



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: <https://doi.org/10.22214/ijraset.2023.51321>

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A Literature Review on Pneumatic Operated CPM Machine for Knee and Ankle

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Abstract: Continuous passive motion (CPM) is a therapy in which a machine is used to move a joint without the patient having to exert any effort. A motorized device gently bends the joint back and forth to a set number of degrees, and the amount of movement and speed can be adjusted by the physical therapist. CPM machines are most commonly used on knee joints (after some types of knee surgery), but there are versions made for other joints as well. CPM is helpful when used according to a different principle than continuous motion. Rather than having the device flexing and extending the elbow on a continuous basis, I use the device asslow intermittent passive positioning.

The day after release, my patients start slow intermittent passive placement, using the first 12 to 24 hours for rest and elevation. The machine is originally set to its most extreme acceptable extension and flexion positions. The antecubital fossa bandages must be taken off since they will prevent bending. The patient (or parent) is instructed on how to operate the machine-stopping button.

The absolute minimum displacement rate is chosen. The patient is told to let the machine extend the elbow to its fullest extent, stop it, and hold it there for 20 to 30 minutes. When the button is pressed, motion is resumed up to the point of maximally tolerable flexion. Once more, the position is maintained for 20–30 minutes. The joint is kept in its most extreme position from the start of rehabilitation in this fashion, which is the intended outcome. There is no benefit to cycling the joint more frequently, and doing so could make the swelling worse. The indwelling catheter can be used to provide anaesthesia to treat pain and calm the muscular guarding if the CPM causes substantial guarding.

Keywords: CPM, physiotherapy, Pneumatic, Patient, Cycling.

I. INTRODUCTION

The largest joint in the human body, the knee is anatomically complicated but mechanically straightforward. Additional stabilisation is offered by a group of ligaments during flexion, extension, and a minor amount of rotation. Patients find it extremely difficult to lead normal lives in both their professional and personal spheres due to pain, movement restrictions, and other joint damage caused by disease (degenerative and rheumatic diseases, neoplasms, or congenital defects). A surgical intervention may be required in some circumstances, along with different types of post-operative physiotherapy (including different types of kinesiotherapy accompanied by physiotherapy).

Knee alloplasty is one type of surgical procedure that is used. The foundation of this surgical technique is the excision of the joint's damaged articular surfaces. One of the most frequent operations in adult orthopaedics is this one. According to 1.55 000 joint alloplasty operations were reportedly carried out in Poland in 2012. extra sources

II. PROBLEM IDENTIFICATION

Certainly! Another area of problem identification for the review article could be to compare the pneumatic-operated CPM machine for the knee and ankle joints with the available market solutions for the knee and ankle separately. This can entail comparing the benefits and drawbacks of utilising a single machine to perform both the knee and ankle CPM duties versus using separate devices for each joint. Here are some examples of possible comparisons:

- 1) *Efficiency and Effectiveness:* Comparing a combined knee and ankle CPM machine to individual machines in terms of patient outcomes, rehabilitation development, and therapeutic efficacy. To analyse the advantages and drawbacks of employing a single machine for the knee and ankle joints, as well as aspects like treatment time, range of motion, and pain management, this could entail studying pertinent literature and research papers.
- 2) *Cost and Resource Use:* Comparing the use of a combined CPM machine for knee and ankle joints to using two separate machines in terms of cost and resource use.

The review paper could offer helpful insights into the potential advantages and challenges of using a combined machine by comparing the pneumatic-operated CPM machine for both knee and ankle joints with existing market options for knee and ankle separately. It could also contribute to the understanding of the current landscape and future directions of CPM technology in knee and ankle rehabilitation.

