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Effect of continuous passive motion device on knee range of motion post-burn surgery in pediatric patients

Eman Mohammed Othman, Salah El-Deen Abd El-Ghani, Ereny Sobhy Wahba Khalil, Mona Mohamed Mohamed Ali*

Physical Therapy Surgery Department, Faculty of Medicine, Cairo University, Egypt.

*Correspondence: Mona Mohamed Mohamed Ali; Mm1119922@gmail.com

ABSTRACT

Objectives: To assess the therapeutic effectiveness of CPM devices on knee motion range post burn surgery in pediatric patients, and to aid in the development of an appropriate physical therapy rehabilitation program for these patients.

Methods: Thirty children (10-18 years old) who had undergone burn surgery were randomized and assigned to one of two groups equally: group A got a continuous passive motion device postoperatively additionally to their physiotherapy program (splinting, stretching, strengthening, and ROM ex.) and medical therapy for 12 weeks, and group B received their physiotherapy program (splinting, stretching, strengthening, and ROM ex.) and medical therapy for 12 weeks.

Findings: The mean ± SD value of knee flexion ROM at 12 weeks of group A was 81.91 ± 9.97 degrees and that of group B was 109.36 ± 10.26 degrees. The median variance between groups was -27.45 degrees. At 12 weeks, group B had a substantially larger knee flexion range of motion than group A ($p = 0.0001$).

Conclusions: In pediatric children who have had knee surgery after a burn, extended CPM treatment is an excellent way to promote postoperative recovery.

KEYWORDS: Continuous Passive Motion; Physical Therapy; Rehabilitation; Pediatric Patients; Knee Flexion ROM

1. INTRODUCTION

A burn is a form of tissue damage produced by high temperature, electrical, chemical, friction, or radiations to the skin or other tissues. Burns that just damage the top layers of the skin are called superficial or first-degree burns. A partial-thickness or second-degree burn occurs when the damage spreads into parts of the underlying layers. The harm to all layers of the skin occurs in a full-thickness or third-degree burn. A fourth degree burn also harms deep tissues including muscle, tendons, and bone [1].

Burn damage is a critical issue, not only in terms of emergency care, but also in terms of the long-term health repercussions that follow from the injury and subsequent therapies. Burns are linked with considerable systemic consequences [2] and reduce immune function in protracted periods of systemic catabolism and hyper metabolism, despite the fact that they primarily damage the skin [2].

Heat, cold, voltage, chemicals, friction, or radiation cause harm to the skin or other tissues (like sunburn). Most burns are caused by heat from hot liquids, solids, or fire. While male and female rates are comparable, the underlying reasons are typically varied. In certain regions, danger is associated with the use of open flames or faulty cooking stoves. The work environment is linked to risk in males. Other risk factors include alcoholism and smoking. Burns may also be caused through self-harm or interpersonal violence.

Continuous passive motion tools have been found to help people preserve or improve their health. With the labor-intensive character of burns, increasing ROM, reduces joint stiffness, minimizes pain, accelerates healing, and improves nutrition to the joint regions [3].

Additionally, the necessity for this investigation arose from a lack of quantitative knowledge and information in studies published about the effectiveness of a CPM device on knee range of movement in pediatric patients after burn surgery.

Burn damage is a critical issue, not only in terms of emergency care, but also in terms of the long-term health repercussions that follow from the injury and subsequent therapies. Burns have severe systemic consequences, including reduced immune function and hyper metabolism during protracted periods of systemic catabolism and hyper metabolism [2].

The goal of this research was to provide a guideline for the impact of a CPM device on knee ROM in pediatric patients after burn surgery, and to aid in the development of an appropriate therapeutic regimen for enhancing mobility after burn surgery [4].

During the initial phase of rehabilitation after a soft tissue surgical operation or trauma, CPM devices are employed. The aims of phase 1 are to control post-operative discomfort, minimize inflammation, offer passive mobility in a particular plane of action, and preserve the mending repair or tissue. A CPM device pushes the joint through a regulated range of motion on a continuous basis; the precise range varies per joint, but in most instances the range of motion is raised with time.

