapy session included respiratory exercises along with isometric-isotonic exercises for knees, ROM exercises with active assistance, walking, and transfer practise. On the first postoperative day, all patients began to walk, initially with a walker and subsequently with forearm crutches. To the degree that they could take it, patients were instructed to shift their body weight from their trunk to their limbs.

The database was collected from the three allied hospitals of my institute i.e. Rawalpindi Medical University, Rawalpindi. A total of 40 patients were included in the study, out of whom 20 were allocated in the experimental and 20 in the control group.

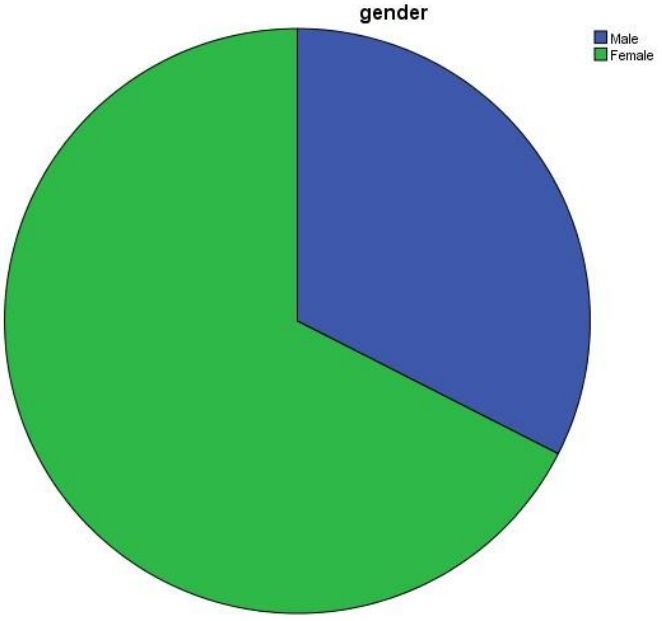
The patients were assessed based on their pain levels, their functional activity levels (ADLs), muscle strengths and knee ROMs for flexion and extension. For this purpose, Visual Analogue Scale, WOMAC index were used along with Manual Muscle Testing and Goniometric Measurements. These were the variables of assessment and were checked in both the experimental and the control groups after the said time. Data was collected and analyzed using SPSS 21. Independent-samples t test were applied with a significance of 5%.

The data analysis showed no statistical difference between the experimental and control groups, proving that the use of CPM does not add or reduce the benefit of a standard physiotherapy treatment regimen after TKA. The patients receiving CPM reached the same levels of functional activity, pain reduction, ROM and muscle strength as the patients receiving the physiotherapy sessions alone. Hence, the Null Hypothesis was accepted which stated that 'there will be no difference between the effect of routine post-op physiotherapy sessions alone and when combined with Continuous Passive Motion'

T01: Table of Gender Distribution: gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	13	31.7	32.5	32.5
	Female	27	65.9	67.5	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

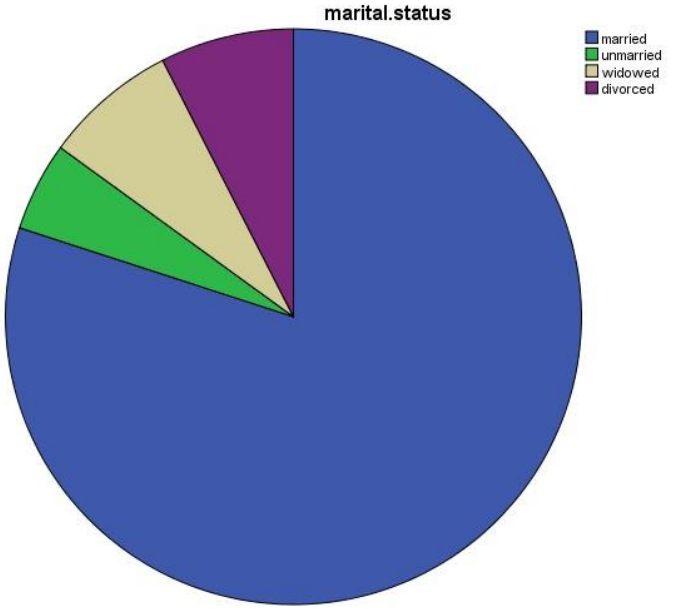
C01: Pie Chart of Gender Distribution:



