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Research Article

Pharmacological prophylaxis and functional restoration of the lower limb in total knee arthroprosthesis

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Abstract

The complexity of the movements of the bones of the knee joint requires an anatomical study to construct a knee prosthesis. The reasons for knee replacement are related to wear of the articular cartilage, which leads to pain, deformation, and limitation of movements. The consequences of the surgical intervention allow functional restoration of the knee joint and the supporting function of the lower limb. Kinesitherapy begins the day after surgery and aims to reduce pain, restore mobility of the knee joint, actively lock the knee during extension, increase and maintain muscle strength, and ensure the functional independence of patients. To a large extent, the volume of movement is restored, and the pain symptoms are reduced. Patients have the comfort of everyday movements and the possibility of participating in certain sports activities—swimming, cycling, and golf. The paper deals with pharmacological prophylaxis, the kinesitherapeutic program, and total knee arthroprosthesis.

Keywords

drugs, knee joints, endoprosthetics, functional recovery

Introduction

Continuously increasing demands on the quality of life are also reflected in increasing demands on endoprosthetics, related to maximum speed of recovery, achievement of full functional activity, and even longer periods of survival of artificial joints (Vladeva et al. 2018). The satisfaction of these requirements depends on the complex application of several interrelated main factors: the materials from which the joint is made, the method of fastening the components to the bone, the operative technique, and last but not least, the timely start of rehabilitation for endoprosthetic patients (Yotov and Rusimov 2013).

The majority of patients who undergo total knee arthroplasty are over 65 years of age. The survival period of a knee joint is about 20 years. About 85% of patients have good or excellent results after prosthetics (Ilieva 2000). Despite the known benefits of patient involvement in pain

management, gaps remain in providing patients with the knowledge and opportunity to take an active role in their recovery (Keast et al. 2022).

A study by Slavchev (2021) indicates that patient satisfaction with the outcome of knee arthroplasty cannot reach that of hip arthroplasty. While between 89 and 93% of patients are satisfied or very satisfied with the result after hip alloplasty, after knee arthroplasty, the proportion of satisfied patients is around 85%, with some series dropping to 75%.

In general, long-term outcomes are continually improving with the introduction of new implants and new surgical techniques. There is also a tendency for the rate of complications related to knee arthroplasty to not decrease (Fisher et al. 1997).

Reasons for knee replacement

The knee joint is subject to a large static and dynamic load. It is often subjected to traumatic injuries that cause instability and later dystrophic-degenerative changes in the joint (Ilieva 1996). Arthroplasty is a routine operation to relieve joint pain and range of motion. It is used when there is a permanent disorder in joint mechanics. Endoprosthetic replacement ensures activity and a high quality of life. Usually carried out in the elderly, the intervention leads to good results (Kraydjikova et al. 2014).

The reasons for a patient to undertake surgical treatment are pain during movement and in a state of rest or nighttime, specific arthritis (rheumatoid arthritis), gouty conditions after trauma and infections of the joint, failure to influence the pain with the methods of drug and injection treatment, loss of movements in the knee joint, instability, a changed way of walking with a load on the other joints, limitation of mobility to carry out everyday commitments, and limitation of the possibilities of inclusion in the established way of life, contacts, and entertainment (Huten and Pasquier 2023).

Recommendations for pharmacological prophylaxis in planned knee arthroplasty

Pharmacological prophylaxis is recommended for patients undergoing knee arthroplasty, according to consensus guidelines established by the American College of Chest Physicians (ACCP), the American Academy of Orthopedic Surgeons (AAOS), the National Institute for Health and Care Excellence (NICE), and the Scottish Intercollegiate Guidelines Network (SIGN). The prophylaxis can be administered using low-molecular-weight heparin, low-dose unfractionated heparin, vitamin K antagonists, fondaparinux, apixaban, dabigatran, rivaroxaban, aspirin, or intermittent pneumatic compression. The use of low-molecular-weight heparin is considered the gold standard. The recommended duration for prophylaxis is between 14 and 35 days (Geerts et al. 2008; Falck-Ytter et al. 2012).

