GUIDELINES OF OPERATIONAL STANDARD PROCEDURES IN REHABILITATION AFTER LOWER LIMB ORTHOPEDIC SURGERY
GUIDELINES
OF OPERATIONAL STANDARD PROCEDURES
IN REHABILITATION
AFTER LOWER LIMB ORTHOPEDIC SURGERY

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The current guidelines aim to develop common OT rehabilitation protocols after orthopedic surgery for vocational education & training (VET).

The Document introduces a brief picture of selected standard rehabilitation operational procedures after lower limb orthopaedic surgery aiming to develop basics skills for medical specialists in rehabilitation (theoretical and practical skills for assessment, decision, treatment in different pathologies).

The goal of these protocols is to provide the clinician with a guideline to establish and progress a patient through post-op rehabilitation. It is not intended to be a substitute for one’s clinical decision making. The plan of care should be based upon the patients clinical exam and individual goals.

We must take into consideration multiple variables, including: mechanism of injury, fracture type, fixation method, fixation stability, bone and tissue quality, patient’s characteristics (including comorbidities, age, goals and expectations) and surgeon specific philosophy preferences.

Based upon these variables, wide variations of progressions and patient outcomes may exist, however the following is a basic guideline that can be used in reference.

In every clinical case physiotherapists must notify the PRM & OT medical doctors immediately of any concern for DVT, infection, excessive oedema, or significant variation in expected progression / outcomes.
1.1. Scope

The Recommendation of the EU Parliament and of the Council of the Establishment of ECVET are taking place in a framework in which there is a serious need of complementarity between vocational training and higher education. Increasing the quality of vocational skills requires the development of world-class VET systems. The need for harmonisation development of an unitary system in medical education across Europe with common standard procedures is a well known fact.

In orthopedics, in particular after surgery, a long and difficult rehabilitation process follows in order to regain normal gait and requires INTERDISCIPLINARY TEAM approaches. Rehabilitation should be commenced early to promote independent mobility and function. The initial emphasis should be on walking and activities of daily living (ADL), for example, transferring, washing, dressing, and toileting. Balance and gait are essential components of mobility and are useful predictors in the assessment of functional independence.

Collaboration between orthopaedic surgeons, PHYSIATRISTS and rehabilitation professionals should be sought to assist in medical management and rehabilitation. The benefits of shared postoperative management by orthopaedic surgeons and rehabilitation professionals include trends towards earlier functional independence, reduced length of stay, improved management of medical conditions and decreased future need for institutional care, including nursing home care.

In these circumstances we decided to develop the COR-skills project that adresses to Vocational Education on higher education level. Our Strategic Partnership is supporting a project-based collaboration between hospitals and HEIs, to develop, test and adapt a continous VET programme, based on an exhaustive needs analysis and focusing on a “real-life” transnational approach. We aim to stimulate resident learning by new approaches, as the development of an innovative e-training method which is able to provide the trainees with a range of case studies and an advanced training curriculum. This will function as a
virtual medical environment, similar with the work place and help attune curricula to current and emerging labour market needs and equip the specialists with required skills, by developing active cooperation between HEI and partners from outside academia: hospitals, medical centers, research centers.

We are committed to providing the highest possible quality research products to aid in both education and applied clinical decision making. In addition, we hope to stimulate interest in solving clinical problems in the field of OT rehabilitation and to offer personalised support both for the learners but also for the clients (patients). Implementation of individualised health care approaches is one of the major innovations of the current project, encouraging critical thinking of the trainees, reinforcing the quality of rehabilitation services, increasing the level of health care, decreasing the rehabilitation time and health costs, stimulating the development of inter-sectorial and international collaborative cultures by sharing of knowledge and ideas from teaching to workplace.

One major output in our project is the development of the Guidelines of operational standard procedures in rehabilitation after lower limb orthopedic surgery. Rehabilitation Guidelines present an online information resource providing up-to-date treatment principals to orthopaedic surgeons, to physiatrists and rehabilitation professionals. The guideliness contains 12 standard procedures for post surgery rehabilitation in selected pathologies and corresponding OT procedures of the three principal joints, included in gait, which will be proposed for implementation in the medical society from participant countries. The innovation consists in development of procedures that will allow to advance the physician-patient communication process and enhance the diagnosis and treatment of musculoskeletal conditions, especially after a OT intervention. The recomendations, associated with each procedural step, are aligned to the actual medical evidence, as for each procedure there are corespondent videos, capturing in real practice the manoeuvres presented in the guide, enabling the user to watch the procedure that is presented in the text and ensuring a better connection between knowledge and practical skills’ development. Also the video material will create support for autonomous leaning practical skills for the OT & PRM trainees.
The easy to follow guidelines enable practitioners to look up a pathology and quickly see the recommended rehabilitation strategy. Phases of treatment are defined to clearly show goals and tasks, methods and precautions, strategies and criteria for rehabilitation.

Each presented procedure includes:

- the rationale for the procedure
- role of diagnosis
- preliminary recommendations
- rehabilitation timing and methodology (steps)
- Early Postoperative Exercises and Profilaxy of complications,
- Intermediate Exercise Program
- Advanced Exercises and Activities
- Communication with patients

1.2. Methodology

The present clinical guidelines were developed by a Work Group within the COR-skills partnership and is provided as an educational tool based on an assessment of the current scientific and clinical information and accepted approaches to orthopeadic surgery. It is not intended to be a fixed protocol as some patients may require more or less treatment. Patient care and treatment should always be based on a clinician’s independent medical judgment given the individual clinical circumstances.

Our Strategic Partnership involves a diverse range of partners in order to benefit from their different experiences, profiles and specific expertise to produce
relevant and high quality project results. The consortium includes hospitals and higher education institutions well known in the field, with consistent experience and strong networks with their target groups from 2 countries with high qualified specialists in orthopedics and traumatology (OT) and physical and rehabilitation medicine (PRM) with a long standing reputation for providing student-centered programmes of health education. Issues taking into consideration were: competence and thematic expertise in the field, relevant experience in working in transnational context, specific interest in the development of medical skills for health professionals in the orthopedic and rehabilitation field.

The structure of the partnership based on the complementary of HEIs and hospitals helps to ensure the necessary competence and adequacy of the skills developed, but also aiming to contribute in this way to the development of inter-sectorial and international collaborative cultures by sharing of knowledge and ideas from teaching to workplace, helping medical vocational education to meet the current and future labour market needs.

This partnership between education and employment will stimulate the flow exchange of knowledge between higher education and hospitals / medical clinics (world of work) and lead to the development of high quality VET with a strong work-based learning component.

The present material represents the best practice of experts with the Clinical Hospital Filantropia from Craiova, Romania and Sainte Anna Hospital from Sofia, Bulgaria, one of the best known and most respected rehabilitation hospitals in the correspondent countries.

The didactic team began working on these guidelines by constructing a set of preliminary recommendations. These recommendations specify [what] should be done in [whom], [when],[where], and [how often or how long].

In the development of the present guidelines we used the WHO criteria
First step in the process included reviewing the results of the evidence analysis.

The result of the literature research was a report for the current state of art in the field of protocols for orthopedic surgical procedures and rehabilitation procedures after surgery, aiming to:
- select the most common surgical protocols in all participant countries and the correspondent rehabilitation procedures;
- make first steps in standardization of protocols;
- develop an interdisciplinary approach (orthopedics-rehabilitation);

In order to attain these objectives the partnership reviewed different abstracts, recalled pertinent full articles for review and evaluate the studies.
meeting the inclusion criteria. They also abstract analysed, interpreted and/or summarized the relevant evidence for each standard procedure.

Upon completion of the systematic reviews, each medical partner registered 30 examples of orthopedic surgical procedures in lower limb pathologies and 30 examples of rehabilitation procedures after surgery in lower limb pathologies. From these procedures, we select the most common in the clinical practice 12 orthopedic surgical procedures in lower limb pathologies and 12 correspondent rehabilitation procedures were proposed to be negotiated in the partnership as eligible procedures for the Guide of operational standards.

Evidence-based information, in conjunction with the clinical expertise of physicians from multiple medical specialties, was used to develop the criteria in order to improve patient care and obtain the best outcomes while considering the subtleties and distinctions necessary in making clinical decisions.
1.3. Recommendations

Designed to help therapists provide post-surgical rehabilitation based on best practices and evidence-based research, this comprehensive reference presents effective guidelines for postsurgical rehabilitation interventions. Its authoritative material is drawn from the most current literature in the field as well as contributions from expert physical therapists, occupational therapists. A specific video accompanies every procedure, featuring over ……. minutes of video of patients demonstrating various therapeutic exercises spanning the different phases of postsurgical rehabilitation.

This guideline is not intended to be construed or to serve as a standard of care. Standards of care are determined on the basis of all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve.

Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available.

This summary of recommendations is not intended to stand alone. Treatment decisions should be made in light of all circumstances presented by the patient. Treatments and procedures applicable to the individual patient rely on mutual communication between patient, physician and other healthcare practitioners.
2. PRINCIPAL BASES OF THE REHABILITATION IN ORTHOPEDIC AND TRAUMATIC CONDITIONS

2.1. INTRODUCTION

According the definition of the European Union of Medical Specialists – PRM Section [46] Physical and Rehabilitation Medicine (PRM) is an „independent medical specialty, oriented to the promotion of physical and cognitive functioning, activities (including environment), participation (including quality of life) and changes in personal factors and environment. The specialty PRM is responsible for the management of the prevention, diagnostics, treatment and rehabilitation of patients with health-related disability and co-morbidity of all ages. According the World Report on Disability of the World Health Organization and World Bank [48] rehabilitation measures are divided into three categories: rehabilitation medicine, therapy and assistive technologies.

According the White Book on Physical and Rehabilitation Medicine [46] the basic objective of PRM is the optimization of social participation and the amelioration of the quality of life of patients. This includes the aid of the patient to reach possible levels and patterns of autonomy and independence, including participation in professional, social and leisure activities, part of his human rights [29, 36].

Tasks of PRM are: treatment of existing pathology; reduction of disability; prevention and therapy of complications; amelioration of functioning and activity; stimulation of patient’s participation in different types of activities [33, 43, 46].

The World Report on Disability [48] defines the goals of rehabilitation: prevention of the loss of function; slowing the rate of loss of function; improvement or restoration of function; compensation for lost function; maintenance of current function.

Modern rehabilitation has an integrative and holistic approach to the patient, based on the International Classification, disability and Health (ICF) and on clinical principles [23, 45, 47]. Current book presents the author’s opinion about the necessity of structuration of complex rehabilitation algorithms (PRM programmes of care), including not only different natural and pre-formed physical modalities, but too a detailed functional evaluation at the beginning (baseline) and at the end of every rehab course – in all patients with orthopedic and traumatic conditions.
2.2. FUNCTIONAL EVALUATION

The first step of our algorithms is the qualitative and quantitative functional evaluation, including ICF assessment (ICF, 2001), and evaluation scales, applied commonly in the clinical practice of OT and rehabilitation [8, 10, 12, 18, 31, 35].

According ICF principles the complex functional assessment must include (figures 1, 2 & 3): body functions (pain, range of motion, muscle force or motor deficiency, alterations of coordination); activities (mobility, grasp, gait, activities of daily living /ADL/, transport); participation (family relationship, relaxing activities, social life, political activity); environmental factors (conditions of life and work, transport, family and friends, health insurance, social relationship); personal factors (life style, co-morbidities, age, sex) [26, 30, 32, 40].

Fig. 1-2. International Classification of Functionning, disability and Health (ICF), 2001 [47]

Fig.3. ICF options

Fig. 4. Rehabilitation puzzle
During clinical assessment we accentuate on some analyses: pain (localization, type, intensity – verbal or visual analogue scale; modifying pain activities); joint stability (including joint position sense) and range of motion (active and passive); presence of oedema, muscle or joint contractures; evaluation of the muscle force / muscle insufficiency, motor deficit; analysis of the grasp and gait; mobility (necessity of technical aids - canes, walking sticks, crutches, walkers, wheelchairs and other devices); fatigue (physical endurance, necessity of rest during the examination or the functional activity); autonomy in everyday activities (bathing, dressing, eating, putting shoes on, personal hygiene, need of help in ADL). Evaluation of problems must be qualitative and quantitative, including: fatigue, motor deficiency, coordination problems (body position, gait, grasp); pain; conscience for the necessity of technical aids; difficulties in ADL; limitations in functional mobility [2, 8, 12, 15, 38, 40].