T02: Table of Marital Status Distribution:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	married	32	78.0	80.0	80.0
	unmarried	2	4.9	5.0	85.0
	widowed	3	7.3	7.5	92.5
	divorced	3	7.3	7.5	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

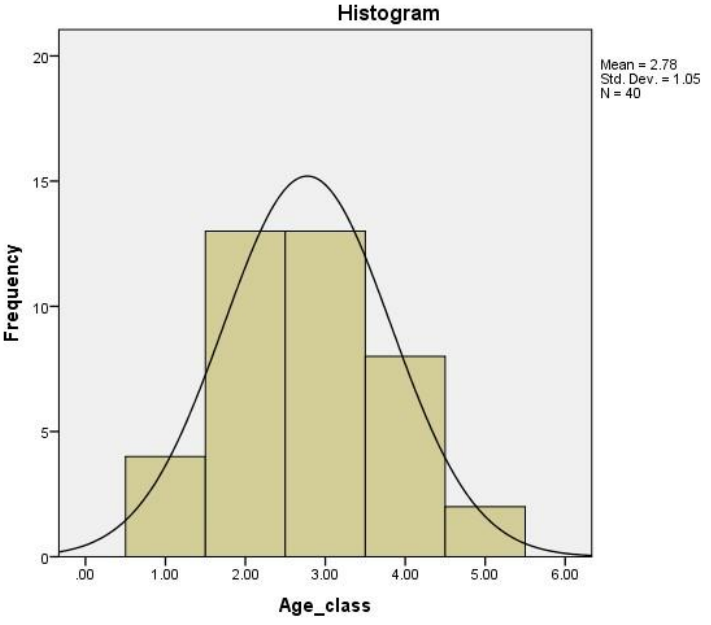
C02: Pie Chart of Marital Status Distribution:



T03: Table of Age Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	41-50	4	9.8	10.0	10.0
	51-60	13	31.7	32.5	42.5
	61-70	13	31.7	32.5	75.0
	71-80	8	19.5	20.0	95.0
	81-90	2	4.9	5.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

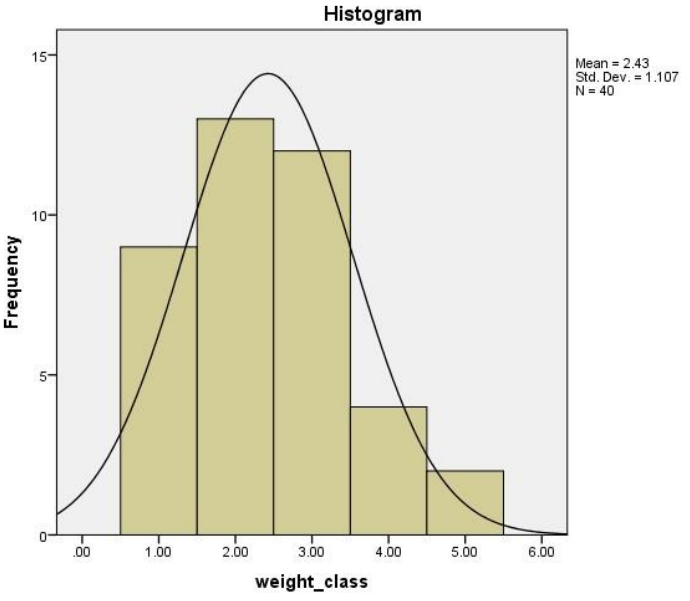
C03: Histogram of Age Distribution



T04: Table of Weight Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	61-70	9	22.0	22.5	22.5
	70.5-80	13	31.7	32.5	55.0
	80.5-90	12	29.3	30.0	85.0
	90.5-100	4	9.8	10.0	95.0
	100.5-110	2	4.9	5.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

