

Research progress of continuous passive motion after total knee arthroplasty

Jiaxing Chi, Huai Huang

Department of Joint and Sports Medicine, The First Affiliated Hospital of Hunan Normal University (Hunan Provincial People's Hospital), Hunan, Changsha, 410000

ABSTRACT

Total knee arthroplasty (TKA) is a common surgical procedure widely used to treat osteoarticular diseases in elderly patients, and its effectiveness has been well established. Postoperative rehabilitation exercises are crucial for restoring knee joint mobility and muscle strength to ensure a successful recovery. Continuous passive motion (CPM) has the advantages of simple operation, moderate economy, and wide application range. It plays a significant role in the postoperative recovery of different diseases, relieves joint discomfort, and promotes the recovery of limb function. This paper discusses the importance of postoperative exercises for TKA patients, introduces CPM, and summarizes recent advancements in CPM for patients following total knee arthroplasty (TKA). The aim is to provide a foundation for developing effective rehabilitation exercises for TKA patients after surgery.

KEYWORDS

Total knee arthroplasty; continuous passive movement; New research progress

With the aggravation of population aging in China, the health problem of the elderly is particularly raised. As a common disease, osteoarthritis is more common in the elderly, especially knee osteoarthritis (TOA), which has become an important cause of disability and death in the elderly, increasing the burden on the family and social economy^[1]. Total knee arthroplasty (TKA) is currently used in the treatment of knee osteoarthritis after surgery; to a certain extent, it alleviates the symptoms and signs, improves joint function, and optimizes the quality of life, but some patients experience continuous/intermittent pain and dysfunction; therefore, strengthen the functional exercise after TKA surgery to improve the effect of the operation and safety^[2-3]. Continuous passive movement (CPM) has high clinical benefits, which can effectively meet the rehabilitation needs of patients after TKA, eliminate local swelling, expand joint flexibility, improve knee joint function, and enable patients to return to normal life and work as soon as possible^[4]. Based on the literature of others, this article reviews the new research progress of continuous passive movement after total knee arthroplasty as follows to provide a reasonable basis for the subsequent development of rehabilitation exercises and the formulation of relevant programs for the patient.

1 The importance of postoperative exercise for TKA patients

There is a link between the quality of TKA and the rehabilitation of patients with adherence to

postoperative rehabilitation exercises; if early exercise does not reach the designated position, it is easy to cause a poor prognosis. Zeng^[5] pointed out that a TKA patient's postoperative prognosis of 19.67% is closely related to whether patients with functional years, with the widespread use of TKA, more and more surgeons actively require patients to carry out early rehabilitation exercises after surgery. Professional training. In recent years, with the widespread use of TKA, more and more surgeons actively require patients to carry out early rehabilitation exercises after surgery. There are more than academics for TKA patients postoperative exercise reported, as Liu^[6] included patients after joint replacement, investigating the hospital rehabilitation exercise behavior, finding the physiology and pathology with patients, mental and social support, rehabilitation care, and other factors. Wang included patients discharged from total knee arthroplasty as an example and found that the knee joint function of patients recovered well in the short term after discharge, which was related to the compliance of rehabilitation exercise and the angle of joint flexion contracture. However, there was still a lot of room for improvement. Combined with the above analysis, it is believed that exercise plays a vital role in the recovery of patients after TKA, and the exercise behavior of patients is affected by many factors.

2 Introduction to CPM

2.1 Definition and theoretical basis

CPM is a new biological concept that accelerates the healing and regeneration of joints, ligaments, and tendons through continuous passive activity. In the 1970s, foreign orthopedic physician CPM, recovery of orthopedic trauma disease, and joint damage repair played a good role in promoting. Based on the following theory:

- (1) Compared with bone injury, articular cartilage injury has limited self-repair.
- (2) Some animal experiments showed that the rabbit knee joint was prone to cartilage fibrosis, cartilage surface ulcer, cartilage necrosis, synovium, and cartilage adhesion after 6 weeks of immobilization. In 1970, foreign orthopedic surgeons proposed that "early shortening exercise has a higher effect than immobilization, and CPM is better than intermittent exercise" for cartilage regeneration and repair of periarticular tissues.

