

# Adapted rehabilitation protocols for knee arthroplasty - Systematic review of the literature

Gavril Gheorghievici<sup>1,2</sup>, Cristian Ioan Stoica<sup>1,2</sup>, Brindusa Mitoiu<sup>1,3</sup>, Anatoli Covaleov<sup>1,4</sup>,  
Alexandru Luchian<sup>1,2</sup>

<sup>1</sup>“Carol Davila” University of Medicine and Pharmacy Bucharest, Romania

<sup>2</sup>Foisor Orthopedics Clinical Hospital Bucharest, Romania

<sup>3</sup>Clinic of Rehabilitation, Physical Medicine and Balneology, “Prof. Dr. Agrippa Ionescu” Emergency Clinical Hospital, Balotesti, Ilfov, Romania

<sup>4</sup>Eforie Nord Rehabilitation, Physical Medicine and Balneology Hospital, Eforie Nord, Romania

## ABSTRACT

Total knee arthroplasty is a frequently met replacement procedure for patients with degenerative knee disease. The main purpose of the intervention is to provide pain relief and to promote range of motion and joint stability for patients in which conservative options such as pharmacological treatment or physical therapy can't accomplish any more an adequate symptom alleviation.

Most guidelines regarding the first stage of the rehabilitation process recommend early mobilization in order to gain as quickly as possible functional independence, and also to promote muscle strength and coordination. This should be done from the first day post-surgery, depending on the patients compliance.

In the subacute stage, the emphasis is put on maintaining a progression of the weight-bearing status, and promoting normal walking without the use of an assistive device. Patient education will be focused on changes that need to be made in a domestic environment and also modifications regarding social and professional activities.

The third phase of the rehabilitation process focuses on limb symmetry and equal weight bearing which represent absolute objectives that need to be obtained. Balance exercises will include progression from bilateral to unilateral, and integration of unstable surfaces if possible associated with cardiovascular training. This phase of the rehabilitation process is considered to be completed once all realistic functional goals are achieved.

**Keywords:** knee arthroplasty, rehabilitation, protocol, functional level

## INTRODUCTION

Total knee arthroplasty (TKA) is a frequently met replacement procedure for patients with degenerative knee disease. The main purpose of the intervention is to provide pain relief and to promote range of motion and joint stability for patients in which conservative options such as pharmacological treatment or physical therapy can't accomplish any more an adequate symptom alleviation. Quality of life improvement is one of the main goals of the procedure with the patient being able to resume most or all of his daily activities in a pain free manner [1-3]. An important aspect is put on pre-surgery rehabilitation in order to identify behavioral and lifestyle and envi-

ronmental risk factors, but also to familiarize the patient with the early stages of the rehabilitation, manage expectations and further set realistic goals for all the phases of the rehabilitation process [4,5].

Over the last decade there have been numerous protocols that have been proposed for total knee arthroplasty rehabilitation, emphasizing on early mobilization in order to manage the immediate post-surgery complications, but also addressing issues such as weight-bearing levels, the use of assistive devices, and types of therapeutic exercises to be used in order to promote functional mobility, however a consensus regarding specific items and approaches of the different rehabilitation stages was not observed [6,7]. A re-

*Corresponding author:*

Gavril Gheorghievici

*E-mail:* gavril.gheorghievici@gmail.com

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habilitation protocol must include a multimodal approach consisting of not only kinesiotherapy, but also the association of other modalities such as aquatic therapy, cryotherapy, neuromuscular electrical stimulation in order to achieve all the set objectives. The purpose of the paper is to analyze the existing data on the topic, and to assess the therapeutic benefit of the rehabilitation programs following total knee arthroplasty [8-10].

## MATERIAL AND METHOD

A comprehensive systematic review was conducted using the online available databases (Pubmed, Cochrane, and EMBASE) in order to assess the current knowledge on the use of protocols for this topic. The search strategy included the words “knee arthroplasty”, “knee replacement” “rehabilitation”, “physical therapy” “balance”, “coordination” “protocol”, “open chained”, “pre rehabilitation”, “aquatic therapy”, “cryotherapy” and the study selection criteria included full text peer-reviewed articles published between 2018-2023. Only articles in English were selected. An additional search for consistent guidelines from different countries was performed, in association with hand research from the literature for relevant data.