The control before and after rehabilitation is obligatory. At the end of every course we realize a detailed clinical, para-clinical and functional (including instrumental) revision of the obtained results, and we prescribe a periodical control and periodical PRM courses. We consider that the functional evaluation is very important not only for control of the quality of rehabilitation, but too for amelioration of independence in everyday activities and of health-related quality of life of patients.

2.3. REHABILITATION PROGRAMME

The complexity of rehabilitation in OT cases imposes the necessity of a holistic approach to the patient – detailed functional analysis before and after the rehabilitation courses; application of therapeutic methods of different medical specialties (principally orthopedics and traumatology; neurology and neurosurgery; rheumatology; PRM) and from non-medical fields (kinesitherapy, sociology, psychology, occupational therapy). We apply basic principles of the specialty Physical and Rehabilitation medicine [8, 9, 11, 18, 23]. Depending on the results of the assessment of the rehabilitation potential of the concrete patient, we use different physical modalities and methods in different combination – the rehabilitation puzzle (figure 4). In every stage of the rehabilitation processus we must define precisely the goal, tasks and algorithms of rehabilitation. In every case our goal is to assure a high quality of the rehabilitation, optimal for the clinical form of the principal disease or condition, adapted to the age, co-morbidities, capacity and desire of the concrete patient; with the strategic goal to receive the best result for his quality of life.
The complex rehabilitation programme includes physical and drug therapy, diet, patient education (table 1).

<table>
<thead>
<tr>
<th>KINESI- and ERGO-therapy</th>
<th>PREFORMED physical modalities</th>
<th>CRYO-/THERMO-/BALNEO-/PELIOIDO-therapy</th>
<th>DIET</th>
<th>PATIENT EDUCATION</th>
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<td>(exercises, activities, massage, manual therapy)</td>
<td>(electric currents, magnetic field, light, LASER, ultrasound)</td>
<td>(ice, mineral waters, therapeutic mud, paraffin)</td>
<td>(proteins/amino-acids/, hypolipidic, hypo-glucidic)</td>
<td>(medicaments; diet; basic physical activity; weight control)</td>
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Table 1: Parts of the complex rehabilitation programme

In our clinical practice we apply a synergic combination of two (2-3) procedures with pre-formed modalities (electro- and photo-therapy, LASER; magnetic field; ultra-sound, etc.); one (1-2) cryo-/ hydro- / balneo- / thermo-therapeutic procedure with three (3-4) kinesi-therapeutic methods and one (1-2) ergo-therapeutic activity [3, 24, 25, 28, 37, 44]. The functional recovery depends principally from the training of grasp and gait, and the education in activities of daily life [1, 5, 6, 7, 11, 27, 28, 34, 41]. For the structuration of the individualized for every patient PRM programme we used everywhere capacities of different traditional and contemporaneous natural and pre-formed factors, accentuating on the potential of modern methods, e.g.: transcutaneous electro-neurostimulation (TENS), functional electrostimulations (FES), Lasertherapy and Laserpuncture, Deep Oscillation; proprioceptive neuromuscular facilitation, analytic exercises, post-isometric relaxation, stretch techniques; and ergo-therapeutic methods [5, 9, 13, 14, 39, 42].

The control after the rehabilitation course and the prescription of periodical ambulatory PRM courses are very important. We consider necessary the continuity of PRM-care: in-patients in acute care hospitals and in PRM clinics (Departments), in-patients in long-term specialized hospitals; out-patients in ambulatory medical and PRM centres; balneo-kinesitherapy in resorts.

2.4. CONCRETIZATION AND CLINICAL APPROBATION OF ALGORITHMS

The presented PRM algorithm can be concretized and we used it during our own clinical investigations and observations (including clinical case studies) of rehabilitation of patients with different OT conditions: shoulder instability and rotator cuff injuries; distal radius fractures & Zudeck’s algoneurodystrophy; hip replacement, partial and total knee arthroplasty, periprosthetic fractures; intertrochanteric & femur shaft fractures; after anterior and posterior cruciate ligament reconstruction; after partial and total meniscectomy; patella (knee cap) dislocation and fracture; tibial plateau and tibial plafond fractures; ankle fractures, Lisfranc and Chopart’s injuries (fracture–dislocation); upper or lower limb amputation with phantom pain and prosthesis. [8, 9, 14, 15, 16, 17, 19, 39, 42].
The on-time initiation of rehabilitation procedures in OT management (especially after OT interventions) has a lot of positive consequences: amelioration of the clinical status of patients and prevention of complications; augmentation of muscle force and range of motion, decrease of pain, намаляване на болката, oedema reduction, regulation of the statics and equilibrium; normalization of the scapula-humeral and the pelvi-femoral rhythm; functional recovery of the grasp and the gait; amelioration of autonomy and quality of life of patients; acceleration of the resocialization and inclusion in functional activity, economic effect.

2.5. SUMMARY

In our clinical practice we apply systematically our structured rehabilitation algorithms, individualized and adapted to the concrete patient. We published periodically our results, proving the amelioration of the quality of life of significant number of patients (age > 18 years) with different OT conditions: orthopedic dysfunctions (scoliosis, spondylolisthesis, spina bifida, lumbalisatio S1, sacralisatio L5), traumatic injuries (incl. sports’ traumas), after alloplastic surgery (hip and knee joint), after arthroscopic surgery (shoulder and knee joints), etc. In case of synergic combination of procedures we received statistically significant favorable effects on the range of motion, muscle force and muscle weakness, neuro-muscular coordination, grasp and gait, independence in ADL, quality of life of patients [1, 4, 9, 10, 14, 15, 16, 17, 19, 20, 21, 22, 39, 42].

The complex rehabilitation stimulates the functional recovery of patients with invalidating diseases and conditions of the locomotory system, ameliorating their independence and the health-related quality of life.

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3. PROCEDURES

3.1. ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

3.1.1. PRINCIPLE BASES OF THE TREATMENT IN CASES OF ACL TEAR

3.1.1.1. The Injury:
The anterior cruciate ligament (ACL) is an important stabilizing ligament of the knee. It is located deep inside the knee joint and provides almost 90% of the stability to forward force on the joint. Injuries to this ligament are very common in aggressive sports such as skiing and basketball. Injury to the ACL usually occurs with a sudden hyperextension or rotational force to the joint. The exact mechanism differs for different sports. Typically the injured athlete will hear or feel a "pop", and will have sudden onset of pain, instability and swelling. If this scenario occurs, the athlete should not attempt to continue playing, and should seek medical attention. Because the ACL is such an important stabilizer of the knee, injury to the ligament makes it difficult to participate in aggressive twisting sports. It should be emphasized that certain sports can continue to be performed quite well without an ACL. These are "straight ahead" sports such as bicycling, rollerblading, light jogging and swimming. Twisting, cutting and jumping sports are not recommended however due to the risk of the knee giving way. The knee is designed to work as a hinge, moving in one plane. With a torn ACL, there is increased play in the joint allowing shearing forces across the cartilage surface, and leading to progressive tearing of the cartilage discs (menisci) and breakdown of the joint surface. Over time, this breakdown leads to degenerative arthritis.

3.1.1.2. Treatment Options:
Treatment of ACL injuries has come a long way in the past ten years. Today athletes have greater than a 90% chance of returning to their pre-injury level of sports participation.

Non-Surgical: Conservative care is recommended for minor and partial tears of the ACL, or tears in which the knee is still within the accepted limits of stability (less than 3 mm of laxity). Non surgical treatment is also recommended for the patient who is willing to modify their activity to non twisting less aggressive sports. In these athletes, we begin an immediate specialized rehabilitation program, and provide a custom fitted knee brace for use during sports activity.

Surgical Options: Surgery for ACL injuries is extremely specialized and should only be performed by a surgeon who specializes in this type of injury. The techniques continue to change and only someone on the cutting edge can hope to stay up with all of the latest changes.

Surgical Technique
- Suture Repair of the ACL.
- Reconstruction: creating a new ligament out of a tendon from another location in the patient's knee or using cadaver tissue. There are three popular choices for the choice of tissue:

**Patella Tendon (Autograft)**

- This means taking a strip of the tendon from the front of the athlete's own knee (autograft), and is the most popular choice for this surgery. This technique has been utilized for the longest period of time in the largest number of patients, and is considered the gold standard for ACL reconstruction.

  **Advantages**: Strong graft, with bone attachments at each end, which allows the graft to be fixed very solidly at the time of surgery and which allows healing to the body in the shortest period of time (bone to bone healing) of 4-6 weeks.

  **Disadvantages**: Requires taking tissue from the body. This may cause donor site soreness in a small percentage of patients. To avoid this we utilize a unique method for harvesting the patella tendon graft. This method utilizes a round oscillating tool, which takes a circular graft and leaves the patella with a smooth defect. This makes the patella much less prone to any post surgical problems, and we have not found this to be a problem in many hundreds of patients.

**New Frontiers - ACL Tightening (Shrinkage)**: Currently a study utilizing a new technique which tightens the partially torn or stretched ACL is performed. This is not applicable to the completely torn ligament. Surgery is done arthroscopically with no incisions. Recovery time is dramatically faster than with a reconstruction.

3.1.1.3. AFTER-CARE REHABILITATION:

In a lot of OT clinics in USA and Europe the patients are sent home with a knee brace for the first day. Range of motion is started as soon as the wound is checked. Early goals are to obtain range of motion and to reeducate the muscles. Weight bearing is begun immediately with crutches. The brace is utilized for three weeks or until the quadriceps are strong enough to support the limb. Crutches are discontinued after 1-2 weeks. Stationary bicycling is begun as soon as the patient can achieve 100 degrees of flexion and can get around on the pedal (usually 2 weeks). Outdoor bicycling and jogging are allowed at 3 months. Return to twisting cutting and jumping sports is delayed for 6 months since this is how long it takes for the graft to biologically heal. Prior to returning to sports, the patient is expected to have regained 90-95% of their muscular strength.
### 3.1.2. REHABILITATION AFTER ACL RECONSTRUCTION

#### 3.1.2.1. In all traumatic knee conditions with a knee surgery the PRM Algorithm includes:

**Functional evaluation of the knee mobility and stability** and a **Complex PRM programme of care**, including natural and pre-formed physical modalities. The pre-defined PRM protocol includes only **physiotherapy (analytic exercises) combined with cryotherapy**.

We consider that the traditions of some rehabilitation schools (including Bulgarian, Romanian, etc.) can be used too: we apply preformed physical modalities - **electrostimulations of the quadriceps femoris muscle** (accentuating on m.vastus lateralis and musculus vastus medialis, especially on m.vastus medialis obliquus); **interferential currents**; **low intensity low frequency magnetic field**; **ultraphonoforesis with NSAIDs**.

#### 3.1.2.2. SCHEMA FOR A PATIENT AFTER ACL RECONSTRUCTION

#### 3.1.2.2.1. FUNCTIONAL EVALUATION:

- Post-operative day No …
- Active range of motion (A-ROM)
- Manual muscle test
- Dynamometry
- Centimetry – of the thigh 10 cm & 20 cm over the patella - for evaluation of the muscular hypotrophy due to the inactivity
- Centimetry of the knee joint – for evaluation of the oedema
- Pain – Visual analogue scale (VAS 0-10 or 0-20)
- Negative sensitive patterns
- Vibroesthesiometry
- Joint Position Sense (JPS)
- Gait assessment (with the orthesis)- SUG test (stand up and go), 5 meters test
- ICF assessment
3.1.2.2.2. PRM PROGRAMME

We effectuate 3-4 PRM courses of 15-20 procedures during the first 4-6 months.

A. Immobilization

Application of orthosis (with possibility of fixation and regulation of the flexion/extension), tape, elastic bandage or brace
During the first 2-3 weeks the orthosis is locked in full extension (if necessary – in 5-10 degrees of flexion) – except during the active exercises.
During the first month the patient will receive a prescription for a lying or sitting position for a minimum 2 hours daily (afternoon) and 8 hours (at night). During the first post-operative period we prescribe the strict execution of the RICE algorithms (Rest, Ice, Compression, Elevation).

B. Pre-formed modalities:

Functional electrical stimulations – for QF, especially for m.VMO
Interferential currents (resulting frequency 90-140 Hz) – 10-20 min., for the knee joint
Low frequency pulsed magnetic field – 16 000 A / m, 10-20 min. – for the knee joint
Ultra-sound or ultra-phonophoresis with NSAID – 0.4-0.8 W/cm², 4-8 min.

