Total knee replacement. Postacute phase in rehabilitation: objectives and strategies in postacute treatment

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Abstract. Identification of a population with homogeneous characteristics is the fundamental introduction to elaborate a rehabilitation plan after operation of total knee arthroplasty (TKA). The main objectives of our rehabilitative protocol are: improvement of the preoperative clinical state, prevention and management of the common postoperative problems and complications. The first objective requires the improvement of the function of the operated knee (good articular excursion, muscular strengthening and recovery of ambulation and of gait pattern), as well as the reduction of pain. These protocol objectives are progressively achieved spreading postoperative rehabilitative strategies into four stages, during which patient should take instruction about the adoption of a correct life style.

Key words: Rehabilitation, arthroplasty, knee

Introduction

It is acquired that in the knee osteoarthritis there are a reduction of quadriceps strength (1-4), propioceptive deficits (5-11) and pathological gait pattern (12-15). Besides, the patient operated of total knee replacement for osteoarthritis presents functional alterations of the limb (4, 16) that , finally, affect gait kinematics (17-19). So, the complete functional recovery may be impaired.

The elaboration of a rehabilitative protocol, intended as a recovery and standardized functional reeducation project, has to consider such experimental evidences starting from the identification and analysis of the population. This protocol shall be applied to a population whose characteristics have to be homogeneous in age, handicap, disability, residual and recoverable abilities.

The patients who undergo first cemented TKA implantation, generally over sixty years old (moderate physical and working activity), are electively operated because of strong pain, functional limitation or after an unsuccessful conservative treatment (FANS, lifestyle modification, FKT, physical therapy, aids) and they expect improvement in the quality of life (reduction of pain and disability).

The acute-phase postoperative rehabilitation consists in the achievement of a knee flexion about 90°-120°, deambulation already started in partial weight-bearing on the operated limb with crutches and without wearing knee immobilizer. Nevertheless a 10°-15° extensor lag is not unusual.

At discharge from orthopedy department, generally on the 7^{th}-10^{th} postoperative day after the cemented TKA implantation, the postacute phase of rehabilitation starts.

Improvement of the preoperative clinical state, prevention of the postoperative complications and management of the common postoperative problems are the objectives of the postacute rehabilitative intervention.

Attainment of the improvement of the preoperative clinical state implies the reduction of the pain and the functional improvement of the operated knee, that

depends on a good articular excursion, muscular strengthening, recovery of ambulation and of gait pattern.

Such objectives are achievable only and exclusively if, together with them, the strategies to avoid interruptions of the rehabilitative course are performed; these interruptions might originate from external factors, but also from the patient's general health conditions (treatment and monitoring of the comorbidity; hydration and nutrition, control of the body weight).

Theoretical basis of the rehabilitation

During the postacute rehabilitation phase after TKA, it's necessary to improve knee articular range. In fact, after operation the knee articular excursion, already compromised in the preoperative period, results of notable importance in carrying out activities of the daily life (ADL), beginning from the ambulation.

The least condition for resumption of the common daily activities is represented by the attainment of 90° knee flexion.

In fact, supposing a normal function of the hip articulation, in the gait on one level, at least 65-70° of knee total flexion are necessary; in the phase of preswing (of the oscillatory phase of the footstep) a flexion of 35-40° is required to lift the foot, and additional 30° are necessary in the phase of initial swing (20-22).

These are the necessary knee flexion degrees to complete some of the daily life activities: 83° to climb the stairs (23), 90° to go downstairs and at least 105° to get up easily from a chair (24), 90° to take a seat and 106° to lace the shoes (23). Besides, it's suggested that for a good ADL recovery the combined flexion of hip and knee should be greater than 190° (25).

The complete extension of the knee, that is of fundamental importance for the execution of some phases of the walk, is realized, during the normal ambulation, in the initial contact (of the phase of double support), in the mid-stance (of the phase of support on single limb) and in the terminal- stance (of the phase of oscillation) (20).

The data related to the pre-operating predictive factors of the postoperative range of motion (ROM) are conflicting; some authors think that the preoperative ROM is the most reliable (24, 26-28) observing how patients, with reduced flexion before the operation (<100-115°), generally improve after TKA (29); others have not noticed any correlation, instead (30, 31).

Prognostic preoperative negative factors are obesity (27, 32) and previous surgical interventions (27).

At discharge, that is the beginning of the postacute rehabilitation phase, the goals that the patient has generally already reached are : an articular excursion in flexion of around 90° and a possible coexistence of an extensor lag of 5-10°.

Concrete and realizable objectives after TKA are represented by a ROM of 105°-110° in flexion (33) - some cultural factors such as the Japanese way of sitting , aid a wider flexion range (32) – and by a complete extension achievable, after opportune physiotherapic treatment and supposing regular postoperative period, in 4-5 weeks from surgical intervention.

The articular excursion restoration after TKA starts from elimination of the factors that potentially interfere with it. So, it's necessary to minimize the quadriceps antagonist reflex controlling the pain (see later) and performing quadriceps isometric exercises; massotherapy from the 2nd postoperative week dissolves adherences at level of the *supra-patellar* bursa .

