Boese CK, Weis M, Phillips T, and et al. The Efficacy of Continuous Passive Motion After Total Knee Arthroplasty: A Comparison of Three Protocols. The Journal of Arthroplasty 2014; 29: 1158–1162.

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Design: Randomized clinical trial

Objective: To evaluate the effects of early aggressive continuous passive motion (CPM) and fixed flexion CPM preceding progressive CPM on the short-term outcomes of range of motion (ROM), pain, and hospital length of stay compared to standardized physical therapy alone in patients after total knee arthroplasty (TKA).

Population /sample size/setting:

- A total of 160 patients who were scheduled to undergo a primary TKA (107 females, 53 males, mean age 68 years) were recruited by one of four surgeons at Alegent Creighton Health Mercy Hospital in Council Bluffs, Iowa. Patients were randomized into one of 3 treatment groups; Group A-CPM device on and moving from the immediate post-operative period (N = 55), Group B-CPM device on and stationary at 90 degree flexion for the first night and then moving throughout the rest of their stay (N = 51), and Group C- no CPM (N = 54).
- Study design was a prospective, randomized experimental trial.
- Inclusion criteria included ages 18 to 90 years who were scheduled to undergo a primary TKA.
- Exclusion criteria included bilateral TKA, non-English speaking, a body mass index (BMI) greater than 40, and starting knee range of motion of greater than 15° flexion contracture or less than 80° flexion.

Methods/Interventions/Outcome Measures:

- Randomization was conducted by consecutive sequencing into one of three protocol groups, A, B, C, during pre-operative classes.
- The nature of CPM prevented blinding in this study. It was not clear if outcome assessors were blinded to group allocation. The operating surgeon was blind to the randomization at the time of surgery.
- Power analysis determined that a total sample size of 150, or 50 subjects in each group, would be needed to yield 81.74% power to detect significant differences in the outcome variables.
- With the exception of CPM, patients received the same care and physical therapy during their hospital stay. Physical therapy targeted active motion of the knee and functional mobility. Patients were encouraged to ambulate on the morning of the first postoperative day and rock in a rocking chair four times a day for 20 minutes to reduce joint stiffness. Beginning on the first postoperative day, twice daily therapy protocol included quad sets, short arc quads, long arc quads, hip abduction, straight leg raises, ankle pumps and

gluteal sets. A five pound sand bag was placed on the operative knee (Ottoman stretch) four times a day for 10 minutes to promote knee extension as tolerated.

- Group A – patients receiving a moving CPM immediately upon arrival to the orthopedic floor moving from 0–110^0 ROM. Degrees of flexion were adjusted per patient tolerance. CPM continued daily for a minimum of 5 hours per day as tolerated for a minimum of 2 days and was continued until 90 degrees of active flexion was obtained.
- Group B – patients receiving a non-moving CPM immediately upon arrival to the orthopedic floor. The operative leg was placed in a fixed, bent position following surgery and held in this position during the first night for a minimum of 8 hours and a maximum of 19 hours. The goal was to hold the knee stationary at 90 degrees; however, flexion was decreased as needed for patient comfort. During all subsequent hospital days, the Group A protocol was followed.
- Group C – control patients did not receive a CPM machine during their hospital stay. The operative leg rested on the hospital bed.
- Patients were discharged home if able to ambulate independently, perform activities of daily living, range of motion flexion >90^0, extension <15^0 and pain controlled with oral analgesics.
- Primary outcome measures included;
    - self-reported pain scores 30 minutes prior to morning and afternoon physical therapy sessions on postoperative days 1 and 2 using the visual analog scale (VAS);
    - Active flexion and extension ROM measurements were collected preoperatively, at each morning physical therapy session on postoperative days 1 and 2, and 3-4 weeks after surgery;
    - Hospital length of stay.
- A secondary outcome evaluated was cost of CPM.

Results:

- Baseline demographics and outcome measures were similar in the groups and displayed no significant differences between the groups.
- There were no significant differences between the groups for ROM and pain scores.
- Morning and afternoon pain scores were greatest in the moving CPM group (Group A) and lowest in the no CPM group (Group C) for postoperative day one, but they were not statistically significant (P =0.13 and 0.09). This was the most clinically significant finding.
- ROM measurements of active flexion and extension were almost identical in the 3 groups on postoperative days 1 and 2, and at the 3-4 week long term follow-up. At the long term follow-up, active flexion was 111^0, and overall ROM was 109^0 in all 3 groups.
- Length of hospital stay was 2.7, 3.2, and 2.6 days for Groups A, B, and C (respectfully). Length of stay showed a clinically significantly longer hospital stay by half a day for patients who received the stationary overnight CPM (Group B) than for any other group (P<0.01). There was no difference in hospital stay between the immediate, moving CPM group (group A) and no CPM group (group C).
- There were no significant differences in the rate of complications between the groups.

- The use of a CPM device adds considerable cost to TKA rehabilitation. The cost to rent a CPM device per year for an institution is at least $2,200, and additionally, there are labor charges for nursing staff to apply, adjust, and monitor the CPM device for an average of four hours per patient.

Authors' conclusions:

- CPM provided no apparent benefit to patients recovering from TKA in all outcome variables. We found no clinically significant differences in ROM, swelling, blood loss, pain scores, or active ROM between any of the groups at any time.
- The results of this study provide evidence that CPM is not beneficial, at least in a facility that is focused on early mobility and a short hospital length of stay following TKA surgery.
- All 3 treatment groups attained similar ROM measurements in this study. These results show that early beneficial increases in active ROM with CPM use were not achieved.
- This study detected an actual increase in length of stay by half a day in the static overnight CPM group (Group B), while there was no difference in hospital stay between the immediate, moving CPM (Group A) and no CPM (Group C) groups.
- If CPM devices were not included in hospital postoperative rehabilitation protocols, institutions could save money.

Comments:

- The strengths of this study were a randomized design and a relatively large sample size. All patients received the same physical therapy protocol, which focused on active ROM and early functional mobility. In addition, all patients also received the same posterior stabilized knee design implanted by one of 4 surgeons at a community hospital and the same postoperative multi-modal pain control program and the same care path.
- Outcome assessors taking ROM measurements could easily have been blinded to patient allocation group.
- One limitation of this study is the fact that patients were in control of the duration of CPM use, within the boundaries of their study group. Patients using CPM devices were not requested to keep a log of their CPM use and so patient compliance is unknown and could not be analyzed. If CPM users were actually not using their devices as recommended, this would decrease any real effect sizes found between CPM groups and non-CPM groups. Therefore, non-adherence to assigned CPM use could be an explanation of why no actual differences were found between CPM groups and the non-CPM group.
- Intention-to-treat analyses were used in this study, and by doing so, patients' non-compliance was taken into account.
- Non-compliance with a CPM device is an important issue to consider when recommending this treatment protocol.

Assessment*:*

- This adequate study provides some evidence that there are no beneficial effects of early aggressive continuous passive motion (CPM) and fixed flexion CPM preceding progressive CPM on the short-term outcomes of range of motion (ROM), pain, and hospital length of stay compared to standardized physical therapy alone in patients following total knee arthroplasty.