2.2 Principles of using CPM

(1) Continuous, which usually refers to the long course of CPM and requires that the daily activity time must meet the requirements, especially 7 days after surgery, to better prevent joint adhesion, remove the joint area of blood, and accelerate cartilage repair, can be carried out continuously for 24 hours^[7]. It should be noted that the early postoperative joint movement did not obtain ideal ROM. With the recovery process of the disease, the effect of CPM weakens, and it is difficult to obtain the full range of motion of the joint, increasing the risk of secondary surgery.

(2) Slow, postoperative swelling is closely related to inflammatory reactions. In the face of the limb, swelling occurs, reducing the speed of CPM used appropriately and the time necessary to carry on the CPM to shorten the daily activity.

2.3 Mechanism of Action

The mechanism of action of CPM involves several aspects, as follows:

- (1) increase the nutritional and metabolic activity of articular cartilage; adult articular cartilage nutrition; full body fluids from healthy synovial joints; with the CPM effect, articular cartilage;

synovial fluid gradually osmosis; diffusion to regulate the metabolism of cartilage cells; enhance regeneration and function of cartilage tissue; and enable harmful substances of the necrotic tissue to wipe out^[8].

(2) To alleviate the postoperative pain of joints, CPM can accelerate the circulation of synovial fluid, eliminate the swelling of the affected limb, and relieve pain.

(3) promote the articular cartilage, joints, ligaments, and (or) tendon injury repair, under the effect of CPM, the adhesion of the joint and surrounding tissue, increase the blood circulation, and accelerate its repair^[9]. Combining the above analysis, CPM has a unique advantage: it improves joint motion and alleviates limb swelling, pain, and discomfort, thus improving the healing rate, shortening hospitalization days, and helping patients reduce the medical burden.

3 New progresses of CPM in patients after TKA

3.1 The use of CPM alone

At present, CPM has been widely used in the field of orthopedics. Many clinical studies have confirmed that CPM is beneficial to the recovery of patients after TKA, increasing the range of motion of the knee joint and improving joint function.

The joint range of motion is the arc of motion through which the joint moves, which can effectively judge the success of TKA. As an example, Zou^[10] included TKA patients and implemented CPM machine-assisted rehabilitation exercises based on routine rehabilitation nursing. The results showed that the excellent and good rates of knee joint activity recovery after 2 weeks and 4 weeks of intervention were 88.89% and 97.22%, respectively, indicating that the effect of CPM machine-assisted rehabilitation exercise was more ideal, which effectively improved the range of motion of the knee joint and ensured the effect of surgery. CPM can also promote local venous blood return of the joint, eliminate local swelling, relieve pain symptoms, and improve joint function. Studies have shown that CPM can promote local venous blood return and effectively reduce local swelling of the knee joint in TKA patients. Xu^[11] was enrolled in TKA patients, who underwent simple joint mobilization training supplemented with early continuous passive movement training. The results showed that the degree of joint swelling of patients on the 14th and 30th days after the operation was significantly improved than that on the 3rd day after the operation, and the VAS score was lower than that on the 3rd day after the operation, and the HSS score was higher than that on the 3rd day after the operation. Chen^[12] included patients with patellar fractures and carried out CPM functional exercise instrument intervention in their postoperative care. The pain symptoms and knee joint function at different periods after the operation were significantly improved, and the prognosis was good. It is concluded that CPM is beneficial to soft tissue repair and ligament healing in patients undergoing total knee arthroplasty and has a significant effect on the prevention and treatment of edema, adhesion, degeneration, and contracture of muscles, tendons, and ligaments around the joint. He^[13] pointed out that CPM was more helpful to improve joint flexion and shorten the length of hospital stay after TKA. The conclusion of the above study fully confirmed that CPM plays an important role in improving the functional recovery of knee joints after TKA. However, there is no scientific evidence to prove the exact effect of CPM on postoperative rehabilitation of TKA, and some scholars believe that CPM has the following limitations in postoperative recovery of TKA:

(1) Some scholars pointed out that CPM has no significant effect on the range of motion of the knee. When discharged after TKA, patients' knee flexion degree with the application of CPM was close to those 4 weeks postoperatively, and patients and CPM had more post-surgical knee and hysteresis, flexion contracture.