Secondly, the articular excursion recovery considers passive (Fig. 1), active and active-assisted mobilization of the knee in flexion and in extension (Tab. 1), beginning from discharge.

Figure 1. Passive flexo-extension exercises

Table 1. Exercises of active and active-assisted mobilization of the knee in flexion and in extension after TKA

Quadriceps flexion exercises	
Exercise n. 1	in sitting position make the foot slip backwards with the plantar surface adherent to the ground. Maintain position for 10 sec
Exercise n. 2	in sitting position, slowly flex the knee up to achieve complete flexion
Exercise n. 3	flex with caution the operated knee helping himself with the controlateral leg, up to feel sensation of strain
Quadriceps extension exercises	
Exercise n. 1	sitting, support the foot on a stool so that passively extend the knee
Exercise n. 2	try to achieve complete extension pushing with the hands on the thigh for 20 sec
Exercise n. 3	sitting, with the sole adherent to the ground and the foot as much posterior as possibile, extend the knee and maintain position for 5 sec

From the sixth week, it's possible to add exercises of lengthening in lunge and exercises of muscular stretching, specially of the hamstrings.

Appropriate muscular recruitment is the basis for the knee dynamic stability recovery. So the muscular strengthening strategy is a fundamental part of the rehabilitation protocol. Quadriceps muscle plays a key role in knee dynamic stability.

During ambulation it takes part in concentric way in the oscillation phase (swing) to extend the knee, in eccentric way in the initial phase of adaptation to the load to prevent body fall and again in the intermediary phase (mid-stance) to maintain knee in middle-flexion .

In the knee osteoarthritis, the reduction of quadriceps strength precedes operation of TKA (1-4) and, according to some authors (2, 5, 34, 35), it is a progression factor in degenerative process; one of the mechanisms responsible for strength decrement is considered the deficit of voluntary activation (*voluntary activation deficit* or *arthrogenous muscle inhibition*) commonly pointed out in these patients (36, 37). Although improving after total knee arthroplasty , reduction of quadriceps strength doesn't resolve completely and therefore it could jeopardize muscular strength recovery during postoperative period (4).

Quadriceps strength recovery is already essential in the precocious phases to begin the load, with the purpose to avoid yeldings in flexion (risk of fall and articular stress) and to allow ambulation without *chalked showers* or extension immobilization supports. In a second phase, quadriceps strength recovery is fundamental for knee dynamic stability and, therefore, it is an integral part of ambulation recovery .

Other muscles acting on the knee in opened and closed kinetic chain are concerned in rehabilitative intervention of muscular strengthening .They are hamstrings, triceps sura and ankle dorsiflexors (Tibialis anterior, Extensor digitorum longus and Extensor hallucis longus) muscles.

Muscular strengthening strategy can be planned in two fundamental phases with a double purpose: to avoid in the first recovery phase the functional overstress and to allow, in a second moment, dynamic stability restoration of the operated knee by increasing the mechanical solicitations resistance.

Till the 6th-7th postoperative week (the first phase), it is necessary to avoid exercises in concentric contraction against resistance and exercises in closed-kinetic-chain and to make quadriceps isometric contraction exercises , that favor reduction of antalgic reflex; in addition active contraction exercises against gravity within active ROM (adduction/abduction of the hip, flexo-extension of the knee and of the ankle), low resistance cyclette, when active ROM allows it, are performed.

From the 6th-8th postoperative week (the second phase), concentric contraction exercises against progressive resistance and exercises in closed-kinetic-chain can be started and continued till needed.

Closed-kinetic-chain exercises, performed in natural weight or with isotonic machines, train inferior limb to bear the elevated solicitations that stress prosthetic implant in the phase of walk support; besides, these exercises protect, at least partly, the joint from

the forces that move forward the tibia during the extension and from those that cause a back shift during the flexion.

In both phases the proposed exercises have to offer appropriate resistances under mechanical conditions that simulate the gesture to re-educate.

Together with the knee articular excursion restoration and muscular strengthening , ambulation recovery plays a basic role in the rehabilitation.

Currently, the concession of the weight-bearing depends, to a large extent, on the surgeon's orientation, as well as, naturally on the model of installed prosthesis, on the anchorage system used, on the bone conditions and on the patient's general health status.

The cemented arthroplasty allows weight-bearing with walker, in the limits of tolerance, beginning from the 1st postoperative day and can nearly bear already a complete load during the second postoperative week. So at discharge the patient has already started weight-bearing and use of crutches , and he has already performed ambulation on level surfaces for a few days and trained to the postural passages.

From the 2nd until the 6th postoperative week, the patient walks with crutches. Later one of these will be left and the other will be maintained for six weeks again. At the end of the third month, generally, total weight-bearing is allowed , so that the patient can leave the crutch.

The ambulation resumption cannot prescind from the walk scheme recovery; it is acquired that in the patients affected by knee osteoarthritis , patogenetically correlated to previously mentioned deficits of muscular strength (1-4) and voluntary muscular activation (36, 37) of the femoral quadriceps , propioceptive deficits (5-11) that alter and compromize normal knee and walk kinematics (12-15) coexist.

