REVIEW

Post-operative rehabilitation in osteoarthritis [version 1; peer review: awaiting peer review]

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Abstract

Osteoarthritis (OA) is a degenerative process involving the progressive loss of articular cartilage, synovial inflammation and structural changes to the subchondral bone that lead to loss of synovial joint structural features and impaired functionality of the articular cartilage. OA represents one of the most common causes of physical disability in the world. Different OA treatments are usually considered in relation to the stage of the disease. However, in the earlier stages of the disease, it is possible to recommend physical activity programs that can maintain joint health and keep the patient mobile, as recommended by the Osteoarthritis Research Society International (OARSI) and the European League Against Rheumatism (EULAR). In the most severe and advanced cases of OA, surgical intervention is necessary. In early post-operative stages, it is essential to include rehabilitation exercise program therapies in order to restore the full function of the involved joint. Physical therapy is crucial for the success of any surgical procedure and can promote recovery of muscle strength, range of motion, coordinated walking, proprioception and mitigate joint pain. After discharge from the hospital, patients should continue the rehabilitation exercise program at home. In this review, we analyze articles from the most recent literature and provide a balanced and comprehensive overview of the latest discoveries in relation to the effects of physical exercise on post-operative rehabilitation in OA. The literature search was conducted in April 2014 using PubMed, Scopus and Google Scholar using the keywords 'osteoarthritis', 'rehabilitation' and 'exercise', in a range of period 2002/2014 and out of 100 papers we have chosen 48 that we considered more appropriate. The available data suggests that

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physical exercise is effective, economical and accessible to everyone, and is one of the most important components of post-operative rehabilitation for OA.

Keywords

Osteoarthritis, Rehabilitation, Exercise

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Introduction

Osteoarthritis (OA) is a degenerative disease of load-bearing synovial joints¹⁻⁵. Knee OA is the most common type of OA⁶ and represents one of the most common causes of physical disability in the world⁷⁻⁹. Deterioration of the articular cartilage is the main problem associated with OA with consequent chronic pain and functional restriction¹⁰. OA can be caused by fractures, ligament tears and meniscal injury, obesity, genetics, age, and kinematics, which lead to alterations in the joint cartilage^{2,8,10}. Traumatic injury to synovial joints is increasingly considered to be an important risk factor for the development of post-traumatic OA (PTOA). Traumatic injuries sustained during the lifetime of an individual combined with normal age-related wear and tear may facilitate the progression of degenerative joint diseases and may lead to chronic disability. OA is an insidious disease and typically develops gradually over a period of years. The primary symptoms include: pain, stiffness, limited range of motion (ROM) in the joint and localized swelling. OA pain is usually worse following activity^{3,11-13}. Stiffness can worsen after sitting for prolonged periods of time. As OA progresses, symptoms generally become more severe and pain can become continuous. OA occurs when joint homeostasis is changed by the dynamic steady-state between destructive forces and repair mechanisms^{7,14}. For example, the tibiofemoral mechanics and loading patterns during walking can influence the regional development of the articular cartilage⁸. Trauma, acute injury, ligamentous laxity, weight gain and improper footwear can lead to changes in gait, shifting load distribution on areas of the articular cartilage not well adapted to bearing different loads⁸. If patients do not improve with other therapies or have excessive pain and loss of mechanical function^{2,15,16}, OA treatments consist of surgical intervention and subsequent rehabilitation^{2,17-19}. However, information should be provided for all patients with hip and knee OA and they must be informed regarding treatment objectives and the importance of lifestyle changes, exercise, programming activities, weight reduction, and other interventions to reduce loads on affected joints. Self-help and patient-driven treatments should receive priority above passive therapies from health professionals. Then non-pharmacological therapies should be encouraged²⁰. The non-pharmacological recommendations have been widely emphasized over the last years. Recently, the European League Against Rheumatism (EULAR) produced eleven evidence-based recommendations for the non-pharmacological management of people with hip or knee OA²¹. Moreover, the Osteoarthritis Research Society International (OARSI) proposed other evidence-based recommendations, providing guidance to patients and practitioners on the treatments applicable to all individuals with knee OA, as well as on individual therapies that can be considered according to specific patient needs and preferences²². In this review article, we analyze the effects of post-operative rehabilitation exercise programs in OA patients treated with surgical procedures. All the data reported in the recent literature, from 2002–2014, suggest that physical exercise is an effective, economical and accessible tool that is useful in the post-operative rehabilitation of OA.