## PREREHABILITATION

It is important to emphasize the need for pre-rehabilitation in patients scheduled for knee replacement surgery. This has a significant impact especially in the perioperative care, when the acute phase necessitates active participation from the patient in order to provide range of motion and active mobilization, which further has an influence over the rehabilitation outcome. It should be noted that in this period it is also important for the rehabilitation team to observe possible quadriceps deficits or balance and coordination problems including gait or walking inadequacies which could impact postoperative functional level and evolution. Strength training interventions are necessary in order to promote voluntary muscle activation not only on the scheduled for operation knee, but also on the opposite limb which will be over solicited in the first weeks following surgery due to weight bearing restrictions [11,12]. Pre-rehabilitation also allows for an initial clinical and functional assessment which should be a minimal benchmark for the post-surgery follow up and rehabilitation period in order to adapt the functional programs and progress compared to the initial functional evaluation. In this period the patient must also receive interdisciplinary counselling including reinsertion in the social and professional environment, family support and assistance and

also house modifications which need to be addressed in the first weeks post-surgery. An occupational therapist should address these concerns. This includes removal of any obstacles in house pathways such as rugs or wires in order to prevent the risk of falling [13,14]. Also appropriate lightening such as a bedside lamp or night light to increase visibility when walking to the bathroom should be provided. The instalment of hand rails must be taken into consideration especially when stair negotiation is involved depending on the household settings. Shower and toilet adjustments are required, with the use of grabbing bars and the placement of a shower chair if possible. The patient will be instructed by the case manager regarding the use of adequate bath rubs and shoe horns for bathing and dressing. This is also the period for nutritional assessment, meal planning and possible specific interventions in case of identification of negative metabolic patterns [15].

Numerous trials have evidenced that tailored pre-operative rehabilitation programs are correlated with diminished length of stay post-surgery, but also have the role to provide safety and patient satisfaction and to anticipate negative patterns, which is an aspect especially necessary for patients who are at risk of complications or possible limited outcomes. In a study by Stuhlreyer et al. regarding treatment expectations and patient state of mind before knee replacement such as fear or distress, the authors found a connection between the emotional status and post-operative pain which can be mediated by negative expectations. The authors used Stanford Expectation of Treatment Scale (SETS) and Pain and State of Health Inventory (PHI) as means of quantifying these results. The obtained data from the analysis emphasize on early detection of such factors and considering them as possible vectors of influence over the rehabilitation outcome [16].

## ACUTE PHASE 0-2 WEEKS

Most guidelines regarding the first stage of the rehabilitation process recommend early mobilization in order to gain as quickly as possible functional independence, and also to promote muscle strength and coordination. This should be done from the first day post-surgery, depending on the patients' compliance. The immediate effects of early ambulation refer to the prevention of deep vein thrombosis, but other issues are also addressed such as pain levels post-urgery, nausea and blood drainage management. Early ambulation also deals with the prevention of other complications due to postponed mobilization, such as atelectasis, infection, stroke or myocardial infarction [17-19].

Fast track rehabilitation is a concept that has been gaining much attention in the last decade, focusing primarily on shortening the length of stay in the hospital, and indirectly lowering the costs that are associated with prolonged hospital stay. There are many reports which suggest that fast track rehabilitation programs offer better results than conventional rehabilitation following TKA in terms of autonomy, acute recovery, faster development of self-care capacity and rapid discharge timing. This is consistent with a prospective multicenter study from the Danish National Patient Registry which monitored the rates of readmission, complications and morbidities and offered significant results in case of implementation of fast-track rehabilitation compared to a classic rehab protocol [20,21].

Immediately postoperative, in order to provide safety for the implant and also to prevent the risk of falling, the patient will be instructed to walk with the use of an assistive device. This usually implies the use of a walker or crutches, depending on the patients balance and capacity for coordination. In order to enhance the patients' adherence, permanent verbalization must be provided by the rehabilitation team concerning precautions, positioning of the operated leg, and self-applied strengthening exercises. Straight leg raise exercises must be performed independently from the first days post-surgery. Most guidelines require to achieve between 80°-90° of flexion in this phase of the rehabilitation process [22,23]. The use of a continuous passive motion (CPM) device still remains in debate, as CPM may be prescribed depending on the surgeon's preference, or in case of patients who develop severe range of motion restrictions, increased pain levels or the inability to actively participate in therapeutic exercises. More recent data does not provide consistent evidence for the use of CPM, outcome results and length of stay being nonsignificant with the appliance of a CPM device. However, prolonged use could encourage bed rest in a non-compliant patient [24,25].