C. Cryotherapy

Ice massage for 5-10 minutes, 3-5 sessions daily

D. Kinesitherapy

We apply a standard kinesitherapy programme, adapted to the level of pain and functional disability.
We begin with passive mobilizations (under the level of pain) for augmentation of the A ROM of the knee joint; after that we introduce (gradually) active exercises for the range of motion and strengthening exercises – from a lying position (after – in sitting position, in a few days – from standing position – with locked orthosis or brace). Gradually we increase the range of motion (of the orthosis and of the exercise).
We accentuate on analytic exercises for m.quadriceps femoris (especially for m.castus medialis and m.vastus lateralis) and for the hip abductors (especially for m.gluteus medius). At the beginning we use isometric exercises; gradually we include isotonic exercises, with a progressive increase of the applied resistance during exercises.
We apply post-isometric relaxation for the m.rectus femoris, patellar mobilizations, training of the locomotion (with gradually increase of the weight bearing and progressive transition from the crutches to gait without aids).
Passive and mixt exercises:
Initiating with passive mobilizations

Post isometric relaxations for the m.rectus femoris
Mobilizations of the patella – only in medial – lateral and proximal-distal directions.

Active exercises – from isometric to isotonic, and contra-resistance:
For muscles around the knee joint (bilaterally): analytic exercises for the knee dynamic stabilizers and for knee mobility – strengthening exercises for the muscles quadriceps femoris, m.triceps surae; m.semitendinosus, m.semimembranosus, etc.
Training of muscles of the hip joint and of the ankle joint – bilaterally
Stretching and Theraband exercises for QF, TS, hamstring muscles - training of proprioception

E.ERGO-Th - Sport and other Activities:
Stationary bicycle
Swimming

Training of gait:
with progressive weight bearing – from non-weight bearing during the first 2-4 weeks, 50 % to full weight bearing and normalization of the gait at the 6th month (at the beginning – with crutches, after that – with cane, after that – without technical aids)

3.1.2.2.3. CLINICAL ALGORITHM
# Table – Rehabilitation Algorithm after ACL Reconstruction

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>Localisation of the rehab</th>
<th>GOAL &amp; Tasks</th>
<th>Weight bearing</th>
<th>Technical aids (brace, orthosis)</th>
<th>CRY O-Th (Ice)</th>
<th>KINESI-Th (active exercises, passive mobilizations, soft tissue techniques)</th>
<th>Training of everyday activities (ADL)</th>
<th>PREFORMED MODALITIES</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Post-operative Day 0-3 | In-patient OT Department | Functional recovery:  
First mobilization of the knee joint – in bed;  
Reduction of pain, oedema;  
First steps | Partial weight-bearing (25 %), gait – using crutches | Crutches (or cane – in the altered side); Locked orthosis or brace (Flexion 75-90°) | 10 min, 3-7 session/s per day | Range of motion exercises:  
- **Flexion**: heel slides;  
- **Extension**: Passive – using towel rolls;  
**Strengthening exercises**:  
- Quadriceps isometry;  
- Begin ankle strengthening exercises: plantar / dorsal flexion. | | | Magnetic field – to patient tolerance;  
Deep Oscillation (DO)  
Gradually increase of ROM and strength;  
Observation for eventual post-operative complications (deep vein thrombosis, pulmonary thromboembolism) |
| Post-op Days 4-15 | In-patient PRM & Rehab Department of the Hospital | Mobilization of the knee joint – in sitting & in standing position; Obtain full knee extension (0°) & 90° of the knee flexion; Gait training | Partial weight-bearing (50-75 %), Gait – with crutches (or cane) | Crutches (or cane); Locked orthosis or brace (Extension 0°) | 15 min, 3 x daily | Range of motion exercises:  
- **Flexion**: knee bends, wall slides, heel slides  
- **Extension**: Passive – using prone hangs and towel rolls  
**Strengthening exercises**:  
- Quadriceps sets with knee support;  
- Hamstring digs with knee support;  
- Ankle strengthening exercises: plantar / dorsiflexion, inversion / eversion  
**VERTICALIZATION BALANCE TRAINING GAIT TRAINING** | | | Magnetic field  
Interferential currents (IFC)  
Deep Oscillation (DO) |
| Post-op Weeks 3-6 | Out-patient PRM Depart of the Medical Center | Gait training | Partial weight-bearing - WB (75 – 100 %), Gait – with crutches (or cane) | Stretching exercises:  
- For Flexors: of the ankle and hip joints (especially for soleus and ilio-psoas muscles);  
- For Extensors: of the ankle and hip joints (especially for m.tibialis anterior and gluteal muscles); | Strengthening exercises:  
- Quadriceps sets with knee support;  
- Hamstring digs with knee support;  
- Ankle strengthening exercises: plantar / dorsiflexion, inversion / eversion | Walking uphill or downhill (with support, but gradually eliminate the support) | FES for m.vastus medialis obliquus | NB! Without pressing on the popliteal fossa |
|------------------|------------------------------------------|---------------|-----------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Post-op Weeks 7-8 | Out-patient PRM Depart of the Medical Center or AT HOME Rehab | Gait training - Goal – to obtain normal ROM & Normal walking | TWB Gait – with cane or without technical aids | Manual therapy:  
- Mobilizations of the patella (in proximal, distal; lateral and medial directions) | Stretching exercises:  
- For Flexors: of the ankle and hip joints (especially for soleus and ilio-psoas muscles);  
- For Extensors: of the ankle and hip joints (especially for m.tibialis anterior and gluteal muscles); | Strengthening exercises:  
- Quadriceps sets with knee support;  
- Hamstring digs with knee support;  
- Ankle strengthening exercises: plantar / dorsiflexion, inversion / eversion | Getting up from a seated position (without support); Going up or down stairs | FES for m.vastus medialis obliquus or Ultra-sound of the knee or MF or IFC |
| Post-op Months 2 - 4 | Out-patient PRM Depart of the Medical Center or AT HOME Rehab | Participation in all ADL Training of working activities | MANUAL therapy:  
- tibio-femoral distraction,  
- anterior tibial glide,  
- posterior glide;  
- Techniques of Maitland and Mulligan  
Stretching exercises:  
- For Flexors: of the ankle and hip joints (especially for soleus and ilio-psoas muscles);  
- For Extensors: of the ankle and hip joints (especially for m.tibialis anterior and gluteal muscles);  
Strengthening exercises:  
- Quadriceps sets with knee support;  
- Hamstring digs with knee support;  
Ankle strengthening exercises: plantar / dorsiflexion, inversion / eversion  
ERGO-Therapy | Kneeling, squatting  
Some sports training – swimming, sitting bicycle;  
Training of working activities | FES for m.vastus medialis obliquus or MF | PRM Control |
| Post-op Months 5-6 | AT HOME Rehab | Every day | Stretching exercises  
Exercising Muscles that Surround The Knee  
Working the Hip Stabilizers  
Increasing Muscle Endurance  
CARDIO-RESPIRATORY FITNESS – including stationary bicycle, swimming, etc. |  | OT control |
<table>
<thead>
<tr>
<th>Longlife maintenance rehabilitation programme</th>
<th>AT HOME Rehab</th>
<th>3 seances weekly</th>
<th>Stretching exercises</th>
<th>Sports</th>
<th>Working activities</th>
<th>Leisure activities</th>
<th>Periodically (monthly or every 2 months): 10-15 seances DO or MF or IFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>Exercising Muscles that Surround The Knee</td>
<td></td>
<td>Working activities</td>
<td>Leisure activities</td>
<td>Periodically (monthly or every 2 months): 10-15 seances DO or MF or IFC</td>
</tr>
<tr>
<td>PRM &amp; OT</td>
<td></td>
<td></td>
<td>Working the Hip Stabilizers</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Increasing Muscle Endurance</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CARDIO-RESPIRATORY FITNESS – including stationary bicycle, swimming, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.1.2.2.4. Prevention of complications

In every period of the rehabilitation process, the patient is observed for possible complications: deep vein thrombosis, pulmonary thromboembolism, muscle or joint contracture, etc.

3.1.2.2.5. Prognosis:

ACL reconstruction is a highly successful operation. 90-95% of patients can be expected to return to full sports participation with 6 months and with aggressive (but well dosed) rehabilitation.
## 3.2. TOTAL HIP ARTHROPLASTY

### REHABILITATION AFTER JOINT REPLACEMENT (ENDOPROSTHESIS)

Endoprostheses are the reconstruction of joints with mobile artificial joint models, consisting of metal alloys and synthetic materials. These reconstructions are performed on the shoulder, elbow, hip and knee joints. The achievement obtained on the knee and hip reconstructions could not be obtained in upper extremity reconstructions.

Endoprostheses are a good option for: knee calcifications that do not respond to intra-articular injection or physiotherapy; for patients who are considered not to benefit from knee arthroscopy and directing operations; in those who had such operations but have persistent complaints; for calcifications which do not respond to drug injection or physiotherapy applications in the hip joint.

### REHAB:

Patients with hip or knee endoprosthesis are transferred from acute to subacute or outpatient rehab at an ever earlier stage. In rehab, major goals are the improvement of range of motion of the knee or hip. In addition to individual physiotherapy, it is inevitable that the patient participates in accompanying measures.

In the early stage of rehab, a motor splint is usually utilized. Further on in the rehab process, it is important that the patient starts to become active and to apply his/her own strength. Often, the transition from continuous passive motion with the motor splint to active training on an ergometer turns out to be problematic. Due to a small range of motion, pain or hematoma, the application of a cycle ergometer is not yet possible in many cases.

### Training goals:

- Improvement of motor skills, cardiovascular conditions and strength
- Prevention of contractures (mobilization of joints, muscles and tendons)
- Prevention of thrombosis (improvement of the venous backflow from the legs)
- Rapid muscle build-up: Particularly in patients with a non-cemented endoprostheses, who usually tend to have larger deficits in the area of quadriceps and gluteal muscles, enforced muscle gain can regularly be observed after additional training with a mechanotherapy device, v.g. the MOTOmed leg trainer.
- Early start of active training (less muscle loss, less stiffening). Particularly for weaker and older patients, the combination of passive-assistive and active training has proven to be of great value: In order to initiate movement, the legs are being moved and loosened up by the motor without any strain on the patient. After that, the patient can start cycling him/herself against a minimal resistance, even if putting in very little impulses. The motor supports the movement (assistive
training). A further progression of the training is the active cycling against finely adjustable resistances.

- Improvement of circulation and therefore increased sensation of warmth
- Improvement of the general patient condition: Psychologically, a transition to an active form of training is of great importance for many patients. Thus, it can be quite valuable for post surgery patients to be able to perform movements without pain or tension after a long time of great pain and relieving postures.
- Support of the process to restore a correct gait pattern: Usually, physiotherapy training is only provided during the first two months after surgery. However, studies show that the largest increase of muscle strength only happens after those two months. Therefore, it is important that the patients continue with muscle strength training after the period of physiotherapy.
Rehabilitation program in a patient with total hip arthroplasty (after coxarthrosis)

Patient Complaints

- Excessive pain and stiffness in the left hip and muscles around it,
- Difficulties in standing up, transfers and mobility,
- Reduction of autonomy in activities of daily living (ADL).
- Gait with walker or crutches, if possible; with or without assistant.

CLINICAL EXAM:
- Limited range of motion of the correspondent lower extremity.
- Post-operative cicatrix – without complications.

FUNCTIONAL ASSESSMENT

KINESIOLOGICAL ANALYSIS:
- Goniometry of the operated hip joint
- Difficulty in transfers, normal gait impossible, the patient can or can’t effectuate 10 meters walk test – with walker, 1-2 crutches and an assistant PT.
- Evaluation of the rehabilitation potential

ICF assessment:
- Impairments of body functions – hip pain, muscle weakness, and restricted hip ROM;
- Changes in body structures;
- Activity limitation - limited walking ability and problems with putting on socks;
- Participation restrictions - reduced participation in leisure activities;
- Decrease of the patient’s level of autonomy.

EVALUATION TESTS:
- 10 meters walk test (10mWT) – seconds before & after rehab;
- Timed Up and Go test (TUG) - seconds before intervention;
- 6 Minutes Walk Test (6 MWT) - impossible before rehabilitation; … meters after rehabilitation (one week inpatient rehab cycle)
REHABILITATION PROGRAMME

GOAL – functional reeducation

TASKS:

- recovery of the stability and mobility of the lower limb joints,
- restoration of the muscle and ligament balance, accentuating on muscles around the hip joint; keeping the hip in the economic limb biomechanics;
- pain control;
- control of the cicatrix;
- control of joint ROM;
- control of possible complications;
- education of transfers,
- normal gait recovery with correction of eventual abnormal walking scheme;
- ADL (activities of daily living) training;
- amelioration of autonomy in everyday life;
- psycho-emotional stimulation,
- amelioration of the health-related quality of life.