Morphological aspects of osteoarthritis

Cartilage is the most commonly studied tissue in the joint in the context of OA research. It is a unique load-bearing connective tissue with viscoelastic and compressive properties that are largely due to the presence of extracellular matrix, which is mainly composed

of collagen type II and the proteoglycan aggrecan^{9,17,18,23}. OA is a degenerative process involving the progressive loss of structural features and functionality of the articular cartilage caused by an imbalance between anabolic and catabolic processes in the cartilage tissue. Cartilage degradation exceeds the reparative processes as OA progresses^{10,14,24}. Generally, the surface of healthy hyaline cartilage appears white, shiny, elastic and firm. In contrast, OA cartilage shows a dull and irregular surface with discoloration, softening, and often more synovial fluid is produced²⁵. Cartilage, in advanced OA, often manifests signs of rupture with a surface that is rough and is fractured and cracked, even as far as the calcified zone²⁶; chondrocytes may disappear or gather in clusters near fissures. Cartilage organization is generally lacking in order and is substituted with fibro-cartilaginous, scar-like tissue with fibroblast-like cells²⁷. The damaged cartilage tissue can be covered by a rheumatoid-like 'pannus' of various extents which has been described in detail by several authors^{28,29}. The extent of damage to the articular cartilage depends on the joint surface area, which is exposed to different loading patterns and conditions in distinct regions²⁵.

First step post-operative rehabilitation in OA

Post-operative rehabilitation is crucial for the success of any surgical procedure³⁰. It has the purpose of recovery of muscle strength, ROM, coordination in walking and mitigation of pain. The post-operative rehabilitation program usually starts 48 hours after the surgical procedure as a result of the clinical evaluation of each specific case of OA. The rehabilitation is often long because of the time necessary for the cartilage cells to adapt and mature into repair tissue. Cartilage is a slow adapting tissue; in fact it undergoes 75% adaptation in approximately 2 years. When the rehabilitation period is too short, the cartilage repair might be placed under too much stress, causing the repair to fail³⁰. The type of post-operative exercise program used depends on the type of injury. Post-operative management and immobilization for primary treatment of acute musculoskeletal soft-tissue injuries is less effective than controlled mobilization. Early mobilization encourages a rapid return to physical activity, reduces persistent swelling, restores the stability of the tissue involved, restores ROM, and makes patients happier with the rehabilitation outcome³¹.

A post-operative rehabilitation exercise program should be based on the type of surgical procedure and on the location, size and depth of the lesion in order to facilitate the healing process³². The individual program should be structured according to the needs of the individual patient; it should depend on the type of surgery, age and medical condition. Arthroscopic procedures, such as chondroplasty or microfracture, may resolve faster than osteochondral autograph transplantation (OATS) or autologous chondrocyte implantation (ACI) that involve larger incisions, requiring a slower exercise rehabilitation program^{32,33}. Since immobilization and unloading result in the loss of proteoglycan in the articular cartilage and gradual weakening, controlled weight bearing and ROM are essential to facilitate healing process and to prevent degeneration of extracellular matrix of articular cartilage due to surgical procedure and subsequent immobilization^{24,34,35}. Indeed, bearing weight with its controlled compression and decompression forces, actually nourishes the articular cartilage and stimulates the production of an optimal extracellular matrix³⁴. The rehabilitation program is enhanced with a force platform in performing limited

weight-bearing activities for a normal gait pattern and increasing strength, proprioception, and balance³². The post-operative rehabilitation exercise program includes motion exercises and muscle strengthening, training in postural changes, training with any ambulatory aids (walker, Canadian crutches) and training in the climbing of stairs. During rehabilitation, passive range of motion (PROM) activities, in a limited ROM, are also indicated to nourish the healing articular cartilage and prevent the formation of adhesions³⁶. Continuous passive motion (CPM) enhances cartilage healing and long-term outcomes following cartilage surgery procedures³⁶. As the lesion heals and the symptoms decrease, the ROM is modified to allow greater muscle strengthening over a greater range of movement³². With surgical procedures, particularly with the OATS and ACL, arthrofibrosis could take place because of the large incision and extensive soft tissue trauma. Rehabilitation exercises should avoid this event³². When prostheses are implanted, it is advisable to use special machines for the passive flexion-extension of the joint depending on the type of prosthesis.

Symptoms, such as pain and effusion, could cause the inhibition of the muscle function, therefore electrical muscle stimulation and bio-feedback can be complementary to the rehabilitation exercise program to promote the active contraction of musculature³⁶.

Stretching exercises should be included as the patient progresses to advanced phases of rehabilitation³². As the patient returns to functional activities, it is important to gradually increase the amount of stress applied to the treated joint and to provide a stimulus for healing to cartilage tissues without causing damage³². Studies exist on articular cartilage health, highlighting that lack of movement results in articular alterations of the joint, and that physical activity reduces inflammation¹⁶. The rehabilitation exercise program following surgical procedures for OA is fundamental to the long-term success and functional outcome for the patients involved³².