Cryotherapy should be intensely applied in this phase of rehabilitation, and education towards home self-appliance must be provided for the patient. The use of cryotherapy should be done for 20 minutes before and after the kinesiotherapy program. The main therapeutic benefits refer to pain management and reduction of swelling, but it also has the advantage that it can be easily applied in most patient settings, and has diminished costs. Education and instructions must be made thoroughly, in order to prevent the risk for skin irritation, which is not an issue in most cases, if prescribed correctly [26,27]. Also, a towel roll should be positioned beneath the ankle in order to facilitate knee extension. Isometric exercises for quadriceps, hamstrings and gluteal muscles should be performed every hour for the first days post sur-

gery. Transfer training and gait training on flat surfaces should be performed every day, and after the patient has developed an adequate walking perimeter, stair negotiations should be initiated. Passive and active assisted exercises have to be performed every day, with the patient both sitting and in the supine position, using open chain exercises depending on strength, coordination, and pain levels. By the end of the first week, or by the time of discharge the patient has to be able to demonstrate an appropriate functional autonomy, with independent transfers and ambulation for at least 20-30 meters, and a sufficient quadriceps contraction [28-30].

However, most clinical practice guidelines recommend a continuity of the rehabilitation process in an inpatient or outpatient setting, which is more beneficial compared to a home-based physical therapy program. In a longitudinal data analysis by Christensen et al. regarding functional outcomes in case of direct transfer to an outpatient rehabilitation center versus a home set physical therapy program, patients from the rehab center group presented a better recovery at 1 month follow-up compared to the group of patients that only applied a home set physical exercise program in terms of residual postoperative pain, stair climb test, quadriceps and hamstring strength, six minute walk test and time up and go test. This pleads for the need of a continuum of the rehabilitation interventions following TKA in order for such patients to make the transition faster to complete autonomy and to resume their social and professional activities [31].

## PHASE II 2-8 WEEKS

In this subacute stage, the emphasis is put on maintaining a progression of the weight-bearing status, and promoting normal walking without the use of an assistive device. Patient education will be focused on changes that need to be made in a domestic environment and also modifications regarding social and professional activities. The evolution in this stage will mainly depend on the patients level of involvement, for more retained patients, and encouragement being necessary in order to actively participate in the process, while more intense motivated patients will be advised to scale down their level of exercise, in order to promote rest and facilitate the healing process. Management of edema will be continued in this phase, with the indication of the use of cryotherapy and leg elevation. If swelling is present in a large amount, compressive stockings could be indicated. By the end of the 8<sup>th</sup> week, patients will have to present 110° of knee flexion and complete extension of the operated leg [32,33]. Not being able to achieve this objective for some patients is mostly due to inadequate pain management. If the patient presents a

poor quadriceps activation, neuromuscular electrical stimulation (NMES) can be applied. In a 2021 meta-analysis which included 9 randomized controlled studies and a total of 691 patients, the authors found that associated NMES to the rehabilitation program in the first weeks post-surgery improves short-term and long-term quadriceps muscle strength, and also has an impact over mid-term pain and functional level. However, the study encountered certain bias issues, such as the fact that most procedures from the studies were not standardized, therefore influencing the heterogeneity of the study [34].

Proprioception exercises will be continued in this stage in order to promote body and spatial awareness. Also, gait and balance training with assistive device will be performed in order to provide normal gait pattern. By the end of this stage assistive devices will be generally discontinued, or in some cases even earlier if the patient demonstrates good muscle control and balance regarding his daily activities. Sit to stand and chair exercises will be executed in order to increase knee flexion and integrate it to other related functional tasks. Active assisted open chain kinetic exercises will be performed with the purpose to target not only the operated knee, but also core, hip and ankle muscles. Cycle ergometer is introduced if knee flexion is greater than 110°. Aquatic therapy can be initiated if the incision area is fully healed and has been approved by the interdisciplinary medical team. Clearance for return to driving should be given at the end of this phase [35,36].