METHODS:

✓ drugs – Fraxiparine; analgesics.
✓ patient’s education;
✓ posture (activity modification),
✓ electrotherapy – magnetic field, interferential currents.
✓ paraffinotherapy - for the hip joint (before the massage and the kinesitherapy);
✓ massage – classic massage (relaxing for the anterior group of muscles of the hip; stimulating for gluteal muscles),
✓ Individualized kinesitherapeutic programme - correct posture of lower limb, analytic exercises for gluteal muscles especially for gluteus medius muscle, lower limb joint mobilization (active range of motion), post-isometric relaxation /PIR/ for iliopsoas muscle; gait training with supporting walker or two crutches, education in mobility up and down the stairs.
✓ Occupational therapy & ADL training.
FUNCTIONAL ASSESSMENT at the end of the rehab:

- Goniometry of the operated hip:
- 6 Minutes Walk Test (6 MWT) - in meters.

RESULTS OF THE REHABILITATION PROGRAMME

- Amelioration of the range of motion of the left hip;
- Amelioration of the functional capacity;
- Independent stand up and transfers
- Independent gait with crutches – in the room and the corridor
- Balance & Gait stabilization;
- Decrease of dysesthesiae and pain in distal parts of lower limbs;
- Stabilization of the metabolic patterns;
- Amelioration of the autonomy in ADL.

RECOMMENDATIONS:

Treatment plan after the dehospitalization:

Auto-PT at home: kinesiotherapy every day at the 3-th month after the operation

Gait – with walker, one or two crutches

Next rehabilitation course at hospital – after 3 months
General HIP CONDITIONING PROGRAM – for longlife protection after surgery

**Aim:** to stimulate the patient to return to daily activities, to sport and other recreational activities.

**Methods:**
- Strengthening exercises
- Flexibility exercises – stretching the muscles for restoration of ROM and prevention of future injuries

**Target muscles:**
- Gluteus maximus (buttocks);
- Gluteus medius (buttocks);
- Hamstrings (back of the thigh);
- Piriformis (buttocks);
- Adductors (inner thigh);
- Abductors (outer thigh);
- Tensor fasciae latae (outer thigh).

**Length of the program -** 4-6 weeks
After that – maintenance program for lifelong protection of knees (2 – 3 days a week)

**Structure of the procedure:**
- Warm-up (5-10 minutes);
- Stretch;
- Strengthening exercises;
- Stretching exercises.
**Stretching exercises**

Standing ilio-tibial stretch  
Seated rotation stretch  
Knee to chest  
Supine hamstring stretch

**Strengthening exercises**

Hip Abduction  
Hip Adduction  
Hip extension (prone)  
Internal hip rotation  
External hip rotation

**Recommendations:**

*Exercises must be done without pain (or increase of current pain)*

*Patient can realize exercises at home, only if the therapist is sure that the application of exercises is correct!*
3.3. TOTAL KNEE ARTHROPLASTY

DEGENERATIVE JOINT DISEASE OF THE KNEE – REHABILITATION PROGRAM IN A PATIENT WITH KNEE ARTHROPLASTY

3.3.1. Degenerative joint disease of the knee

Osteoarthritis is the most common musculoskeletal affliction, representing a significant health problem worldwide. The knee joint (the largest joint in the human body is intensely stressed in both locomotion and repose, with the rapid deterioration of its elements) is one of the most common sites of osteoarthritis (even the most frequent in some studies) with major dysfunctional impact on the body. Presently, knee osteoarthritis is a major social and health problem and a cause of disability among the aging population, generating an increasingly heavy financial burden on the social society and health care systems in modern societies. Osteoarthritis of the knee is one of the five leading causes of physical disability in non-institutionalized elderly men and women. Knee osteoarthritis significantly contributes to functional limitations and disability in the elderly, affecting the ability to walk and climb the stairs more than any other disease. Like hip osteoarthritis, it might be seen as the primary disease or develop secondary to developmental knee dysplasia, arthritis, etc.

3.3.2. Role of complete diagnosis / assessment (etiopathogenical, clinic, laboratory - screening laboratory, imaging examination and functional assessment):

a. The etiopathogenical and clinical assessment included:
   - careful patient history to determine: the parameters of pain, accompanying symptoms;
   - general physical state examination (system examination including sensory evaluation);
   - musculoskeletal examination – somatoscopic exam, appreciation of the range of motion and manual muscle testing of the leg muscles, especially the knee, the patellar shock assessment;
• exam in loaded/charged bipod, unipodal and sitting, when surgical status permitted;
• gait exam, pace and dynamics, analyze pain when walking (on flat ground and stairs), when surgical status permitted.

b. Imaging examination
• Radiographs: Plain radiographs are usually satisfactory for diagnosis; lateral or medial joint space narrowing, subchondral sclerosis, subchondral cysts, osteophytes may be seen.
• Ultrasound exam: is useful pre – and post surgical, we can monitor the all periarticular structures.
• Magnetic resonance imaging: Useful in determining early stages of the disease, preoperative.

c. Functional assessment
• the VAS - Visual Analogue Scale (from 0 to 10, 0 = absence of pain and 10 = maximum pain score, other values between 0 and 10 is directly proportional with the intensity of pain, depending on the individual pain threshold);
• the WOMAC scale for assessing the impact of osteoarthritis on lower limbs for completing usual activities of daily living (total score = 0 = maximum functional status and functional status 96 = minimum, with maximum disruption of daily activities).

3.3.3. Rehabilitation program (RP)

3.3.3.1. Preoperative period
Objectives of RP:
• painful status control;
• controlling the inflammatory process;
• regaining stability and mobility of the knee, muscle and ligament balance, restoring balance to the muscle groups serving the entire "knees" complex;
• correcting abnormal walking scheme, with recovery of normal walking;
• keeping the knee in the economy of the limb biomechanics;
• regaining motor control, optimal knee function.
**Methods** of RP:
- non-pharmacological and non-surgical modalities:
  - educational, dietary (weight reduction) and hygienic, posture (activity modification),
  - physical (thermotherapy - paraffin knee and electrotherapy - magnetodiaflux, TENS, ultrasound) - decreased joint swelling and pain will reduce chances of developing complications during the rehabilitation process;
  - massage – classic and special massage (Cyriax),
  - kinetic – correct posture of lower limb (nothing should be placed behind the operative knee, to promote maximal knee extension and prevent knee flexion contracture), disto-proximal lower limb joint mobilization (assistive active and active range of motion, early patellar mobilization), stretching and strengthening in all muscles (early quadriceps retraining and strength training), gait training with supporting cane in the opposite hand;
  - knee orthoses;
- pharmacological modalities - analgesics, chondroprotective medicine, anti-inflammatory drugs;
- surgical modalities – total knee arthroplasty is the procedure of choice in most cases of knee osteoarthritis.

**3.3.3.2. Postperative period**

**3.3.3.2.1. First interval.** See table 1.

1 – 7 days (week 1) = Before rehabilitation department (inpatient orthopedic department).
Table 1. Components of the kinetic program applied for patients with knee arthroplasty during the first week after surgical intervention

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components / Early Postoperative Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control postoperative knee swelling</td>
</tr>
</tbody>
</table>
|           | 1. Cryotherapy (at least 4 times/day, 3 – 7 days after surgery).  
|           | 2. Physical therapy – TENS, reflex ultrasound (in plantar foot). |
| 2         | Increase range of motion (ROM) in the knee ≥ 80° flexion ≤ 10° extension |
|           | 1. Lower extremity passive range of motion (PAROM) exercises (supine and seated positions).  
|           | 2. Patella femoral and tibial femoral joint mobilization.  
|           | 3. Straight leg raises (SLR) exercise.  
|           | 4. Correct postures in bed (a towel roll should be placed at the ankle to promote knee extension when patient is supine; heel slides in supine or sitting to increase knee flexion) |
| 3         | Enhance muscle control and strength in the involved lower extremity |
|           | 1. Soft tissue massage.  
|           | 2. Gentle stretches for the hamstrings, calf, and iliotibial band.  
|           | 3. Independently perform extremity SLR exercise and ankle pumps.  
|           | 4. Lower extremity strengthening - isometric quadriceps, hamstring, and gluteal isometric exercises. !! No exercises with weights or resistance.  
|           | !! Avoid torque or twisting forces across the knee joint.  
|           | 5. Closed chain exercises (if patient demonstrates good pain control, muscle strength and balance) performed with bilateral upper extremity support while maintaining appropriate assistive device (weight bearing).  
|           | 6. Transfer training (supine in bed ↔ sit down ↔ stand up)  
|           | 7. Gait training on flat surfaces with assistive device (cane maintained in opposite hand). |
| 4         | Maximize patients’ mobility and functional independence |
|           | 1. Bed mobility and transfers with the least amount of assistance while maintaining appropriate weight bearing (WB) precautions.  
|           | 2. Ambulate with an assistive device for 200 meters to allow for independence activities while maintaining appropriate WB.  
|           | 3. Verbalize understanding of post-operative activity recommendations/precautions including use of proper positioning of the lower extremity, range of motion and strengthening exercises. |
| 5         | Profilaxy of complications |
|           | Observe for any signs of deep vein thrombosis (increased swelling, calf pain, erythema), pulmonary embolism, loss of peripheral nerve integrity. |
3.3.3.2. Second interval. See table 2.

8 - 21 days (weeks 2 - 3).

**Inpatient rehabilitation department** - patient has minimal knee pain and inflammation, active knee range of motion (10°-80°) and is able to: ascend/descend stairs performs quadriceps contraction and/or perform a straight leg raise, independent transfers and walks at least 250 meters with appropriate assistive device (cane).

**Table 2. Components of the kinetic program applied for patients with knee arthroplasty during weeks 2 and 3 after surgical intervention**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components / Intermediate Exercise Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimize pain</td>
</tr>
<tr>
<td></td>
<td>Pain modulation modalities – cryotherapy, medication</td>
</tr>
<tr>
<td>2</td>
<td>Increase knee range of motion (0-90°)</td>
</tr>
<tr>
<td></td>
<td>1. Heel slides in supine or sitting to increase knee flexion</td>
</tr>
<tr>
<td></td>
<td>2. Lower extremity range of motion (ROM) → active assisted</td>
</tr>
<tr>
<td></td>
<td>active (AA/AROM) exercises (supine and seated positions) for</td>
</tr>
<tr>
<td></td>
<td>ankle dorsiflexion mobilization knee flexion / extension, hip</td>
</tr>
<tr>
<td></td>
<td>extension.</td>
</tr>
<tr>
<td></td>
<td>3. Patellar mobilizations in all directions</td>
</tr>
<tr>
<td>3</td>
<td>Enhance muscle control and muscle strength 3/5-4/5 in the involved lower extremity</td>
</tr>
<tr>
<td></td>
<td>1. Active straight-leg raises in supine, prone, and sidelying</td>
</tr>
<tr>
<td></td>
<td>positions.</td>
</tr>
<tr>
<td></td>
<td>2. Progressive passive stretching for the hamstrings, calf, and</td>
</tr>
<tr>
<td></td>
<td>iliotibial band within a pain-free range</td>
</tr>
<tr>
<td></td>
<td>3. Muscle-setting exercises of the quadriceps, hamstrings, and</td>
</tr>
<tr>
<td></td>
<td>hip adductors.</td>
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<tr>
<td></td>
<td>4. Neuromuscular electrical stimulation (NMES) for quads if</td>
</tr>
<tr>
<td></td>
<td>poor quad contraction is present.</td>
</tr>
<tr>
<td></td>
<td>5. Gravity-assisted knee extension in supine (placing a towel</td>
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<td></td>
<td>roll under the ankle and leaving the knee unsupported) and in</td>
</tr>
<tr>
<td></td>
<td>sitting</td>
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<tr>
<td></td>
<td>6. Agonist-contraction and Kabat techniques to decrease</td>
</tr>
<tr>
<td></td>
<td>muscle guarding, particularly in the quadriceps, and increase</td>
</tr>
<tr>
<td></td>
<td>knee flexion</td>
</tr>
<tr>
<td>4</td>
<td>Maximize patients’ mobility and functional independence</td>
</tr>
<tr>
<td></td>
<td>1. Ambulation with use of an assistive device</td>
</tr>
<tr>
<td></td>
<td>2. Ascend and descend stairs, with assistive device</td>
</tr>
<tr>
<td></td>
<td>3. Training the transfers and sitting and standing balance</td>
</tr>
</tbody>
</table>
### 3.3.2.3. Third interval. See table 3.