The Bulgarian Orthopedic and Traumatology Association (BOTA) recommends the regimens for prophylaxis given in Table 1.

In patients with a Padua Prediction Score of 4 points or higher, low-molecular-weight heparin (LMH) is administered at a standard dose 10–12 hours before surgery. Prophylaxis is continued postoperatively for 6–12 hours with direct oral anticoagulants (DOAC), according to the operator's prescription (Davis 2004).

Each of the above methods of pharmacological prophylaxis can be combined with mechanical prophylaxis

Table 1. Regimens for prophylaxis according to BOTA.

Medication	Standard prophylactic dose	Application
Low-molecular-weight heparins		
Clexane [1]	0.4 ml/24 hours	The first dose is administered 10–12 hours before surgery, and the first postoperative dose – 10–12 hours after surgery. Duration 14–35 days.
Fraxiparin [2]	0.2 ml/24 hours for body weight below 50 kg, 0.3 ml/24 hours for body weight of 50–69 kg, 0.4 ml/24 hours for body weight over 70 kg	
Synthetic pentasaccharide with anti-Xa activity		
Fondaparinux (Arixtra) [3]	2.5 mg/0.5 ml/24 hours	The first dose is administered 36 hours before the surgery, and the first dose after the surgery is given 6–12 hours later. The duration of treatment is between 14 to 35 days. The duration is decided by the operator based on the patient's risk factors and the early verticalization and loading of the limb.
Anticoagulants		
Pradaxa [4]	220 mg	Once daily, for a period ranging from 14 to 35 days. The duration of the treatment is determined by the operator based on the risk factors and the early verticalization and loading of the limb. The first dose should be administered 6–12 hours postoperatively, considering the risk of vertebral bleeding under regional anesthesia.
Xarelto [5]	10 mg	
Eliquis [6]	2×2.5 mg	

[1] http://www.medicine.bg/public/listovka/34401d.pdf
[2] http://www.medicine.bg/public/listovka/27341d.pdf
[3] https://ec.europa.eu/health/documents/community-register/2016/20160915135796/anx_135796_bg.pdf
[4] https://ec.europa.eu/health/documents/community-register/2018/20180108139551/anx_139551_bg.pdf
[5] https://ec.europa.eu/health/documents/community-register/2008/2008093049239/anx_49239_bg.pdf
[6] https://www.ema.europa.eu/en/documents/product-information/eliquis-epar-product-information_bg.pdf

(compression stockings with graduated compression, intermittent pneumatic compression, and a venous foot pump), but mechanical prophylaxis is not recommended as a stand-alone method. The dosage and choice of medication should be tailored to the patient's kidney and liver function (Mihov et al. 2023).

Postoperative period. Periods of the kinesitherapeutic program

After surgery to implant an artificial knee joint, patients stay in the hospital for 5 to 8 days. Sometimes the stay can be longer (Oldmeadow et al. 2004). Active kinesitherapy and physical therapy start the next day. The kinesitherapy program includes isometric exercises for the muscles in bed, flexion and extension of the knee to a straight position (at this stage, passive movement of the „long passive movement" method is also used) (Lenssen et al. 2006), stepping, walking, and climbing stairs (Ilieva 2003). Patients stand up with help on the second postoperative day. In the following days, patients walk independently with two crutches; training is started in proper walking, ascending and descending stairs, active flexion and extension of the knee against gravity, and isometric contractions for the thigh muscles (Roddy et al. 2005). Anticoagulant prophylaxis is administered (Jenny et al. 2020). Pain relievers are given at medical judgment (He et al. 2020).