C04: Histogram of Weight distribution



T05: Independent-samples T test for Visual Analogue Scale

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
visual.a.scale Equal variances assumed	.050	.825	.620	38	.539	.200	.322	-.453	.853
Equal variances not assumed			.620	37.938	.539	.200	.322	-.453	.853

T06: Independent-samples T test for WOMAC Index:

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
womacscale Equal variances assumed	3.486	.070	2.212	38	.033	4.800	2.170	.407	9.193
Equal variances not assumed			2.212	34.653	.034	4.800	2.170	.393	9.207

T07: Independent-samples T test for MMT Flex (Hams gp)

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
mmt_flex Equal variances assumed	2.152	.151	-.309	38	.759	-.050	.162	-.378	.278
Equal variances not assumed			-.309	35.828	.759	-.050	.162	-.378	.278

T08: Independent-samples T test for MMT Ext (Quads gp)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
mmt_ext	Equal variances assumed	.045	.833	.350	38	.728	.050	.143	-.239	.339
	Equal variances not assumed			.350	36.881	.728	.050	.143	-.239	.339

T09: Independent-samples T test for Goniometric Flex

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
gonio_flex	Equal variances assumed	.344	.561	-.304	38	.763	-.87000	2.86431	-6.66850	4.92850
	Equal variances not assumed			-.304	37.963	.763	-.87000	2.86431	-6.66868	4.92868

T10: Independent-samples T test for Goniometric Ext

		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
									Lower	Upper
gonio_exten	Equal variances assumed	.003	.958	-.035	38	.972	-.01000	.28430	-.58553	.56553
	Equal variances not assumed			-.035	37.929	.972	-.01000	.28430	-.58557	.56557

T11: Independent-Samples T test for all variables

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
womacscale	Equal variances assumed	3.486	.070	2.212	38	.033	4.800	2.170	.407	9.193
	Equal variances not assumed			2.212	34.653	.034	4.800	2.170	.393	9.207
visual.a.scale	Equal variances assumed	.050	.825	.620	38	.539	.200	.322	-.453	.853
	Equal variances not assumed			.620	37.938	.539	.200	.322	-.453	.853
mmt_flex	Equal variances assumed	2.152	.151	-.309	38	.759	-.050	.162	-.378	.278
	Equal variances not assumed			-.309	35.828	.759	-.050	.162	-.378	.278
mmt_ext	Equal variances assumed	.045	.833	.350	38	.728	.050	.143	-.239	.339
	Equal variances not assumed			.350	36.881	.728	.050	.143	-.239	.339
gonio_flex	Equal variances assumed	.344	.561	-.304	38	.763	-.87000	2.86431	-6.66850	4.92850
	Equal variances not assumed			-.304	37.963	.763	-.87000	2.86431	-6.66868	4.92868
gonio_exten	Equal variances assumed	.003	.958	-.035	38	.972	-.01000	.28430	-.58553	.56553
	Equal variances not assumed			-.035	37.929	.972	-.01000	.28430	-.58557	.56557

p value > 0.05 ___ not significant

This table summarises the findings of the t-tests performed on each dependent variable and shows no statistically significant differences between the experimental group and the control group. The test findings are not substantially different since the p value is higher than 0.05. In light of this, it can be said that there is no statistically significant difference between the experimental group and the control group in terms of pain, functional activities, manual muscle testing, and the ranges of motion of the knee joints in TKA patients.