22 – 42 days (weeks 4 - 6).

#### Outpatient rehabilitation department.

**Table 3. Components of the kinetic program applied for patients with knee arthroplasty during weeks 4 - 6 after surgical intervention**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components / Intermediate Exercise Program</th>
</tr>
</thead>
</table>
| 1 | Diminish swelling and inflammation | 1. Pain modulation modalities – cryotherapy, medication  
2. Cyriax massage |
| 2 | Increase knee range of motion (0-115°) | 1. Lower extremity range of motion (ROM) → active assisted active (AA/AROM) exercises (supine and seated positions).  
2. Patellar and tibiofemoral joints mobilizations.  
3. Stationary bike without resistance to increase flexion ROM  
!! Sustain mobilization after suture removal, when incision is clean, dry |
| 3 | Increased dynamic joint stability  
Muscle strength 4/5-5/5  
Full weight bearing per implant status | 1. Soft tissue mobilization to quadriceps or hamstrings myofascia (apply to restricted tissue to break up adhesions caused by swelling and inflammation).  
2. Progressive passive stretches to hamstrings, gastrocnemius, soleus, quadriceps within a pain-free range  
3. Active straight-leg raises in flexion, abduction, adduction, extension  
4. Gravity-assisted knee extension in supine (placing a towel roll under the ankle and leaving the knee unsupported) and in sitting  
5. Continue isometric quadriceps, hamstring, gluteal isometric exercises, than Include concentric and eccentric quadriceps exercises.  
6. Initiate isokinetic exercise to challenge the quadriceps and hamstrings throughout the range of motion. Work in concentric and eccentric modes.  
7. NMES for quads if poor quad contraction is present.  
8. Pain-free progressive resisted exercises using ankle weights  
9. Neuromuscular proprioception techniques (Kabat, Frenkel) to decrease muscle guarding, and increase balance.  
10. Closed-kinetic chain strengthening, such as ¼ squats, ¼ front lunges |
| 4 | Return to functional activities (appropriate balance and proprioception) | 1. Ascend and descend stairs, with / without assistive device  
Gait training on stairs to engage the knee through 0-110° of motion, the ROM optimal to ambulate on stairs without compensations. Focus on eccentric quad control and stabilization in stance phase.  
2. Complex gait training - weight shifting, tandem walking, lateral stepping over / around objects, obstacle courses, front and lateral step-ups closed-kinetic chain activities  
3. Protected, progressive aerobic exercise, such as cycling without resistance, walking, or swimming  
!!! Assistive devices are discontinued when the patient demonstrates adequate lower extremity strength and balance during functional activities (usually 1-4 weeks) |
| 5 | Adhere to home exercise program | Postural cues/ reeducation during all functional activities as indicated. |
3.3.3.2.4. **Fourth interval.** See table 4.

**After 6 weeks. Home-training.**

Patient has minimal to no pain and inflammation, an optimal clinical and functional status – knee ROM 0-115°, strength and endurance and motor control of the involved limb (good voluntary quadriceps control, 4+/5 muscular performance based on MMT of all lower extremity musculature), normal age appropriate balance, properly cardiovascular fitness, independent, non-antalgic gait (≥ 500 meters) and independent step over step stair climbing without assistive device, deviations or antalgia.

So, previous exercises must continued with progression (including resistance and repetitions) and performed to functional tasks, such as transferring from sit-to-stand, lifting, carrying, push/pulling, squat/crouching, and return to work and sport tasks. Activities such as bicycling, walking, or aquatic programs are recommended to improve and maintain cardio-respiratory and muscle endurance.

Until week 12, we recommend low impact activities and no twisting / pivoting exercise.

After 12 weeks, patient can return to appropriate recreational sports / activities as indicated golf, doubles tennis, progressive walking or biking program.
Table 4. Components of the kinetic program (home-training) applied for patients with knee arthroplasty after 6 weeks after surgical intervention

<table>
<thead>
<tr>
<th>Objective</th>
<th>Advanced Exercises and Activities</th>
<th>Exercise parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility (ROM)</td>
<td>Active movement of lower limbs&lt;br&gt;Stretching of calf muscles, hamstrings and quadriceps</td>
<td>Daily, 5 sets for each of lower limb joints, since distal to proximal&lt;br&gt;Daily, 5 sets of 6 seconds for each of muscle groups</td>
</tr>
<tr>
<td>Muscle strength</td>
<td>Isometric contraction of vastus medial oblique into quadriceps muscle and gluteus maximus</td>
<td>Daily, 3 sets, 5 repetitions/set, 6 seconds for isometric contraction, 1 minute rest between contractions</td>
</tr>
<tr>
<td></td>
<td>Isotonic contraction of leg flexor and leg extender, quadriceps muscle, calf muscles</td>
<td>Daily, in antigravity position for each muscle, 2 sets, 10 repetitions/ set, 2 minutes’ rest between sets. Intensity equal with maxim voluntary contraction</td>
</tr>
<tr>
<td>Endurance</td>
<td>Cycling, walking, housework</td>
<td>Daily, 30 – 40 minutes. Intensity equal with submaximal voluntary contraction</td>
</tr>
<tr>
<td>Control of movement and gait</td>
<td>Frenkel exercises for lower limbs&lt;br&gt;Exercises on the balance board&lt;br&gt;Front and back cross over stepping&lt;br&gt;Tandem walking&lt;br&gt;Eyes closed walking (supervised !)</td>
<td>3 per week</td>
</tr>
<tr>
<td>coordination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADL (functional activities)</td>
<td>Sitting to standing in chair, bed, other places&lt;br&gt;Stair climbing&lt;br&gt;Getting in and out of car</td>
<td>Daily</td>
</tr>
</tbody>
</table>
3.3.3.4. Communication with patients

3.3.3.4.1. Preoperative

- Most of the osteoarthritis patients are over 60 years of age, when degenerative joint disease involving other joints and spine. Presence of associated illnesses is common.
- Total knee arthroplasty is a major surgery which has a high impact on the body. Before the operation the patients should be informed about the potential complications of surgery, complications specific to total knee arthroplasty and their treatment policies, possibility of transfusion, and use of medication.
- Patients should also know the prosthetics options, brands to be used and alternatives. Expectations of the patient should be realistic.
- Patients should be aware that total knee arthroplasty will relieve pain originating from the knee only. Postoperative pain and management modalities / rehabilitation program should be described.
- Patients should be informed about mobilization time, need for assistive devices, bathroom usage, possible return to regular life.

3.3.3.4.2. Postoperative

- Understand of post-operative activity recommendations/precautions including use of proper positioning of the lower extremity, range of motion and strengthening exercises
- Care for the prosthetics for longevity of the device should be told.
- Learning and respecting the orthopedic hygiene of the knee, and other lower limb joints, are very important and complete the program. Reminder for stair use:
  - upstairs - the nonoperative leg goes first, then the arthroplasty leg, lastly the assistive device (crutches or cane),
  - downstairs - the crutches or cane go first, then the arthroplasty leg, lastly the opposite leg.
- Develop a maintenance program and educate patient on the importance of adherence, including methods of joint protection
- For relative repose between kinetic sessions, the patient was asked to comply with the correct posture, alternating the position (with knees slightly flexed) with functional position (with knees in extension).
All patients must understand the importance of regular exercise to restore/maintain the knee mobility and strength, 20 – 30 minutes two or three times a day, walk 30 minutes.

Please see video.
3.4. HALLUX VALGUS
REHABILITATION PROGRAM IN A PATIENT WITH HALLUX VALGUS – PRE AND AFTER SURGICAL TREATMENT

1. Hallux Valgus
Hallux valgus is a progressive foot deformity in which the first metatarsophalangeal (MTP) joint is affected (the medial eminence becomes prominent as the distal end of the first metatarsal drift medially and the proximal phalanx deviates laterally) and is often accompanied by significant functional disability and foot pain. There is a high prevalence of hallux valgus in the overall population (23% in adults aged 18-65 years and 35.7% in elderly people aged over 65 years). It has a higher prevalence in women (females 30% - males 13%) and the elderly (35.7%).
The MTP joint is gradually subluxed (lateral deviation) resulting in an abduction of the first metatarsal while the phalanges adduct. At a late stage, these changes lead to an exostosis on the dorsomedial aspect of the first metatarsal head (bunion) with pain and impaired gait (lateral and posterior weight shift, late heel rise, decreased single-limb balance, pronation deformity).

2. Role of complete diagnosis / assessment (etiopathogenical, clinic, laboratory - screening laboratory, imaging examination and functional assessment):

a. The etiopathogenical and clinical assessment included:
   • careful patient history to determine: the factors that have been considered to play a role in the development of hallux valgus (gender, shoewear - tight pointed shoes, congenital deformity or predisposition, chronic achilles tightness, severe flatfoot, hypermobility of the first metatarsocuneiform joint, and systemic disease), parameters of pain, accompanying symptoms;
   • general physical state examination (system examination including sensory evaluation);
exam clinically anatomy; the angle created between the lines that longitudinally bisect the proximal phalanx and the first metatarsal is known as the hallux valgus angle; the values of this angle are:

- less than 15 degrees is considered normal;
- values of 20 degrees and greater are considered abnormal (hallux valgus);
- values >45-50 degrees is considered severe.

musculoskeletal examination – somatoscopic exam, appreciation of the range of motion and manual muscle testing of the leg muscles, especially the leg alignment, the presence of pes planus and contracture of the Achilles tendon, the height of the longitudinal arch; if physical examination is executed, performed with the patient both seated and standing, the following indications could be present:

- pain,
- lateral deviation of the MTP joint - the first MTP becomes subluxed, what leads to a lateral deviation of the hallux, medial displacement of the distal end of the first metatarsal and bony enlargement of the first metatarsal head; with progression, the pull of the adductor hallucis tendon and the intermetatarsal ligament cause the sesmoids to erode the cristae underneath the first metatarsal causing the sesmoids to sublux laterally,
- swelling of first MTP joint,
- shortening of flexor hallucis brevis muscle,
- tenderness of hallux,
- weakness of hallux abductor muscles,
- gait exam, pace and dynamics, analyze pain when walking (on flat ground and stairs); during weight bearing, the deformity is generally accentuated.

**b. Imaging examination** – radiographs (Manchester scale)

- the hallux abductus angle formed between the longitudinal bissections of the first metatarsal and the proximal phalanx,
- the degree of displacement of the sesamoids,
- the osteoarthritic change within the first MTP joint.
c. **Functional assessment**
   - the VAS - Visual Analogue Scale (from 0 to 10, 0 = absence of pain and 10 = maximum pain score, other values between 0 and 10 is directly proportional with the intensity of pain, depending on the individual pain threshold);
   - the WAS - walking ability scale;
   - the FHSQ - foot health status questionnaire for pain and function.

3. **Rehabilitation program (RP)**

3.1. **Preoperative period**

**Objectives** of RP:
- painful status control;
- restoring normal toe and foot joint range of motion and muscle length;
- restore normal muscle control and strength;
- correcting abnormal walking scheme, with recovery of normal walking;
- regaining motor control, optimal foot function.

**Methods** of RP:
- non-pharmacological and non-surgical modalities:
  - educational, dietary (weight reduction) and hygienic, posture (activity modification), adjustment to footwear help in eliminating friction at the level of the medial eminence (patients should be provided of a shoe with a wider and deeper tip);
  - physical (thermotherapy - paraffin leg and electrotherapy - magnetodiaflux, TENS, ultrasound, whirlpool) - decreased joint leg pain will reduce chances of developing complications during the rehabilitation process;
  - massage – classic and special massage (Cyriax);
  - kinetic (three times per week for 3 – 6 months)
    - deloading taping techniques,
    - joint mobilisation (foot mobilization techniques) and alignment techniques,
    - graded mobilisation of the affected hallux /1st MTPJ, increase extension of MTP joint (passive abduction of the hallux with traction of the first metatarsophalangeal joint and active abduction of the hallux), passive abduction
of the hallux with traction of the first metatarsophalangeal joint and active abduction of the hallux;

- sesamoid mobilization,
- muscle and joint stretches,
- stretching or even lengthening of Achilles tendon;
- the ankle dorsiflexion exercise strengthens the ankles and lower leg muscles (without and with towel or band exercises), special of the peroneus longus muscle;
- gait training (the different phases)
  - leg orthoses (to relieve weight-bearing stresses) - orthotics to off-load the bunion; the condition of pes planus may be helped by an orthosis; a sever pes planus condition can lead to a recurrence of hallux valgus following surgery;
- pharmacological modalities - analgesics, chondroprotective medicine, anti-inflammatory drugs;
- surgical modalities (more than 150 surgical options published in literature)
  - classes of surgical procedures include the following:
    - capsulotendon balancing or exostectomy,
    - osteotomy,
    - resectional arthroplasty,
    - resectional arthroplasty with implant,
    - first MTP joint arthrodesis,
    - first metatarsocuneiform joint arthrodesis.