Second step post-operative rehabilitation in OA

After discharge from hospital, the patient should continue the rehabilitation exercise program at home. The physiotherapist will indicate and teach the exercises to be carried out independently after discharge, aimed at maintaining a good muscular and articular quality. Patients surgically treated for OA often suffer from pain and have problems in carrying out daily activities, and physical activity programs could attenuate these deficits³⁷. Strengthening exercises, aerobic exercises or both together, show positive effects in reducing pain and improving physical function^{37,38}. However, the data reported in the literature show that the long-term benefits of exercise have no significant effect on pain or physical function after 6 months from the surgical procedure if the rehabilitation program is interrupted and not implemented with supporting exercise sessions, except when booster sessions are implemented³⁹.

Resistance exercise decreases pain, increases physical function and reduces disability⁴⁰. It should take into account loads, repetitions, movement speed and frequency of sessions, and is often supported by the use of machines or free weights⁴¹. Strength, ROM, pain throughout the ROM and patient access to the necessary equipment for exercise should be considered when planning a resistance exercise program⁴¹. When access to machines is too expensive for

patients, the exercise program should be performed at home^{42–44}. The resistance exercise program should be performed 3 days per week, with 2–3 sets per exercise at 8–15 repetitions per set⁴¹, and loads should vary from high to low⁴⁴. It is important to take into account the patient's tolerance to pain, in order to avoid his or her abandonment of the exercise program. The patient's tolerance should take into account the initial resistance loads and the joint ROM⁴¹. The resistance loads or number of sessions per week should increase as the patient acquires strength and confidence⁴¹. Data from the literature show that in a period of 2–9 months of progressive resistance exercise, pain could decrease by 42%–43%^{42,43}. Moreover, resistance exercise leads to increased muscle strength^{42,43}. Isokinetic torque can further increase after greater resistance exercise intensity⁴². These data support the idea that improvements in symptoms and functions are directly related to the intensity of the exercises and that higher intensity resistance exercise sustains muscle strength and preserves functionality⁴¹.

Aerobic exercise includes several activities such as walking, cycling or the use of a seated stepper machine. It has beneficial effects on joint mobility and pain, and it improves functional status of their general mobility and respiratory capacity^{30,45}. Aerobic exercise programs should take into account the age, mobility, co-morbidities and preferences of the patient³⁰. Modality and dosage are currently not well defined³⁰. The exercise bike is a helpful tool for exercising at home. Aquatic exercise, including aerobic, stretching and strengthening exercises, seems not to have effects on walking ability or joint ROM⁴⁶, thus it should be considered only as an optional activity for exercise programs^{30,46}. Land-based exercise and aerobic exercise show higher beneficial effects for pain reduction and function compared with aquatic exercises and strengthening exercises⁴⁷. A combination of both aerobic training and strengthening exercises could be the optimal choice to reduce impairments⁴⁸. The beneficial effects of exercise programs are mostly related to the patient's adherence to the exercise program, consistency and the number of sessions completed, while variations in the delivery, content and dosage do not influence the outcome³⁷. Data previously reported show that exercise programs have short-term benefits in reducing pain and improving physical function, but they do not persist in the long term if the patients do not adhere rigorously to the exercise program^{37,39,45}. Therefore, other strategies to increase long-term adherence to exercise are necessary to maximize the benefits of exercise program³⁷. Self-exercise is also linked to greater discipline and more positive results⁴⁵. Conclusively, the exercise program should be run parallel with information and behavioural strategies related to positive lifestyle changes and increased physical activities³⁰.

Conclusions

The articular joint is a highly complex 'organ system' that requires regular maintenance. When joints are immobilized for any reason, a number of negative physiological consequences may result. The severity, mobility issues, pain, stiffness and negative radiographic progression may be partly mitigated by a reduction in the level of chronic inflammation in OA patients. In the most severe cases of OA, surgical intervention is necessary. It is essential to associate a post-operative rehabilitation exercise program with surgical interventions in order to restore the full function of the involved joint. Rehabilitation is crucial for the success of any articular cartilage

surgery procedure, and has the purpose of recovery of muscle strength, ROM, coordination in walking and mitigation of pain. After discharge from the hospital, patients should continue the rehabilitation exercise program at home, performing strengthening exercises, aerobic exercises or a combination of both so that positive benefits may be gained in terms of pain control and restoration of physical function. Furthermore, regular physical activity promotes healthy joint cartilage, improves physical functions, reduces some OA symptoms and leads to psychological benefits. Physical activity can enhance fitness, muscular strength and endurance, preventing functional limitations and mitigating their progression, thereby improving the quality of life. The aim of this article was to underline the importance of exercise in post-operative rehabilitation as an effective, economical and accessible tool for all OA patients.

Author contributions

All authors have made substantial intellectual contributions to the conception and design of the study.

GM conceived the study design and supervised, wrote and structured the review. CP researched the area and identified papers, wrote and structured the review. MAS and RI structured the paper. AM reviewed and edited the paper. All authors have approved the final submitted version.

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