With knee arthroplasty, the swelling of the tissues around the knee joint, lower leg, ankle joint, and foot spreads much more slowly and with difficulty, which further limits the range of motion and is often accompanied by pain and discomfort in the endoprosthetic limb (Vladeva et al. 2018). The goal of the kinesitherapy is to achieve 120° knee flexion by day 30. Practicing activities of daily living is applied. It is recommended to carry out cryotherapy for at least three hours a day in parts of 20 minutes (Aggarwal et al. 2023). Passive-assisted manual mobilization is applied without forcing the knee or mobilizing the patella (Dimitrova 2011). Patient re-education includes extension work consisting of locking the knee by applying isometric contractions, manual control by assisting patellar movements, and training for the m.vastus medialis. On the 8th day, antigravity loading is applied to the quadriceps femoris muscle—the lower legs lowered outside the couch (Vasileva-Decheva 2012). Flexion in the knee joint is trained, and by the 10th or the 12th day, it should reach 90° flexion. Towards the end of the period, a training device for flexors in the knee joint against manual resistance is applied (Kostov et al. 2010).

Mobilization of the patella is applied in all planes, especially cranio-caudally. A massage is performed to affect adhesions and achieve an elastic cicatrix (Barakova 2003).

The application of myofascial techniques to the soft tissues improves the mobility of the fascia to activate blood and lymph circulation and balance the static and dynamic muscle tone of the body. Myofascial techniques involve compression, stretching, and the release (relaxation) of soft tissues. Myofascial techniques applied in the area of the lower limb should not cause painful symptoms. A V-shaped caudal movement is performed with the fingers on the calf muscle from the occipital position with slight flexion in the knee joints; cranial movement of the tissues using the thumbs from the calcaneus region in the direction of the popliteal fossa; and soft fist thrust in a caudal direction on the lateral line of the thigh /m. tensor fascia latae/ (Kraydjikova et al. 2014).

Global work includes training for m. gluteus medius, m. ticeps surai, and the lateralizers of the foot. Gait is trained, and activities of daily living are included to gradually return the patient to autonomy (Lebleu et al. 2020). Table 2 presents the restoration of autonomy in a knee arthroplasty patient by period, according to Vasileva-Decheva and Barakova (2012).

Table 2. Restoration of autonomy in a knee arthroplasty patient by periods.

Period	Patient autonomy
From day 0 to day 10	Walking with 2 crutches.
From day 10 to day 20	Gradually increases the walking distance with both crutches.
From day 15 to day 21	The walking distance increases, which should be greater than 200–300 m. Climb 20 to 25 steps.
After day 21	Closed circuit training, increasing gait parameters.

When performing bipodal support by the patient, the kinesitherapist monitors the co-contraction of m. quadriceps femoris and m. triceps surae (Mihailova et al. 2016).

From day 30 to day 90, patients walk daily with full limb support, allowing discontinuation of anticoagulants. Gradually stop the analgesics and continue the application of cryotherapy (Ilieva et al. 2003). Elastic stockings are gradually removed, except in patients with preoperative venous insufficiency. In this phase, the patient can perform all daily activities (Evans 2023).

During this period, it is necessary to train the gait. The application of rhythmic stabilization helps to achieve adequate motor control in the knee joint, which is a necessary condition for good locomotion in the endoprosthetic limb. The progression of the training starts with the removal of the cane while walking on level ground, and then it is improved by adding obstacles and walking up and down slopes. (Jahier 2022). The range of motion is increased in the second phase, with aiming flexion above 95° and locking the knee joint at 0°. Additionally, mobilization of the patella and massage are performed, and active exercises are applied to further improve motor control. (Lacote and Chevalier 2019).

Exercise is applied to the muscles of the M. quadriceps femoris. The training aims to achieve good knee joint locking to create stability during the single-support phase of walking. A gentle stretching of the dorsal muscle groups of the endoprosthetic lower limb is applied, along with training with periodic static work of both quadriceps with progressive application of resistance (Fernandez et al. 2023). Balance training ensures safe walking. To achieve this goal, balance training is applied from a bipodal stance on level ground (Yassine 2021).