The most frequent procedure applied, depending on the severity of the injury, are:

- distal soft tissue procedure in mild case,
- Chevron osteotomy or diaphyseal osteotomies in halux angle < 30°,
- Akin procedure in hallux < 25°,
- Keller arthoplasty in patients with age > 65 year,
- arthrodesis - the most common surgical procedure.

3.2. Postoperative period

3.2.1. First interval. See table 1. - Period of operative sandal / special shoe worn
Table 1. Components of the rehabilitation program applied for patients with surgical hallux valgus correction

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 – 7 days (week 1) = The first week after a surgical intervention</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Control postoperative leg</td>
</tr>
<tr>
<td></td>
<td>1. Strict elevation for pain, swelling and wound healing control</td>
</tr>
<tr>
<td></td>
<td>2. Special postoperative shoe / rigid postoperative sandal – mobilize full weight bearing</td>
</tr>
<tr>
<td></td>
<td>3. Seeing the toe bandage (some bleeding is normal in the first days)</td>
</tr>
<tr>
<td></td>
<td>4. Icing on the top of the surgical toe, periodically</td>
</tr>
<tr>
<td>2</td>
<td>Increase / mention the range of motion (ROM) of lower limb</td>
</tr>
<tr>
<td></td>
<td>1. Moving the all joints of lower limb (toe, ankle, knee, hip)</td>
</tr>
<tr>
<td></td>
<td>2. Gait without weight bearing in the operated leg; patient can used two crutches or canes</td>
</tr>
<tr>
<td><strong>8 – 14 days (week 2) = the second week after a surgical intervention</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Control postoperative leg</td>
</tr>
<tr>
<td></td>
<td>1. Strict elevation for pain, swelling and wound healing control</td>
</tr>
<tr>
<td></td>
<td>2. The rest of leg on a big pillow, especially in sleep time</td>
</tr>
<tr>
<td></td>
<td>3. Special postoperative shoe / rigid postoperative sandal – mobilize full weight bearing</td>
</tr>
<tr>
<td></td>
<td>4. Icing on the top of the surgical toe, periodically</td>
</tr>
<tr>
<td>2</td>
<td>Increase / mention the range of motion (ROM) of lower limb</td>
</tr>
<tr>
<td></td>
<td>1. Moving the all joints of lower limb (toe, ankle, knee, hip)</td>
</tr>
<tr>
<td></td>
<td>2. Raising the straight legs</td>
</tr>
<tr>
<td></td>
<td>3. Gait without weight bearing in the operated leg; patient can used two crutches or canes</td>
</tr>
<tr>
<td>3</td>
<td>Restore the hallux joint movements</td>
</tr>
<tr>
<td></td>
<td>Hallux joint exercises – 4 times / day</td>
</tr>
<tr>
<td><strong>15 – 21 days (week 3) = the third week after a surgical intervention</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Restore / consolidate the hallux joint movements</td>
</tr>
<tr>
<td></td>
<td>Hallux joint exercises – 5 times / day</td>
</tr>
</tbody>
</table>
### 3.2.2. Second interval. See table 2. - Period of normal shoe worn

Table 2. Components of the rehabilitation program applied for patients with surgical hallux valgus correction

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>22 – 42 days (weeks 4 - 6) = the fourth, fifth and sixth weeks after a surgical intervention</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **1** | Reduce the swelling | 1. Elevation of the leg  
2. Lymphatic drainage  
3. Activation of the muscle pump of the lower limb  
4. Cryotherapy (cool packs)  
! once a day for 20 minutes |
| **2** | Restore / consolidate the hallux joint and metatarsophalangeal (MTP) joints movements | Hallux joint exercises – 5 times / day  
- caudal sliding of the proximal phalanx (to improve flexion),  
- dorsal sliding of the proximal phalanx (to improve extension)  
Manual therapeutic interventions for all MTP joints - mobilization of the first MTP, Lisfranc, transverse tarsal, subtalar, and ankle joints.  
1 day session of 45 minutes |
| **after 42 days (after 6 weeks) = after 6 weeks post surgical intervention** |
| **1** | Restore / consolidate the hallux joint movements | Hallux joint exercises – 5 times / day  
A marble pick-up exercise  
Active range of motion of Hallux |
| **2** | Regain the tone and strength of all muscles of the toes | 1. Isometric contraction of the intrinsic muscles of the foot to maximum tolerance (three repetitions twice daily),  
2. Isometric contraction of the extrinsic muscles of the foot to maximum tolerance (three repetitions twice daily),  
3. Dynamic adduction and release of the abductor |
| 3 | Regain / maintain the tone and strength of calf muscles | 1. Hallux joint exercises – 5 times / day  
2. Ankle and calf exercises  
- ankle plantar flexion  
- ankle dorsiflexion  
- selective strengthening of the peroneal muscles  
- stretching the tibialis anterior muscle, the Achilles tendon |
| 4 | Gait training | Optimize the load distribution for the whole surgical foot  
For the stance phase - performing a heel-strike in its physiological position at the lateral aspect of the heel, followed by weight bearing of the first metatarsal during midstance  
For mid stance and terminal stance - training of active push-off by the great toe flexors, the flexor digitorum longus and brevis muscles, and the lumbrical muscles. |
| 5 | Maximize patients’ mobility and functional independence | Balance / proprioception work  
Returning to work  
Driving |
4. Communication with patients

a. Preoperative

- Most of the patients are over 60 years of age, when degenerative joint disease involving other joints and spine. Presence of associated illnesses is common.
- Patients should be aware that surgery for hallux valgus, while technically demanding, has a high rate of success in appropriately selected patients.
- Postoperative pain and management modalities / rehabilitation program should be described.
- Patients should be informed about mobilization time, need for assistive devices, bathroom usage, possible return to regular life (work).

b. Postoperative

- All patients must understand the importance of the special shoe postoperative that allows weight bearing of the operated limp while reducing stress in the forefoot region. Also, patients need to wear a compressive dressings for 8 weeks.
- Develop a maintenance program and educate patient on the importance of adherence, including methods of joint protection and gait training.
- For relative repose between kinetic sessions, the patient was asked to perform the selective strengthening of the peroneus longus muscle, because the function of this muscle is to pronate the midfoot and pronation is essential for ground contact of the first ray, the most heavily loaded structure of the foot during gait.

Please see video.
3.5. OSTEONECROSIS OF THE FEMORAL HEAD

REHABILITATION PROGRAM IN A PATIENT WITH OSTEONECROSIS OF THE FEMORAL HEAD – PRE AND AFTER CORE DECOMPRESSION

1. Osteonecrosis of the femoral head

Osteonecrosis of the femoral head (avascular necrosis or aseptic necrosis) is a painful disorder that occurs when the blood supply to the bone is disrupted, so osteocytes of the femoral head dying along with the bone marrow; resorption of the dead tissue by new but weaker osseous tissue can then lead to subchondral fracture and collapse; ultimately lead to destruction of the hip joint and arthritis. Although osteonecrosis affects people of all ages, it most commonly occurs between the third to sixth decades of life. Men develop osteonecrosis more often than women (the ratio is about 4:1). In many cases (at least 50%), both hips are affected by the disease. This condition develops in stages and the progression varies from several months to over a year. It is important to diagnose this disease early, because some studies show that early treatment is associated with better outcomes.

2. Role of complete diagnosis / assessment (etiopathogenical, clinic, laboratory - screening laboratory, imaging examination and functional assessment):
   a. The etiopathogenical and clinical assessment included:
      • careful patient history to determine the traumatic or atraumatic form of disease, parameters of pain, accompanying symptoms;
      o the traumatic form of hip osteonecrosis occurs in 10% of undisplaced femoral neck fractures, 10% of hip dislocations, and 15-30% of displaced femoral neck fractures;
      o corticosteroid use and alcohol abuse contributes to the atraumatic form of osteonecrosis in 5-25% of patients;
      o the idiopathic cases make up the third most common category.
      • general physical state examination (system examination including sensory evaluation);
o musculoskeletal examination – somatoscopic exam, appreciation of the range of motion and manual muscle testing of the lower limb muscles, especially the hip muscles.

o pain is typically the first symptom; may lead to a dull ache or throbbing pain in the groin or buttock area; pain with range of motion;

o gait exam, pace and dynamics, analyze pain when walking (on flat ground and stairs). As the disease progresses, it will become more difficult to stand and walk, put weight on the affected hip, and moving the hip joint will be painful.

b. **Imaging examination**

   - **X-rays** - are used to determine whether the bone in the femoral head has collapsed and to what degree.
   
   - **Magnetic resonance imaging (MRI) scans** – are used to evaluate how much of the bone is has been affected by the disease. An MRI may show early osteonecrosis that has yet to cause symptoms (if it is developing in the opposite femoral head).
   
   - **PET scans** – are used to show earlier involvement in the acetabulum than is discernible by other radiographic modalities.

c. **Functional assessment**

   - the VAS - Visual Analogue Scale (from 0 to 10, 0 = absence of pain and 10 = maximum pain score, other values between 0 and 10 is directly proportional with the intensity of pain, depending on the individual pain threshold);
   
   - the WAS - walking ability scale;
   
   - the WOMAC scale.

3. **Rehabilitation program (RP)**

3.1. **Preoperative period**

**Objectives** of RP:

- Relief of symptoms; painful status control;
- Prevention of disease progression / reduce the risk of further damage to the bone;
- Improvement of the affected joint and ensure bone and joint survival;
- Improvement of functionality.
It must take into consideration that physical therapy cannot cure avascular necrosis, but it can slow down the progression of the disease and decrease associated pain.

**Methods** of RP:
- non-pharmacological and non-surgical modalities:
  - educational - restricted patient weight bearing with the use of a cane or crutches, dietary (weight reduction), addressing known risk factors (smoking, alcohol abuse, monitor steroid use), rest (activity modification, to restrict patient physical activity);
  - osteoporosis screening is indicated in in patients with prolonged corticosteroid use;
  - physical therapy provides only symptomatic control and also does little to alter disease progression, can be used to stimulate bone growth (thermotherapy - paraffin and electrotherapy - magnetodiaflux, TENS, interferential current, ultrasound, whirlpool, electrical stimulation); shock wave therapy in an attempt to get the bone to heal;
  - massage – classic and special massage, particularly for the buttocks, back, or anterior and lateral hip muscles;
  - kinetic (three times per week):
    - training the patient in how to properly use crutches or other gait aids, for regaining lower limb function and relieve painful symptoms;
    - exercises to maintain joint mobily and improve the range of motion in all joints;
    - mobilization of the hip may be combined with assisted stretching of any tight muscles around the joint;
    - muscle stretches; it may also be necessary to stretche knee, ankle and calf - areas that can become tight with the use of a walking aid;
    - exercises to strengthen the muscles around the affected hip joint, thight and back - resistance band exercises (Theraband), soft weight lifting (exercises promote the flow of blood to the joint); exercises that involve the entire lower limb, such as squats on both legs at the same time or just one leg, exercises in these non-weightbearing positions, sitting (exercise bike) or lying in will be prescribed;
• pool exercises (gentle aerobic exercises);
• exercises to regain balance and proprioception;
• daily physical therapy exercises for recreational activities and an active lifestyle.

!! Should be avoided:
• excessive compressive and shear forces on the joint;
• exercises that work the muscles while in standing most effectively assist with daily activities (walking, stair climbing);
  o occupational therapy – teaching how to do ADLs, to rebuild general endurance.
• pharmacological modalities - analgesics, nonsteroidal anti-inflammatory drugs, osteoporosis drugs (bisphosphonates - alendronate), cholesterol lowering drugs, blood thinners.
• most patients will eventually need surgical treatment, such as:
  o core decompression - the most commonly performed prophylactic surgical intervention often supplemented with bone grafting, in early stages of the disease, before the stage of collapse;
  o bone transplant (graft),
  o bone reshaping (osteotomy),
  o arthroplasty (total joint replacement) - the most commonly performed and successful surgery for advanced AVN of the hip,
  o regenerative medicine treatment (stem cells transplant).