Precautions in this stage include monitoring swelling and wound healing and refer to orthopedics department if any signs or symptoms of infection are present. Also, it is recommended to avoid consecutive days of intensive kinesiotherapy exercises.

Criteria for advancement to the next phase include an active knee flexion of more than 110° with the absence of knee lag and normal gait patterns and the capacity to ascend and descend 10 centimeters stairs with the absence of an assistive device [37].

### PHASE III 9-16 WEEKS

The goals of this phase are to maximize knee range of motion, restore normal function and return to baseline activities. Limb symmetry and equal weight bearing represent absolute objectives to be maintained in these weeks. The patient must gain his independence with all of his activities of daily living. Recommended exercises in this period include improvement of endurance, muscle strengthening and joint mobilization, increase in flexibility with moderate resistance as tolerated by the patient and expansion of proprioception. Balance exercises will include progression from bilateral to unilateral, and integration of unstable surfaces if possible. Cardiovascular

training is indicated in this period using bike or treadmill devices [38,39].

Specific recreational activities will begin after 4 months depending on the patients' pre surgery sports background and level of participation. However, it is recommended that high impact activities to be initiated only after supervision and referral from the interdisciplinary team and, if indicated, it should be age appropriate. This phase of the rehabilitation process is considered completed once all realistic functional goals are achieved [40,41].

### DISCUSSIONS

Although total knee arthroplasty is a widely practiced surgical intervention, unfortunately, not all patients receive satisfactory results after implantation and are not able to reach their full functional goals. This is potentially owed to multiple factors. One of them is the pain level which is particular to each patient. At the same time, associated comorbidities such as anxiety or depression should be carefully monitored, since it can represent a significant predictive factor for dissatisfaction, due to the possible influence over the perception of pain, and therefore present an impact over the level of participation in the rehabilitation program, resulting in lesser muscle strength, shorter walking distance, poor balance and diminished overall functional outcome [42,43].

In a 2022 observational study collecting data from 56,233 patients from the Dutch Arthroplasty Registry, in which the authors evaluated if symptoms such as anxiety or depression could influence the revision rate in patients with TKA, it was observed that increased pain levels were associated with revision surgery suggesting at the same time an influence of psychological factors, however more prospective data is needed in order to confirm such a correlation and adapt appropriate protocols [44].

Enhancing the patients engagement in the rehabilitation program is a continuous challenge and is always in need for new technologies in order to increase the level of participation and commitment. Virtual reality is a possible solution for such a requirement. In a 2022 meta-analysis regarding the use of virtual reality-based rehabilitation programs following TKA versus standard of care rehabilitation, the authors found that immersion in a virtual environment could offer therapeutic advantages over a more traditional rehab program. The analysis included studies that observed different technologies such as gaming activity for postural balance, dynamometric platforms, or weight-bearing biofeedback solutions. However, since virtual reality is an emerging field, there is a demand for more methodological data in order to provide better scientific evidence [45,46].

Aquatic therapy is also a treatment possibility which offers significant therapeutic results in patients with TKA, especially at the end of the second phase of rehabilitation and through the entire third phase due to its specific characteristics such as buoyancy, conductivity or thermal capacity. In a 2021 comparative study analyzing the therapeutic benefit of using aquatic therapy programs versus conventional land-based exercises and home-based exercise programs following TKA over a period of two weeks, the authors observed significant improved outcomes for the aquatic and land-based groups over the home-based group. There was an improvement in knee flexor strength in the aquatic therapy group compared to the classic kinesiotherapy group, but similar results regarding extensor muscle strength. This however evidences the fact that hydro-kinesiothera-

py alone or in association with more classic physical therapy exercises could enhance the functional prognosis following TKA [47,48].

## CONCLUSIONS

Data from the literature suggests that there is a variability regarding treatment methods and protocols following TKA. Although the general view inclines for a consensus and uniformity regarding therapeutic attitude, it is at the same time very difficult to apply the same rehabilitation framework to every patient, since each patients functional level is particular, and therefore the variability of the individual requires for a personalization of the rehabilitation options and strategies in order to obtain the best possible outcomes following TKA.

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