(2) The quadriceps femoris is the main muscle that controls the knee joint movement. How to

improve the strength of the quadriceps femoris has become the key content to accelerate the recovery after TKA^[14].

(3) CPM can also increase postoperative pain after TKA. Combined with the above analysis, the long-term effect of CPM is general, and its application is limited.

3.2 Combined application of CPM

In recent years, scholars have advocated CPM combined with other interventions for the postoperative recovery of orthopedic patients.

(1) Traditional Chinese medicine therapy (Chinese medicine decoction, Chinese medicine fumigation, washing, moxibustion, etc.) combined with CPM. Zhang^[15] pointed out that traditional Chinese medicine fumigation and massage, as external treatments of traditional Chinese medicine, are widely used in clinical practice because of their unique advantages and are well-received by patients and doctors. For patients with ankle fractures after surgery, the implementation of traditional Chinese medicine fumigation and massage based on CPM has achieved satisfactory rehabilitation effects, improved ankle joint activity, reduced complications, and optimized quality of life. An^[16] included TKA patients and implemented acupuncture and acupoint therapy based on CPM. That is, according to the etiology and pathogenesis of the patient (liver and kidney deficiency, qi and blood deficiency, resulting in the loss of muscles and vessels to each other), the treatment was carried out based on syndrome differentiation to achieve the purpose of relieving tendons, relieving rheumatism, promoting blood circulation, and so on. Accelerate inflammatory absorption, repair damaged tissue, and can better improve soft tissue circulation, promote the knee functional recovery, and couple with CPM limb to help patients exercise, accelerate the lower limb muscle isometric contraction diastole, improve blood flow, eliminate joint swelling, and enhance the muscle strength and knee joint motion.

(2) Local compression cooling therapy, early closed-chain functional exercise, and other methods combined with the CPM program. Li^[17] included patients undergoing knee anterior cruciate ligament reconstruction and implemented the combined intervention of continuous passive movement and isokinetic closed-chain training, which could not only reduce the pain symptoms of the affected limbs but also improve the range of motion of the knee joint, improve the function of the knee joint, and reduce the incidence of complications. Chen included TKA treatment patients, according to the disease characteristics and the specific condition, CPM and Glauber's salt cold therapy can obtain the ideal effect; the CPM, Glauber's salt + ice packs external single effect better, better improve the effect of patients with individualized rehabilitation treatment, consideration, and CPM joint mirabilite ice scheme of "multi-dimensional" "multi-channel" mechanism. The advantages of complementary and synergistic effects can better accelerate the recovery of the affected limb activity, reduce swelling and pain, and reduce local temperature. Combined with the above reports and analysis, the combination of CPM and other methods has a good synergistic effect, meets the rehabilitation needs of patients, and accelerates the recovery process of the body.

4 Summary

TKA is a commonly used surgical method with a definite curative effect, but it has large trauma and many complications. Therefore, patients are required to carry out early rehabilitation exercises after operation to improve the surgical effect and safety. CPM is a common functional exercise tool with a wide application scope and remarkable effects. Through the analysis of the research results of others, this paper believes that TKA patients must carry out rehabilitation exercises after surgery, and CPM has a certain improvement effect on postoperative recovery, but there are limitations.

Therefore, it is advocated to use CPM in combination with other interventions to improve the rehabilitation level of TKA patients, but there are few reports on relevant aspects, and the long-term effect is not confirmed.

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