3.2. Postoperative period
3.2.1. First interval. See table 1. – The acute care period and inpatient rehabilitation
3.2.2. Second interval. See table 2. - Period of outpatient rehabilitation

4. Communication with patients
a. Preoperative
  • Postoperative pain and management modalities / rehabilitation program should be described.
  • Patients should be informed about mobilization time, need for assistive devices, and possible return to regular life (work).
• All patients must understand that moving the joint helps to move any swelling that may be present, and gets fresh blood to the healing areas.

b. Postoperative
• The activity level will depend on which joint have undergone a core decompression.
• All patients must understand the importance of the cane / crutches postoperative that allows weight bearing of the operated hip while reducing stress in the femoral head, for six weeks, possibly longer depending on the severity of the disease. Using a walking aid allows pressure to be taken off the bone while it heals and reduces the risk of fracturing the hip while the bone is healing. Patients who have had bone and blood vessels grafted are required to limit how much weight they place on the hip for up to six months.
• During the kinetic program, only mild discomfort at the very end ranges of motion during the stretching exercises, however, is permissible.

Table 1. Components of the rehabilitation program applied in the 1 – 3 weeks after core decompression

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
</tr>
</thead>
</table>
| 1 – 7 days (week 1) = The first week after a surgical intervention  
Acute care period | 1. Cryotherapy – ice around hip can decrease any pain or swelling, periodically, seeing the local bandage (in the first and second days)  
2. Electrotherapy – TENS, dyadinamic current, ultrasound in the hip region; the neuromuscular electric stimulation of muscles around operated hip  
3. Massage - gentle around the surgical site and classical anywhere down the extremity (hip, ankle, leg) and back  
4. Posture in the lying (supine) position, with neutral abduction of lower limbs |
2 Mention the ROM of other joints of the lower limbs without operated hip

1. Standard mobilization of the opposite lower limb – passive and active ROM exercises of toe, leg, ankle, knee and hip (20 minutes / three times / daily)
2. Assisted stretching of any tight muscles around the previous joints
   !! Stretches for knee, ankle and calf may also be necessary as these areas can become tight with the use of a walking aid
3. Gait without weight bearing in the operated lower limb; teaching how to safely use the crutches or a walker

3 Preserve the muscle status of the lower limbs

1. Isometric contraction – bed exercises aimed at mention the strength of thigh and calf muscles (6 – 10 seconds / contraction; 1 session = 6 – 10 contractions; 6 sessions / daily)
2. The neuromuscular electric stimulation of muscles around operated hip

8 – 21 days (weeks 2 and 3) = the second and the third weeks after a surgical intervention

**Inpatient rehabilitation**

1 Increase / mention the range of motion (ROM) of lower limbs

1. Operated hip joint - passive flexion and extension ROM exercises were initiated 2 weeks after surgical treatment; passive adduction was initiated 3 weeks after surgical treatment (20 minutes / three times / daily)
2. Active mobilization of all other joints, in all plans of motion (20 minutes / three times / daily)
3. Assisted stretching of any tight muscles around the previous joints

2 Increase muscle strength of lower limbs

**Operated lower limb**

1. Isometric contraction – bed exercises aimed at mention the strenght of thigh and calf muscles (6 – 10 seconds / contraction; 1 session = 6 – 10 contractions; 6 sessions / daily)
2. The neuromuscular electric stimulation of muscles around operated hip and quadriceps
Opposite lower limb
1. Isometric contraction in kinetic chain (6 – 10 seconds / contraction; 1 session = 6 – 10 contractions; 6 sessions / daily)
2. Isotonic contraction of hip muscles (abductors, flexors, extensors), quadriceps and calf muscles, with constant low resistance weight tied on the ankle (example - daily knee extension with sandbags strapped to the ankle, leg press and knee extension) 3 sets by 10 repetitions / set, daily

Increase / preserve the upper limb muscle-strength
Upper limb muscle-strengthening exercises – isotonic contractions; the intensity of exercise was increased by increasing the load by 40% to 80% of 10-repetition maximum (RM)
Patient may adopted the seated position

Gait without weight bearing in the operated lower limb

Table 2. Components of the rehabilitation program applied for patients with core decompression in outpatient period.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 – 42 days (weeks 4 - 6) = the fourth, fifth and sixth weeks after a surgical intervention</td>
<td></td>
</tr>
</tbody>
</table>
| 1 Restore / consolidate the ROM of lower limb | 1. All previous ROM exercises must performed  
2. Passive rotation ROM exercise in affected hip may be initiated |
| 2 Restore / consolidate the strength muscles of lower limbs | Operated lower limb  
1. Isometric contraction exercises in sitting or lying  
2. Isotonic flexion muscle-strengthening exercise, straight leg raising with no weight  
3. Electrical muscle stimulation to assist the muscles in contraction  
Opposite lower limb  
1. Exercises will focus mainly on the muscles of hip and
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
|   | thigh  
2. Exercises that involve the entire lower limb, such as squats on both legs at the same time, or just on one leg, will be prescribed.  
3. Exercises used of Theraband or weights to provide some added resistance for hip and lower extremity |   |
| 3 | Gait training | Gait without weight bearing in the operated lower limb |

**After 42 days (after 6 weeks) = after 6 weeks post surgical intervention**

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| 1 | Consolidate the ROM of lower limbs | 1. All previous ROM exercises must performed  
2. Active ROM exercise in operated hip in all directions may be initiated |
| 2 | Consolidate the strength muscles | 1. All previous muscle strength exercises must performed  
2. Isotonic and isokinetic muscle strengthening in operated hip may be performed (flexor, abductor, extensor, adductor, rotators muscles)  
The intensity of exercise is defined by pain level and is increased by increasing the load by 50% to 80% of 10-repetition maximum (RM). |
| 3 | Regain balance and proprioception | 1. Exercises that work the muscles while in standing are most effective for improving balance, walking and stair climbing.  
2. Standing on one foot or balancing on an stable, then unstable surface  
3. Advanced exercises such as the stepper or elliptical machines |
| 4 | Gait training | 1. Optimize progressing the load of weight bearing  
2. Full weight-bearing was permitted 6 - 10 weeks after intervention |
| 5 | Maximize patients’ mobility and functional independence | 1. Exercises that simulate your specific everyday activities of daily living and any recreational activities that you may want to return to  
2. Aerobic training is started 8 weeks after surgical intervention (stationary bicycle exercise, pool) |
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<td>3. Returning to work, driving are permitted after 10 – 12 weeks after&lt;br&gt;4. Patients were allowed to resume sports 4 - 6 months, when bone is healed</td>
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Please see video.
3.6. CHONDRAL / OSTEOCHONDRAL DEFECTS OF THE KNEE

PATELLA PATHOLOGY
The patella is a relatively small bone in the front of the knee that is embedded in the quadriceps (thigh muscle) tendon and acts to increase the biomechanical leverage of the quadriceps. The patella slides in a groove on the femur as the knee flexes and extends. Because the patella ‘floats’ within the substance of the quadriceps, proper tracking of this bone in the femoral groove is dependent on proper muscle balance to maintain a central position. Congenital anatomic factors such as the shape of the patella also influence this tracking. Also, because of the location of the patella, it is subject to higher stresses than other joint surfaces. So, despite having a thicker cartilage lining than any other bone, it often begins to wear out before other parts of the knee.

CHONDROMALACIA PATELLAE
Definition: Latin term, meaning softening or break down of cartilage. Chondromalacia of the patella is one of the most common problems to affect the knee, and is particularly common in running and jumping athletes. Chondromalacia usually begins as softening of the otherwise very resilient cartilage and proceeds to cracking and eventually complete loss of the cartilage lining beneath the patella. Symptoms include: Pain in the front of the knee, crunching under the knee cap, swelling in the knee, symptoms increase with stair climbing, or prolonged sitting. Early on, symptoms may simply be mild aching in the area of the patella due to the loss of integrity of the cartilage and a diminished ability for it to protect the underlying bone. Nerve fibers in the bone sense the increased stresses and pain occurs. In later stages of chondromalacia, the cartilage surface of the patella becomes roughened as pieces of cartilage begin to break off. This roughened surface causes a crunching sound under the patella and can lead to swelling of the knee. Symptoms will aggravate as small fragments of cartilage continue to break off and irritate the joint.

Treatment Options: Initial treatment focuses on physical therapy techniques for strengthening the muscles around the patella to balance the patella tracking and more evenly distribute forces on the patella. In severe cases, ice and anti-inflammatory drugs will be necessary to calm down inflammation before exercises can be initiated. Occasionally, a patella tracking brace or special taping techniques will be utilized. Most patients will improve with non surgical management. In resistant cases arthroscopic surgery can be very helpful in smoothing out the roughened surface of the patella, removing any loose fragments of cartilage, and realigning the patella. Many cases of chondromalacia can be helped by a mini arthroscopy performed under local anesthesia in the office.

PATELLA MALALIGNMENT
The normal patella should track straight down the middle of the femoral groove. There are varying degrees of abnormal tracking, or patella malalignment. In mild cases of
malalignment the patella is simply tilted in the groove, leading to increased pressure on the downward tilted side of the patella. Think of this as being like a tire out of alignment, where a subtle imbalance can quickly lead to uneven wear of the tire treads. In more severe cases, the patella will actually sublux, or slide partially out of the groove. In the most severe cases of malalignment, the patella will actually completely dislocate.

Proper tracking of the patella is influenced by many factors. Proper muscle balance is important and is one of the few factors that we can control. Usually the patella wants to sublux toward the outside of the knee (lateral). Strengthening the inside muscle (the VMO) can act to counter this tendency.

Tracking is also influenced by the anatomical shape of your patella, femoral groove, the angle your knee makes with your hip (knock knees) and even the position of your foot (pronation). The hip knee angle is important because the patella is embedded in the quadriceps tendon which originates at the hip and attaches at the knee. The more knock kneed someone is, the more of an angular pull occurs on the patella every time the quadriceps contracts. This angle is called the "Q" angle in medical terminology. In severe cases of angulation (a high "Q" angle) surgery can be performed to correct the "Q" angle. The shape of the patella and femoral groove cannot be easily modified. Increased pronation of the foot (flat feet) can influence the tracking of the patella. This occurs because the rotation of the rest of the leg is affected by the way the foot contacts the ground. In patients with increased pronation, use of shoe orthotics (arch supports) may help patella tracking by modifying the rotation of the knee.

**Patella malalignment - Surgical Treatment:** For severe cases of patella malalignment surgery may be necessary. This is a new all arthroscopic method for realigning the patella (knee cap). Traditionally, patients with an unstable patella are subjected to an extensive operative procedure that involves making an incision to tighten the inner ligaments controlling the tracking of the patella.

An even newer technique for treatment of some types of patella instability is the use of a heated probe to shrink the stretched patella ligament or retinaculum. This method eliminates the need for any incisions or sutures in the knee. This method is currently being utilized for patients with less severe instability of the patella (called subluxation). With this method, rather than using sutures to tighten the ligaments and realign the patella, the stretched ligaments are heated which shrinks and tightens them.

**PATELLA DISLOCATION**

The patella is held in place by thin ligaments that act as check reins, keeping it from coming out of the femoral groove, while the muscles provide the fine tuning. With severe twisting maneuvers or direct trauma, the patella can dislocate, tearing these ligaments and coming completely out of place. Sometimes the patella will spontaneously reduce, sometimes a trip to the emergency room is necessary. Because the ligaments have torn, the patella usually will continue to be off balance even after the dislocation is reduced. This will lead to abnormal tracking and increased risk of redislocation in the future. In
addition, small fragments of cartilage are often chipped off as the patella dislocates, and can cause damage to the joint as they float around. Numerous studies have shown that patients who have dislocated their patella do not do well in the long term, and suffer either repeated dislocations or develop degeneration under the knee cap due to the now abnormal tracking. Recommended treatment is for immediate arthroscopic evaluation to remove the loose chips and to repair the torn ligaments and rebalance the patella tracking.