Often, the knee osteoarthritis , with different severity degrees, it's bilateral and it's accompanied to arthrosic damages in the other side (hip, rachis, …); so the re-education to a correct gait pattern becomes essential to reestablish a mechanical equilibrium, that is strongly altered also by preoperative pain, and to reduce risk of falls.

Knee flexion ROM of 90°-120°, knee complete extension and tone recovery of muscles involved in the walk are the basis for ambulation recovery.

Besides, the patient needs to learn the postural passages, the correct use of the crutches in the walk on a level surface and to go up and down the stairs and finally rules of life style (well stuffed shoes to the heel and forefoot) (38) that protect the operated limb and facilitate recovery of daily activities.

The patient is not allowed either to run or to jump, he cannot drive for 4-6 weeks. The length of the physical activity must be gradually increased, alternating frequent periods of rest; for a long time term is advisable to perform certain sporting activity as swimming, golf, bicycle, cross-country skiing (39) .

Pain is a common experience in the postoperative period and it can interfere with the normal recovery of articular excursion and muscular force, triggering the quadriceps antagonist reflex and inhibiting the load, or because it can subtend some complications.

Medical therapy, kinesitherapy and cryotherapy control the late postoperative pain.

The medical therapy with analgesic (FANS or tramadolo) must of course take into account of the comorbidity and the side effects for every patient. It would be preferable a dosage that assures the analgesia during the whole day, so that the therapeutic exercises can be effectively performed.

The isometric exercises made with and without physiotherapist since the first days favor the reduction of quadriceps contraction .

Often, with the progressive increase of the weight-bearing and of the time of physiotherapy, the pain becomes acute again, with knee redness and heat after physiotherapic sessions. In such occasions, cryotherapy application at intervals recovers the inflammatory symptomatology.

The common postoperative problems for which the patient consults physician to ask him if they reenters in the normality or in case they are complications , are knee inflammation, leg, ankle and foot edema, instability and articular noises.

They have to be monitored in their evolution . In fact, mild knee inflammation signs in the first weeks or even for some months can be normal, without other suspicious elements of articular infection as reduced articularity or fever. The leg, ankle and foot edema overseeing is of fundamental importance for deep ve-

Table 2. Scheme for TKA rehabilitation protocol of the postacute phase

From the 7th/10th to 14th postoperative day

Exercises:
- Physiotherapy at least 2-3 times/week
- Passive, active and active assisted knee mobilization
- Active hip mobilization (extension-adduction-abduction)
- Active ankle mobilization (flex-extension)
- Femoral quadriceps isometric exercises

ROM:
- Flexion 90° at least from the 2nd postoperative week
- Extension 0°, but 10-15° extensor lag is not unusual
- Begin rotula mobilization

Ambulation:
- Partial weight bearing with two crutches
- Walk on a level and start education to climb the staircases with aids

Functional activities:
- Education to the postural passages

2nd-5th postoperative weeks

Exercises:
- Continue with the autoadministered progressive resistance exercises
- Begin cyclette when the active flexion ROM allows
- Surgical wound mobilization once ablated the agraphes.
- Continue rotula mobilization

ROM:
- Flexion: 90° at the 2nd week, 110° at the 5th week
- At the 2nd week 10-15° extensor lag is not unusual
- Extension 0° at the 5th week

Ambulation:
- Walk without assistance with two crutches on plain level and go up and downstairs

From the 6th postoperative week

Exercises:
- Begin closed kinetic chain exercises
- Gradually progressive resistance cyclette

ROM:
- 0 – 120° flexo-extension.

Ambulation:
- Leave one cructh

From the 12th postoperative week

- Continue autoadministered exercises
- Cyclette
- Training to the walk
- Leave crutches

nous thrombosis differential diagnosis. Besides, lateral and anteroposterior instability sometimes persists and, in the light forms, it can be corrected with the use of knee orthoses and with quadriceps and hamstrings reinforcement. Finally, the crackle is the most common noise felt by patient in the knee during the active articular excursion, probably due to the articular tissue glide on the metallic surface of the prosthesis. It

doesn't have clinical implication and, like all other clicks, disappears in the time.

For some of these symptomatologic questions there is no treatment because they represent the normal postoperative course.

For the light forms of instability, it is necessary to concentrate the physiotherapic treatment on the reinforcement of the knee articular muscles.

A correct style of life is necessary to optimize and to maintain the therapeutic successes obtained. It consists in avoiding functional stresses ,reducing the risk of falls, performing moderate aerobic activity for the maintenance of the correct cardiovascular tone.

Practically the patient should use rubber antislip rugs, and a stool when he has a bath by himself till the confidence acquisition. Besides he doesn' t have to run nor to jump. It's recommended toincrease gradually the exercises intensity with long rest periods, wear low-heeled shoes, stuffed in the forefoot and to moderate physical activity on the basis of the indications already introduced (39).

Considering the previous statements, we have elaborated a TKA rehabilitation protocol of the postacute phase, currently applied in our department. The fundamental protocol characteristics are listed in table 2.

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