2. METHODS

2.1. Participants

This study involved 30 pediatric patients with limited knee range of motion post burn surgery (knee capsular release). Their ages ranged from 10-18 years. They were free from any other diseases that might affect or influence the results, and were chosen at random from Damanhur Hospital and split into two equal groups.

Patients were randomized and assigned to one of two groups (15 patients each) in this investigation: - Group A (Study group): This group included 15 pediatric patients with knee burn who received one hour of continuous passive movement device (CPM) in addition to their traditional physical therapy (stretching-splinting-strengthening- ROM exercises) for 12 weeks. Group B (Control group): This group involved 15 patients who got their physical therapy program (stretching-splinting-strengthening-range of motion exercises) for 12 weeks.

Inclusion Criteria: Pediatric patients aged from 10 to 18 years will take part in the trial; all pediatric patients will have burns ranging from 9% to 28% (mean 19%); all pediatric patients will have no severe conditions; all children will be treated for 2 to 4 hours after surgery; time of use: Open or arthroscopic surgery therapy might take anywhere from 1 to 4 hours.

Exclusion Criteria: Exposed knee tendons, fourth degree burn, inflammatory diseases (i.e. rheumatoid arthritis, psoriatic arthritis, or reactive arthritis) and wound problems.

2.2. Instruments and procedures

The equipment of the study was divided into measuring and therapeutic equipment. Measurement equipment can be seen in Figure 1. The therapeutic equipment was the CPM device (Figure 2).

Figure 1. Electronic goniometer

Figure 2. Continuous passive motion device

Measurement procedures

The electrogoniometer measurement system (SG150; Biometrics Ltd, Gwent, UK) is made up of a thin, elastic strain-gauged strip (also called a shin) with two light plastic plates connected at each end (Fig. 2). The transducer detects flexing-extensions and abduction-adduction angles in two planes of motion. Because the electro goniometer is light, elastic, and noninvasive, it may be attached to the knee without restricting joint mobility. A portable digital display device was used to see the output data in real time.