4. Discussion

The patients suffering from Osteoarthritis undergo the surgery of Total Knee Arthroplasty, if they have pain that is unbearable and joint condition that is beyond the scope of conventional care. Accelerating patients' mobility after TKA and improving their activities of daily living (ADL) are crucial to lowering problems that are likely to arise when patients remain bedridden for a lengthy period of time.[10] The criteria used to determine whether patients with TKA are released from the hospital include the ability to move from the supine position to the sitting position, rise from the sitting position, walk, and ascend and descend stairs.Along with the ranges of motion and the strengths of the knee joint motions, another important thing taken into account is the presence or absence of pain. Postoperative management and care of a TKA patient is majorly dependent on all of these factors. [9, 11]

Post-op rehabilitation is of crucial importance after TKA, and is a subject of wide research with new methods and regimen being added to the treatment protocols. One of such a regimen is the use of a CPM machine, along with the standard physiotherapy right from the day zero post operatively. The short-term effectiveness of CPM following TKA is still hotly debated, yet physiotherapists still use it a lot in clinics. Although there are publications in the literature showing that CPM speeds up wound healing and lowers risk factors for DVT, its effects on knee range of motion (ROM) and other operational factors are yet unknown.[12]

CPM is used to increase knee ROM, enhance knee functionality generally, and facilitate walking by changing gait patterns, all while attempting to relieve pain.Functional actions including rising from a sitting posture, changing from the supine position, and walking speed are crucial for patients' independence. 3 Patients have been observed to have knee ROM between 61-80° in the early postoperative phase (7-10 days after surgery) in various studies on knee ROM, an essential criterion among the requirements for patients with TKA to be discharged.[13]

However, there is a void in the research on the impact of various CPM treatments on functional activities throughout the early phase of the TKA postoperative period. Still we have many studies regarding this topic. Researchers are working all around the globe to determine the efficacy of CPM in the post-op management of a TKA patient and to determine whether it is efficient to add it in the regimen.[14]

In a research utilising the WOMAC questionnaire, Lenssen found no differences in the effects of conventional physical therapy and CPM implementations used in

conjunction with standard physical treatment on patients' functioning behaviours in the initial postoperative period. Beaupre 25 determined similar results. Both of these studies gave evidence that there is no particular importance of the use of CPM post operatively for a TKA patient, as it shows no statistically significant benefits in the patients. [3]

Bennett showed that using CPM methods at various ranges had little impact on Knee Society Scores (KSS).). However, Akarcal28 found that TKA patients who had intensive PT and quicker CPM treatment could walk, climb stairs, and elevate their straight leg earlier than those who did not get these treatments.His research showed the importance of CPM but very little literature has been seen to support his study as the majority of the literature denies the importance of CPM. [15] According to some of the other studies in this situation, patients with TKA continue to experience postoperative walking difficulties that were present during the preoperative period. 29 Following TKA, muscle strength and knee ROM diminish, which slows down gait. Compared to healthy participants, the step length of patients shortens and the double support period lengthens, which worsens the gait pattern.[8, 16]

As a result, evaluating the walking abilities of TKA patients is essential to figuring out how independent they are in performing ADL..While our study did not specifically include the evaluation of walking functions or the performance of ADLs, the literature review of these researches give evidence on the effectiveness of use of CPM as we observed the functional activities as a measure of knee functioning along with the pain, ROM and muscle strength. There is a vacuum in the research about how various CPM applications affect gait patterns following TKA.[17] Examining the results of vigorous exercise and CPM application on walking capacity, Bruun-Olsen used the Timed Up and Go Test (TUG). They found that the findings they reached the third month and first postoperative week evaluations were identical.[18]

Our present study also aimed to compare Early postoperative functional activity measurements revealed that patients receiving CPM along with physiotherapy and those receiving only the standardized physiotherapy after gone through TKA gained similar end results in relation to functional levels of activity as well as pain levels, range of motion and the muscle strengths in the early postoperative period. At the conclusion of the CPM procedures, postoperatively to the TKR patients in comparison to the standardized physiotherapy, it was noted that both of the regimens were equally effective and produced the same results in a patient. None of the treatment plan was more effective than the other.

Conclusion

With the inclusion of CPM, there was no appreciable short-term change in ROM in the patients' post-TKA rehabilitation. Even while a few studies have shown that CPM has some short-term benefits, These ROM effects are too insignificant and clinically inconsequential to support routine usage, which must be carefully evaluated against the discomfort and cost, especially in a resource-constrained context.

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