During the final phase of kinesitherapy, which starts on the 90th day, the patient should be trained to maintain the recovery results achieved by performing simple exercises multiple times a day at home. If the patient has functional deficits, it is advisable to continue kinesitherapy twice a week. (Groupe MPR Rhone-Alpes et Fedmer 2008). The gait pattern should incorporate the knowledge gained during the patient's re-education phase (Boukebous et al. 2023). Patterns of walking on level and uneven terrain, climbing and descending stairs, and standing or sitting summarize good recovery after total knee replacement. The goal of the kinesitherapy program is to properly train patients, prevent contractures from forming, and strengthen the muscles around the new joint. Patients are instructed not to overtax the artificial joint excessively (Pozzi et al. 2013).

In summary, we can say that the kinesitherapy program for patients with knee replacement is tailored to the most common clinical functional problems in these patients and aims to overcome muscle imbalance and restore neuromuscular control over the knee joint.

The functional recovery program includes muscle energy techniques for relaxing m. rectus femoris (reciprocal inhibition by isotonic contraction of its antagonists), to stimulate flexion and overcome extensor deficiency in the knee joint, myofascial techniques to reduce soft tissue pain, swelling and increased muscle tone, analytical training to increase active flexion and extension in the operated knee joint within comfort, if necessary with the help of a kinesitherapist (for prevention of postoperative contractures), elements of proprioceptive neuromuscular facilitation (rhythmic stabilization in a closed kinetic chain), training in correct walking with two aids, in early postoperative kinesitherapy is the verticalization of patients. Patients with ankle joint endoprosthesis during the first 1–3 months use aids such as crutches, canes, etc. The transition to full loading of the operated joint occurs gradually, and about 60 days after the operation, loading can be started without aids (Troev and Mavrova 2009).

Possible complications of knee arthroplasty

Patients with an implanted artificial knee joint should monitor their condition carefully and seek medical attention if they notice stabbing in the chest, shortness of breath, or expectoration of blood. All of these can be symptoms of a pulmonary embolism. Watch for pain with swelling and redness of the lower legs (Oldmeadow et al. 2003), swelling and redness of the operated knee, discharge from the wound scar of a cloudy, bloody, or pus-like secretion, increased temperature, etc. In these cases, it concerns a possible infection around the endoprosthesis (Jenny and Gisonni 2022).

Pain is always an alarming symptom; it must be distinguished from normal pain „on the motion," which usually occurs at the beginning of motion during the first 3 to 6 months after the placement of the artificial joint. The infection is characterized by a dull, deep, vague pain that occurs at night. Patients may have neuropathic pain that has a significant impact on their function and quality of life (Priol et al. 2023). Pain, which usually increases with excessive physical exertion, walking, and physical activity and decreases with rest, is characteristic of the wear of the prosthesis (Vanhersecke 2020).

Conclusion

The main goal of installing a knee replacement is to return to work and have a satisfactory daily life with less pain and good function (Mangin et al. 2022). The number of operations continues to increase, and the length of hospital stays decreases. As most patients require treatment for several months, the physician's role is essential to detect and treat factors that affect functional outcomes (Peter et al. 2015) by prescribing physical therapy at a constant pace without interruption during the first weeks. In the longer term, it should also encourage adapted physical activity (Lüthi et al. 2012). Patients have the comfort of everyday movements and the possibility of certain sports activities, such as swimming, cycling, and golf (Ethgen et al. 2004). In more than 85–90% of patients, the implanted artificial knee joint works very well about 10 years after the first operation (Jennings et al. 2019).

Resuming walking, hiking, or golfing are motivating goals for knee replacement surgery. The risks of sports after knee replacement are accelerated wear of the prosthesis and the risk of loosening (Mandzuk et al. 2015).

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