Figure 3. Measuring flexion of knee by goniometer

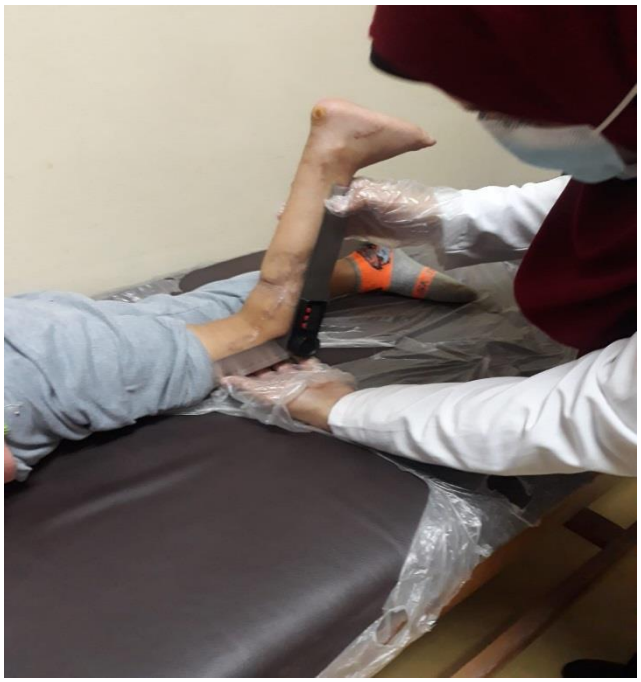

Figure 4. Measuring knee extenion by goniometer

Treatment procedures

We recruited 20 healthy volunteers and used an electrogoniometer to measure the degree of flexion in both knees. The circumferences of the mid-thigh and calf were 21 ± 3 and 15 ± 2 inches, respectively. The CPM device was then subjected to a series of motion arcs, beginning at 0° and advancing in 10° increments until it attained a CPM movement arc of 0° to 90°. The individuals' knees were measured naked or with cast padding and compressive band on both legs at three distinct head of bed settings (0°, 30°, 60°). The knee moving data was then compared to the CPM motion arc that had been programmed. Before the beginning of this investigation, the Institutional Review Board approved these trials. In each case, the identical CPM machine was used to evaluate ROM, and the knee was positioned regarding the manufacturer's instructions. Furthermore, a metal clamp was also attached to the CPM machine's distal end to prevent the machine from sliding and subsequent position adjustments. The CPM device was set to perform the nine motion arcs outlined earlier. The CPM machine was reset to 0° after each 10° increase to ensure the knee was in its initial position of 0° flexion. Six different scenarios were tested on both knees: bare leg with head of bed set at 0°, 30°, and 60°, and identical leg covered in cast pad and an elastic wrap (ie, compressive bandages) with head of bed raised at the same angles. Each knee was dressed following the typical procedure employed at our institution after TKA: the cast padding was overlapped by 50% beginning from the ankle and progressing toward the middle

region of the thigh, so the whole knee was dressed with two layers. The compressive bandages were then put around the cast padding in the same way.

Throughout the investigation, one CPM machine (McKelor Technologies, Ltd, Grove City, OH, The PhoenixTM Series, Model 1850 Knee CPM) was utilized. A portable digital display unit was used to modify the ROM for the CPM device. To examine the reliability of the CPM display, an elastic electrogoniometer was immediately installed on the lateral side of the CPM device's swing arm, which is positioned across from the knee's axis point. The CPM machine was programmed to move through a sequence of motion arcs, beginning at 0° and increasing by 10° until it achieved a total ROM of 0° to 90°. The degree of flexing observed on the electrogoniometer was compared to the ROM setting indicated on the CPM display at each 10° increment. This calibration was done at the start of the investigation and at regular intervals during the study (after every five individuals) to ensure uniformity between measurements. With this data, a calibration curve was created using median CPM movements at each 10° increment on the CPM display unit, against which real knee ROM values could subsequently be matched.

Figure 5. Application of CPM device on knee joint

2.3. Statistical analyses

The average age, weight, and length of the groups were compared utilizing an unpaired t-test. The difference in knee flexion ROM across groups was compared using an unpaired t-test. The assessment of knee flexion ROM between pre, post I, and post II data in each group was done using an ANOVA with repeating measures. For following multiple comparisons, post-hoc testing using the Bonferroni test was performed. The relevance level for all statistical tests was set at $p < 0.05$.

3. RESULTS

The pre-treatment knee flexion ROM, 6 weeks' post treating (Post I), and 12 weeks' post treating (Post II) data from both groups were statistically examined and compared.

Group A: This group includes fifteen children who had had burn surgery. Their median ± SD age, weight, and length were 14 ±2.59 years, 47.2 ±12.31 kilograms, and 156.46 ±15.01 centimeters, respectively as indicated in table 1 and figures 1-3. *Group B:* This group includes fifteen children who had had burn surgery. As indicated in table (1) and figure 1, their median SD age, bodyweight, and length were 13.33 ±2.87 years, 45.33 ±8.94 kg, and 153.8 ±12.03 cm, respectively, as indicated in table 1 and figures 1-3. When the basic features of the participants in both groups were compared, no substantial variations in average age, bodyweight, height, and sex were found ($p > 0.05$) (Table 1).

Table 1. A comparison of group A and B's average age, weight, and height

	Group A	**Group B**	**MD**	**t- value**	**p-value**	**Sig**
	$\overline{X}$ **± SD**	$\overline{X}$ **± SD**				
Age (years)	14 ± 2.59	13.33 ± 2.87	0.67	0.66	0.51	NS
Weight (kg)	47.2 ± 12.31	45.33 ± 8.94	1.87	0.47	0.63	NS
Height (cm)	156.46 ± 15.01	153.8 ± 12.03	2.66	0.53	0.59	NS
Sex						
F	7 (47%)	6 (40%)			0.71	
M	8 (53%)	9 (60%)				

SD: Standard Deviation; MD: Median differences; t value: Unpaired t value; p value: probability value; NS: Non significant

The gender ratio of group A indicated seven females with a reported percentage of 47 percent and eight men with a stated proportion of 53 percent. The gender ratio of group B indicated that there were 6 females with a recorded proportion of 40%, while there were 9 men with a recorded proportion of 60%. The gender distribution across groups did not vary significantly ($p = 0.71$) (Table 2).