III. LITERATURE SURVEY

- 1) National Journal of Physiology, Pharmacy and Pharmacology Effectiveness of continuous passive motion after total knee replacement: A randomized controlled trial from North India Girish Sahni¹, Sukhjot Singh¹, Daljinder Singh¹, Ashish Kavia²
¹ Department of Orthopaedics, Government Medical College, Patiala, Punjab, India, ² Department of Physical Medicine and Rehabilitation, Government Medical College, Patiala, Punjab, India Correspondence to: Ashish Kavia, E-mail: ashishkavia@yahoo.com Received: January 09, 2022; Accepted: February 02, 2022
Abstract -Background: Continuous passive motion (CPM) is a common strategy for early post-operative rehabilitation of patients who have undergone knee surgery. During an early recovery time following primary total knee replacement (TKR), the efficiency of the CPM approach was evaluated in this study
- 2) Journal of Orthopaedic Surgery 2002: 10(2): 194–202 Review article: Knee flexion after total knee arthroplasty KY Chiu, TP Ng, WM Tang, WP Yau Division of Joint Replacement Surgery, Department of Orthopaedic Surgery, The University of Hong Kong, Queen Mary Hospital, Pokfulam, Hong Kong
ABSTRACT -Many factors affect or predict the flexion range achieved after total knee arthroplasty. While the knees that have good preoperative flexion have better final flexion, knees with good preoperative flexion do lose some flexion whereas those with poor preoperative flexion can gain flexion. Although studies of different prosthetic designs have produced conflicting results, recent studies appear to favour posterior cruciate ligament (PCL)—substituting over PCL-retaining prostheses. Several factors related to surgical techniques have been found to be important. These include the tightness of the retained posterior cruciate ligament, the elevation of the joint line, increased patellar thickness, and a trapezoidal flexion gap. Vigorous rehabilitation after surgery appears useful, while continuous passive motion has not been found to be effective. Obesity and previous surgery are poor prognostic factors; certain cultural factors, such as the Japanese style of sitting, offer ‘unintentional’ passive flexion and result in patients with better range. If the flexion after surgery is unsatisfactory, manipulation under anaesthesia within 3 months of the total knee arthroplasty can be beneficial.
- 3) Int. J. of Applied Mechanics and Engineering, 2017, vol.22, No.1, pp.241-251 DOI: 10.1515/ijame-2017-0014 STUDY OF CPM DEVICE USED FOR REHABILITATION AND EFFECTIVE PAIN MANAGEMENT FOLLOWING KNEE ALLOPLASTY R. TROCHIMCZUK* Bialystok University of Technology Faculty of Mechanical Engineering Department of Automatic Control and Robotics Wiejska 45C, 15-351 Bialystok, POLAND E-mail: r.trochimczuk@pb.edu.pl
ABSTRACT-This paper defines the design assumptions for the construction of an original demonstration of a CPM device, based on which a solid virtual model will be created in a CAD software environment. The overall dimensions and other input parameters for the design were determined for the entire patient population according to an anatomical atlas of human measures. The medical and physiotherapeutic community were also consulted with respect to the proposed engineering solutions. The virtual model of the CPM device that will be created will be used for computer simulations of changes in motion parameters as a function of time, accounting for loads and static states. The results obtained from computer simulation will be used to confirm the correctness of the design adopted assumptions and of the accepted structure of the CPM mechanism, and potentially to introduce necessary corrections. They will also provide a basis for the development of a control strategy for the laboratory prototype and for the selection of the strategy of the patient's rehabilitation in the future. This paper will be supplemented with identification of directions of further research.
- 4) Journal of Rehabilitation Research and Development Vol. 37 No. 2, March/April 2000 Pages 179—188 Continuous passive motion (CPM) : Theory and principles of clinical application Shawn W. O'Driscoll, MD, PhD and Nicholas J. Giori, MD, PhD Mayo Clinic, Rochester MN 55905
ABSTRACT—Stiffness following surgery or injury to a joint develops as a progression of four stages: bleeding, edema, granulation tissue, and fibrosis. Continuous passive motion (CPM) properly applied during the first two stages of stiffness acts to pump blood and edema fluid away from the joint and periarticular tissues. This allows maintenance of normal periarticular soft tissue compliance.

CPM is thus effective in preventing the development of stiffness if full motion is applied immediately following surgery and continued until swelling that limits the full motion of the joint no longer develops. This concept has been applied successfully to elbow rehabilitation, and explains the controversy surrounding CPM following knee arthroplasty.

IV. CONCLUSIONS

The purpose of rehabilitation following a total knee arthroplasty is to fully regain muscular control over the operated knee joint as well as its complete range of motion (ROM). In post-operative rehabilitation, a variety of physiotherapy techniques are used, including various forms of kinesiotherapy that are greatly aided by passive exercises performed using CPM devices. The development of an original design for a hybrid, dual-limb CPM rehabilitation device was the product of original research that was preceded by several studies of commercial solutions and assessments of the literature in the field of CPM rehabilitation devices. The conceptual model of the CPM device reported in this research satisfies the contemporary requirements of patients and medical facilities dealing with rehabilitation following total knee replacement. Because of the engineering solutions used, arthroplasty procedures. Functionality was increased in comparison to CPM systems now on the market since it was reasonably simple to adapt the device to the dimensions of individual patients' limbs and because it was possible to configure different workout programmes separately for each leg. Another benefit of the solution is the possibility to simultaneously rehab the ankle joint in addition to the knee after arthroplasty, greatly expanding the variety of kinesiotherapeutic exercises. Causal Productions permits the distribution and revision of these templates on the condition that Causal Productions is credited in the revised template as follows: "original version of this template was provided by courtesy of Causal Productions (www.causalproductions.com)".

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- [3] Int. J. of Applied Mechanics and Engineering, 2017, vol.22, No.1, pp.241-251 DOI: 10.1515/ijame-2017-0014 STUDY OF CPM DEVICE USED FOR REHABILITATION AND EFFECTIVE PAIN MANAGEMENT FOLLOWING KNEE ALLOPLASTY R. TROCHIMCZUK* Bialystok University of Technology Faculty of Mechanical Engineering Department of Automatic Control and Robotics Wiejska 45C, 15-351 Bialystok, POLAND E-mail: r.trochimczuk@pb.edu.pl
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