Table 2. The frequency distribution and chi-square test for comparing the gender distributions of Group A and Group B

	Group A	**Group B**	**χ^2 value**	**p-value**	**Sig**
Females	7 (47%)	6 (40%)	0.13	0.71	NS
Males	8 (53%)	9 (60%)			

χ2: Chi squared value; p value: probability value; NS: Non significant

The mean ± SD value of knee flexion ROM at post I of group A was 76.75 ± 10.64 degrees and that of group B was 98.96 ± 11.25 degrees. The average temperature variation between the two groups was -22.21 degrees. At post I, group B had a substantially higher knee flexion ROM than group A ($p = 0.0001$). The mean ± SD value of knee flexion ROM at post II of group A was 81.91 ± 9.97 degrees

and that of group B was 109.36 ± 10.26 degrees. The average angle of separation between groups was -27.45 degrees. At post II, group B had a substantially higher knee flexion ROM than group A (p = 0.0001) (Table 3).

Table 3. Comparison of median values of Knee flexion ROM at post I and post II between study I and II

	Knee flexion ROM (degrees) $\overline{X}$ **±SD**		**MD**	**t- value**	**p-value**	**Sig**
	Group A	**Group B**				
Post I	76.75 ± 10.64	98.96 ± 11.25	-22.21	-5.55	0.0001	S
Post II	81.91 ± 9.97	109.36 ± 10.26	-27.45	-7.42	0.0001	S

MD: Median differences; p value: probability value; SD: Standard deviation; t value: Unpaired t value; S: Significant

Within-group comparisons indicated that group A and B had a considerable rise in knee flexing ROM at post I compared to pre therapy (p <0.001), and a major increase at post II compared to pre therapy (p <0.001) and post I (p < 0.001) (Table 4).

Table 4. Mean knee flexion ROM pre-treatment, post I and post II

	Pre treatment	**Post I**	**Post II**	**Pre vs post I**	**Pre vs post II**	**Post I vs post II**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**% of change (p-value)**	**%of change (p-value)**	**% of change (p-value)**
Knee flexion ROM (degrees)						
Group A	72.34 ± 9.78	76.75 ± 10.64	81.91 ± 9.97	6.1% (0.001)	13.23 (0.001)	6.72 (0.001)
Group B	75.44 ± 6.61	98.96 ± 11.25	109.36 ± 10.26	31.18% (0.001)	44.96 (0.001)	10.51 (0.001)

Post I, after 6 weeks of therapy; Post II, after 12 weeks of therapy; SD, Standard deviation; p-value, probability value

In pre-treatment, there was no statistically differences among groups (p > 0.05). At post I and post II, group B had a significantly higher knee flexion range of motion than group A (p< 0.001) (Table 5).

Table 5. Comparison of Knee flexion ROM at pre-treatment, post I and post II between group A and B

Knee flexion ROM (degrees)	**Mean ± SD**		**MD**	**t-value**	**p-value**
	Group A	**Group B**			
Pre treatment	72.34 ± 9.78	75.44 ± 6.61	-3.1	-1.01	0.31
Post I	76.75 ± 10.64	98.96 ± 11.25	-22.21	-5.55	0.001
Post II	81.91 ± 9.97	109.36 ± 10.26	-27.45	-7.42	0.001

Post I, after 6 weeks of therapy; Post II, after 12 weeks of therapy; SD, Standard deviation; MD, median difference; p value, probability value

4. DISCUSSION

The pre-treatments, 6 weeks' post-treatments (Post I), and 12 weeks' post-treatments (Post II) knee flexion ROM data from both groups were statistically examined and compared. Analysis of our findings revealed that in group A; Their median ± SD of age, bodyweight, length, were 14 ± 2.59 years, 47.2 ± 12.31 kg, and 156.46 ± 15.01 cm respectively, while in group B; median ± SD of age, bodyweight, length, were 13.33 ± 2.87 years, 45.33 ± 8.94 kg and 153.8 ± 12.03 cm respectively. In terms of median age, bodyweight, length, there was no substantial variation among groups ($p > 0.05$). The gender distribution of group A indicated seven females with a reported proportion of 47 percent and eight males with a reported proportion of 53 percent. The sex ratio of group B indicated that there were 6 females with a stated proportion of 40%, while there were 9 men with a reported proportion of 60%. The gender ratio across groups did not vary significantly ($p = 0.71$).

The study of Baloch et al. [5] evaluates median knee flexion in individuals with and without CPM following total knee arthroplasty. Patients were randomized and allocated to one of two groups: Group A got standardized physical therapy from the first operating day until discharge, and Group B got physical therapy and one hour of CPM twice a day from the first operating day until discharge; each group had 38 patients (50 percent). With an average age of 65.5±7.9 years in Group A and 61.6±9.1 years in Group B, there were 61 (80%) women and 15 (20%) males.

Another study of Wirries et al. [6] aimed to analyze the effect of CPM on early rehab after TKA and clinical results over time, with 20 participants in every group (CPM (1) age: 68.0± 9.2 years, female/male: 16/4, BMI: 31.3± 6.1 kg/m2; MT (2) age: 67.4 ±9.2 years, female/male: 13/7, BMI: 28.2 ±6.0 kg/m2; and there were non-statistical substantial distinctions between groups regarding demographic data).

In the current study, we reported that the median ± SD Knee flexing ROM pre-treatment of the group A was 72.34 ± 9.78 degrees and that of the group B was 75.44 ± 6.61 degrees. The average difference between the two groups was -3.1 degrees. There was no substantial variation in knee flexion ROM pre-treatment between groups A and B ($p = 0.31$). In accordance our findings, the study of Baloch et al., [5] in which the median pre-treatment knee flexing in Group A was 90.3±13.2°, whereas it was 96.9±11.5° in Group B.

Wirries et al. [6] reported that in complete PROM, there were changes in KSS and passive flexion before surgery. The MT group 2 randomized participants had a 7.2° larger PROM preoperatively ($p = .03$). Similarly, the MT group 2 had significantly superior functional Knee Society

Score values (2) (p =.03). Although the MT group had a greater preoperative flexion and PROM, the patients with CPM had a significantly greater flexing and PROM at the time of discharge (1) (p =.04/.02). Although the MT group had a greater preoperative flex and PROM, the patients with CPM had a significantly greater flexing and PROM at the time of discharge (1) (p =.04/.02).

Herbold et al. [7] evaluated two groups (CPM and no CPM) with baseline knee flex less than 75° and found substantial improvements in all variables studied; nevertheless, the distinction in the two groups was not statistically substantial. An identical finding was recorded by Brunn-Olsen et al., [8]. After one week or three months of therapy, there was no change at the CPM and no CPM groups. While there were no therapeutic advantages to employing CPM, Joshi et al. [9] observed that there were some extra expenditures, therefore it should no longer be regarded a normal technique. Furthermore, Boese et al. [10], who halted the usual using of CPM following the TKA, observed a similar finding.

On the other hand, we found that the mean ± SD value of knee flexion ROM of group B who received physical therapy program pre-treatment was 75.44 ± 6.61 degrees while at post I was 98.96 ± 11.25 degrees and at post II was 109.36 ± 10.26 degrees. Between the three time periods, there was a substantial change in knee flexing ROM (p = 0.0001). The average variance between pre- and post-treatments was -23.52 degrees, with a 31.18 percent change. When comparing pre- and post-treatment knee flexion ROM, there was a substantial increase (p = 0.0001). The average variation between pre- and post-treatments was -33.92 degrees, with a 44.96 percent change. When comparing pre- and post-treatments knee flexion ROM, there was a substantial increase (p = 0.0001). The average variation between post I and post II was -10.4 degrees, with a 10.51 percent change. When comparing post I to post II, there was a substantial improvement in knee flexion ROM (p = 0.0001).

Evgeniadis et al. [11] observed that an 8-week supervised exercising home program considerably enhanced knee flexing and extensions ROM when compared with the control group that only got inpatient therapy. Valtonen et al. [12] showed that when compared to patients who did not receive any exercise treatments, individuals who did water-based resistance workouts for 12 weeks, walking rate, stair climb rate, and knee flexion and extension ability were all significantly increased. Piva et al. [13] showed that After 6 weeks of balancing training coupled with an intensive functioning rehab program, gait speed rose by 8% and single leg stance time reduced by 24%.

Furthermore, in the current investigation, within-group comparison showed a substantial increase in knee flexion ROM in group A and B at post I compared to pre-treatment (p < 0.001) and a

substantial increase at post II compared to pre-treatment ($p < 0.001$) and post I ($p < 0.001$). In pre-treatment, there was no substantial variation between groups ($p > 0.05$). At post I and post II, group B had a considerably greater flexion ROM than group A ($p <0.001$).

Richter et al. [14] reported that, according to the findings, one-third of the patients achieved 120° of ROM in 3 days, the second third in 4 to 7 days, and the remaining third in more than 7 days of admission. Liao et al. [15] emphasized the significance of implementing CPM ROM since the first day following surgery to each patient separately.

Werner et al. [16] demonstrated the outcomes of CPM in a sample of patients who had undergone Manipulation under Anesthesia (MUA) owing to inadequate flexion progress (< 90° following surgery by 6 weeks). A considerable elevation in ROM was maintained for seven weeks (115°) and continued for 74 weeks (116°) following MUA, steroid medications, and an intense CPM program (110°F from day one, 22 hours each day for the first week, and 8 hours per day for the second week).

Furthermore, D'Amore et al. [17] reported that only one study found a substantial variation in ROM between individuals who got CPM and those who did not. While one study found that dynamic and passive flexing were greater in the first 21 days after operation prior PT, when flex and extensions were examined at the end of the treatment session, the increased ROM was lost. CPM usage did not result in a general increase in following surgery ROM in both groups that received treatment. All but one trial reported no difference in following surgery ROM in patients who got CPM, and no investigations revealed any difference in long-term ROM in individuals who got CPM vs those who did not.

Hosalkar & Bomar [18] reported that in 18 postoperative or post-injury pediatric orthopedic patients, CPM was employed to maintain or improve hip and knee range of motion. Early postoperative passive motion was initiated, and it was supplemented with physical therapy. In 16 of the 18 patients, the device was well tolerated. Except for one, mobility was enhanced as joint discomfort decreased. CPM proved to be an effective rehabilitation strategy in these patients, and it did not interfere with traction, open wounds, nursing care, or external fixing tools.

5. LIMITATIONS

This study's shortcomings were taken into account. First, this research only looked at passive knee flexion; no data on active knee flexion for real knee motion, which is more directly linked to mobility, was supplied. Second, only pediatric patients with knee affection who had knee surgery were

included in our research. Consequently, our findings may not apply to other kinds of knee surgery patients with prior diagnoses such rheumatoid arthritis or osteoarthritis.

6. CONCLUSIONS

In conclusion, the use of CPM treatment at home is an excellent way to assist postoperative knee surgery recovery. These results underscore the need for further research to refine the use of CPM devices in pediatric burn recovery and to explore other rehabilitation strategies that may be more beneficial. Ultimately, the goal is to develop an optimal, individualized physical therapy program that maximizes recovery outcomes for these vulnerable patients.

7. REFERENCES

1. Herndon D, editor. Chapter 4: Prevention of burn injuries. In: Herndon D, editor. *Total burns care*. 4th ed. Edinburgh: Saunders; 2012. p. 46. doi: 978-1-4377-2786-9.
2. Jeschke MG, Gauglitz GG, Kulp GA. Long-term persistence of the pathophysiologic response to severe burn injury PLoS One, 2011; 6: 1-12.
3. Ward RS. The use of physical agents in burn care. In: Richard RL, Staley MJ, editors. *Burn Care and Rehabilitation: Principles and Practice*. Philadelphia (PA): F.A. Davis Co; 1993. p. 435-436.
4. Schneider JC, Holavanahalli R, Helm P, Goldstein R, Kowalske K. Contractures in burn injury: defining the problem. *J Burn Care Res*. 2006;27(4):508-514.
5. Baloch N, Zubairi AJ, Rashid RH, Hashmi PM, Lakdawala RH. Effect of continuous passive motion on knee flexion range of motion after total knee arthroplasty. *J Pak Med Assoc*. 2015;65: 32-4.
6. Wirries N, Marco E, Kai S, Michael S. Impact of continuous passive motion on rehabilitation following total knee arthroplasty. *Physiother Res Int*. 2020 Sep 28;25(1):65-73. doi: 10.1002/pri.1869.
7. Herbold JA, Bonistall K, Blackburn M, Agolli J, Gaston S, Gross C, et al. Randomized controlled trial of the effectiveness of continuous passive motion after total knee replacement. Arch Phys Med Rehabil. 2014; 95:1240–1245. doi: 10.1016/j.apmr.2014.03.012.
8. Brunn-Olsen V, Heiberg K, Mengshoel AM. Continuous passive motion as an adjunct to active exercises in early rehabilitation following total knee arthroplasty – a randomized controlled trial. Disabil Rehabil. 2009; 31(4):277–283. doi: 10.1080/09638280801931204.
9. Joshi RN, White PB, Murray – Weir M, Alexiades MM, Sculco TP, Ranawat AS. Prospective randomized trial of the efficacy of continuous passive motion post total knee arthroplasty: experience of the Hospital for Special Surgery. J Arthroplasty. 2015; 30: 2364–2369. doi: 10.1016/j.arth.2015.06.006.
10. Boese CK, Weis M, Phillips T, Lawton-Peters S, Gallo T, Centeno L. The efficacy of continuous passive motion after total knee arthroplasty: a comparison of three protocols. J Arthroplasty. 2014; 29(6):1158–1162. doi: 10.1016/j.arth.2013.12.005.
11. Evgeniadis G, Beneka A, Malliou P, Mavromoustakos S, Godolias G. Effects of pre-or postoperative therapeutic exercise on the quality of life, before and after total knee arthroplasty for osteoarthritis. J Back Musculoskelet Rehabil. 2008; 21:161-9.
12. Valtonen A, Pöyhönen T, Sipilä S, Heinonen A. Effects of aquatic resistance training on mobility limitation and lower-limb impairments after knee replacement. Arch Phys Med Rehabil. 2010; 91:833-9.

13. Piva SR, Gil AB, Almeida GJ, DiGioia AM, Levison TJ, Fitzgerald GK. A balance exercise program appears to improve function for patients with total knee arthroplasty: A randomized clinical trial. Phys Ther. 2010; 90:880-94.
14. Richter M, Trzeciak T, Kaczmarek M. Effect of continuous passive motion on the early recovery outcomes after total knee arthroplasty. Int Orthop. 2022;46(3):549-553. doi: 10.1007/s00264-021-05245-5.
15. Liao CD, Huang YC, Lin LF, Chiu YS, Tsai JC, Chen CL, et al. Continuous passive motion and its effects on knee flexion after total knee arthroplasty in patients with knee osteoarthritis. Knee Surg Sports Traumatol Arthrosc, 2016; 24: 2578–2586
16. Werner S, Jacofsky M, Kocisky S, Jacofsky D. A standarized protocol for the treatment of early postoperative stiffness following total knee arthroplasty. J Knee Surg 2015; 28: 425–427
17. D'Amore T, Rao S, Corvi J, Jack RA, Tjoumakaris FP, Ciccotti MG, et al. The utility of continuous passive motion after anterior cruciate ligament reconstruction: A systematic review of comparative studies. *Orthop J Sports Med*. 2021;9(6):223-36.
18. Hosalkar H, Bomar JD. RETRACTED ARTICLE: Clinical effectiveness of continuous passive motion (CPM) following femoroacetabular impingement surgery in adolescents. J Child Orthop. 2012; 6(4): 269-75. doi: 10.1007/s11832-012-0416-0. Epub 2012 Jun 30. Retraction in: Hefti F, Wientroub S. J Child Orthop. 2013;7(5):445-53.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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