PATELLA FRACTURES
Fractures of the patella most commonly occur from direct trauma, usually a fall on the knee or a direct blow to the patella. Less frequently, the patella can be fractured by a sudden, violent contraction of the quadriceps.
Patella fractures are classified as either transverse, stellate or vertical. These three categories can be further classified as displaced or nondisplaced. The arterial blood supply to the patella is derived from two systems of vessels from branches of the geniculate arteries. These two systems supply the middle third and apex of the patella. In cases of displaced transverse fractures, the proximal blood supply may be compromised leading to avascular necrosis of the proximal segment.
Overall, the management of patella fractures is based on classification and morphology of the injury. Treatment options range from nonoperative to operative with open reduction and internal fixation to partial or total patellectomy.

Nondisplaced Fractures
Nonoperative care involves the use of extension splinting from four to six weeks. Weight-bearing status is as tolerated. Generally, quad sets and straight leg raises are permitted as soon as pain allows. Usually at around four weeks, active knee flexion can proceed once radiographic confirmation is made of fracture consolidation. The contralateral limb is exercised freely, and a general conditioning program is initiated for upper and lower extremity strengthening. Aerobic fitness is maintained via a single leg stationary cycle ergometer or upper body ergometer (UBE). Care is taken during the maximum protection phase of recovery to guard against passive knee flexion beyond the healing constraints of the fracture.
If quadriceps strengthening and knee flexion are progressed too soon, the forces acting across the healing fracture may delay union. Therefore, the PTA must be acutely aware of osseous healing mechanisms and time constraints when overseeing range of motion and strengthening exercises during each phase of recovery from nondisplaced patella fractures. Usually, active range of motion is initiated. Gradual progression to passive range of motion will correlate with solid bone union. Close consultation with the PT is important, since some degree of evaluative skills is necessary for patient progression.

Displaced Fractures
Treatment of patella fractures is based on ranges of acceptable fracture fragment separation exceeding 3 to 4 millimeters. Although patella fracture patterns may vary, stabilization of displaced patella fragments is best accomplished with an open reduction
internal fixation procedure. Various techniques are used including tension band wiring, cerclage wiring, lag screws or combinations of the above. Commonly, tension band and cerclage wiring is used to stabilize displaced transverse patella fractures. The tension band is a dynamic compression device that approximates and compresses the fracture fragments. The additional use of cerclage wiring adds to the stability of the repair and allows early joint motion without redisplacing the fracture fragment. Postoperatively, the involved limb is immobilized in 20 degrees of flexion to support dynamic compression of the tension band wiring procedure. Postoperative rehabilitation begins approximately one week after surgery. Active knee flexion should be limited to about 100 degrees for at least six weeks following surgery to allow for proper fracture consolidation. Straight leg raises, submaximal quad isometrics and gentle active short arc knee extension exercises characterize the initial maximum protection phase of recovery. Weight bearing as tolerated with assistive devices is encouraged during the first few weeks following surgery, progressing to full weight bearing by the third or fourth week. As clearly stated during treatment of nondisplaced patella fractures, care must be taken not to overstress the healing fracture by aggressive flexion, range of motion or resisted knee extension exercises. Radiographic confirmation of fracture consolidation with stable implant fixation and postoperative time greater than six weeks will dictate to the physician and the PT the gradual implementation of the moderate protection phase of recovery. Active-assisted knee flexion and light resistance quad exercises are begun once the patient is able to demonstrate good quad control, improved knee flexion to 100 degrees, reduced pain and swelling and normalized gait mechanics. Functional closed chain resistance exercises are deferred until the patient is able to demonstrate increased range of motion without signs or symptoms of articular cartilage degeneration. Strength-training exercises of remedial isometrics and progressive concentric and eccentric resistance must approximate and correlate with solid bone union. Severe comminuted patella fractures are treated surgically with a partial or total patellectomy if significant bone mass cannot be salvaged. However, as little as 25 percent of the patella can be retained with a good outcome when compared to the overall poor results of total patellectomy.
PHASES OF THE REHAB PROGRAM (principal bases)

Pre-op (if available)
- Measure for and fit for post-operative brace (double up right, locked at 0);
- Measure for and fit with ted hose;
- Perform crutch / walker training and issue crutches / walker if needed;
- Evaluation should be scheduled for 2-3 days after surgery
- Post-op instructions and education from surgery date to initial physical therapy appointment.

Phase 1: 0-2 weeks post-op
Goals:
- Maintain integrity of repair;
- Decrease pain and inflammation;
- Promote tissue and fracture healing;
- Achieve / maintain full extension;
- Incrementally increase passive ROM (per surgeon consultation);
- Facilitate quadriceps contraction;
- Patient education of precautions and progressions.

Knee immobilizer: worn at all times, taken off only for physical therapy sessions (converted to hinged knee brace at first post-op visit)
Weight bearing: WBAT with the knee locked in extension
Range of motion: A- ROM / AA- ROM / P- ROM 0-30 degrees
Therapeutic exercises: Isometric quadriceps / hamstring / adductor / abductor strengthening. Ankle theraband exercises

Precautions:
- No quick movement;
- No aggressive stretching;
- Avoid passive ROM that is too aggressive or provokes muscle guarding;
- Keep incision dry and clean;
- Ensure proper brace fit / locked in extension.

0 – 2 weeks
- PROM 0° extension – must achieve 0 grades extension, No flexion.
- Patella mobilizations;
- May initiate quadriceps isometrics (relative pain-free);
- Brace locked at 0° and PWB;
Goals for Phase 3:

- Minimal pain / effusion.
- Staged ROM goals achieved (per consultation with surgeon).

Criteria to progress to Phase 3: 6 - 10 weeks post-op

Phase 3: 2 – 6 weeks post-op

- Ambulation with brace locked at 0 degrees, WBAT.
- NMES to facilitate quad contraction (if indicated).
- ROM flexion to 30 degrees.
- Maintain 0 degrees extension.

Note: If painful / swollen may keep PWB for additional weeks (or per physician recommendation).
Knee brace: Unlocked - worn with WB activities
Weight bearing: Full
Range of motion: A-ROM / AA-ROM / P-ROM – progress to full ROM by post-op week 10

**Therapeutic exercises:** Isometric quadriceps / hamstring / adductor / abductor strengthening. Ankle theraband exercises. Initiate straight leg raises.

**Weeks 6 – 12:**
- Initiate functional weight bearing exercises;
- Initiate open kinetic chain AROM;
- Initiate isotonic strengthening exercises;
- Initiate balance / proprioception exercises;
- Advance intensity of PROM;
- Unlock brace with ambulation, once displays functional quadriceps control may switch to functional short hinge knee brace.

**Phase 4: 10 - 12 weeks post-op**
Knee brace: Discontinue
Weight bearing: Full
Range of motion: full ROM

**Therapeutic exercises:** Isometric quadriceps / hamstring / adductor / abductor strengthening. Ankle theraband exercises. Initiate straight leg raises. + Start stationary bicycle.

**Phase 5: 3-6 months post-op**
Return to full activities as tolerated

**Criteria to progress to this phase (12+ weeks):**
- Minimal pain with AROM and strengthening activities;
- Full AROM without substitution;
- 5 / 5 strength without substitution.

**Goals (12+ weeks):**
- Full passive / active ROM;
- Enhancing dynamic stability;
- Gradual restoration of strength, power and endurance;
- Advance neuro-muscular control;
- Return to full ADLs / work.
Note !!!
- Advance all activities based upon patient’s goals and expectations.
- Each patient is an individual and should be treated as such.
- Work together with the referring orthopedic for optimal patient outcome.

Phase 6 (final):
LONGLIFE MAINTENANCE PROGRAMME (KNEE CONDITIONING PROGRAM)

Aim – to stimulate the patient to return to daily activities

Methods:
- Strengthening exercises
- Flexibility exercises – stretching the muscles for restoration of ROM and prevention of future injuries

Target muscles:
- Quadriceps (front of the thigh);
- Hamstrings (back of the thigh);
- Abductors (outer thigh);
- Adductors (inner of the thigh);
- Gluteus medius & maximus (buttocks).

Length of the program – every day for a minimal period of 6 months
After that – maintenance program for lifelong protection of knees (2 – 3 days a week)

Structure of the procedure:
- Warm-up,
- Stretch,
- Strengthening exercises,
- Stretching exercises.
**Stretching exercises**

- Heel cord stretch
- Standing quadriceps stretch
- Supine hamstring stretch

**Strengthening exercises**

- Half squats
- Hamstring curls
- Calf raises
- Leg extensions
- Straight leg raises
- Straight leg raises (prone)
- Hip abduction
- Hip adduction
- Leg presses

**Recommendations to the patient:**

- Do not ignore pain
- Ask questions – to be sure that the exercise is well done
EXAMPLE

MENISCUS TEAR

The meniscus is a disc of cartilage tissue and its function is shock absorption between the bones of the knee. Menisci are frequently damaged in twisting injuries or with repetitive impact over time. Meniscal tear is a frequent lesion in clinical practice of Orthopedics & Traumatology departments. Meniscus rupture can be the consequence of high energy stress of the joint in position of capsulo-ligamentar relaxation in case of closed kinetic chain and the characteristic model includes combination of torsion stress with valgus or varus angulation.

The meniscus tear is among the most common orthopedic injuries and has been colloquially referred to as “torn cartilage” in the knee. It has affected athletes of literally every sport. While it is most commonly seen in the posterior horn, it can occur in any location and affect either the medial, lateral, or both sides. Common types of meniscus tears are: Radial, Flap or Parrot-beak, Peripheral longitudinal, Bucket-handle, Horizontal cleavage, Complex degenerative tears.

The application of mini-invasive arthroscopic techniques in the surgical treatment of meniscal lesions induces actualization of the rehabilitation approach. The post-op rehabilitation can begin immediately with active exercises. Weight bearing is permitted with crutches during the first week. Bandages are removed after 24 hours and band-aids are applied. Stationary bicycling is allowed within a few days.

Normally, the healing process finishes between 4-8 weeks but it can take up to 6 months maximum. The patient can return to his normal life including sportive activity.

Contemporaneous rehabilitation protocols for these patients are principally oriented to kinesiotherapy or physiotherapy. But some rehabilitation schools (Bulgarian, Russian, Romanian, etc.) traditionally prefer to apply a complex rehabilitation program with combination of different physical modalities, not only movement therapy.

Functional assessment methods

The evaluation protocol consists of history of the condition, clinical patterns, and functional assessment, including: goniometry of the knee joint, centimetry, manual muscle test, visual analogue scale of pain (0-20), gait test (test of 5 meters).

Treatment methods

The rehabilitation program is focused on following tasks: functional recovery, restoration of the knee kinetic and kinematic; reduction of pain and oedema; gait training; prevention of complications due to hypomobility (e.g. myo-hypotrophy).

PT programme

All patients must receive a detailed physiotherapeutic program, including active exercises oriented in training the muscles that allow the function of the knee (m.quadriceps femoris, m.biceps femoris, m.semimembranosus, m.semitendinosus and m.triceps surae), working hip stabilizers (with focus on the hip abductors, hip flexors and gluteal muscles), increasing muscle endurance (using low-impact cardio-vascular activities, e.g. stationary bicycle or/and swimming). Special attention is paid to Heel slides à passive flexion and to push the involved leg back up into extension; supine wall
slides to increase flexion ROM (when 110-115° of flexion is achieved); strengthening exercises for the quadriceps muscle (especially for Vastus medialis segment); isotonic strengthening exercises for the hamstring muscles (when 80-90° of flexion is obtained); hip abduction strengthening (when Vastus medialis obliquus /VMO/ muscle is strong enough).

PATIENT EDUCATION

All patients must receive detailed instructions for rest and rehabilitation. Patient education includes information about the lesion and the operation; recommendations to reduce activities and to use crutches - during the first week, to avoid knee-twisting movements or positions, to elevate the knee higher than the heart during rest - for at least 1 month.

CRYOTHERAPY

Cryotherapy is applied for 10 minutes, twice a day for the first week, and once a day for the next week;

MANUAL THERAPY TECHNIQUES

We can add manual mobilizations – patella mobilizations, soft tissue techniques of G. Maitland and B. Mulligan;

PRE-FORMED MODALITIES

- Interferential currents;
- Low frequency low intensity magnetic field;
- Deep oscillation (DO) – a modern physical modality consisting of electrostatic field, that provokes oscillation of the tissues in profundity, explained with the Rahbek–Johnson effect.
3.7. ACETABULAR FRACTURES- POSTERIOR STABILIZATION

3.7.1. REHABILITATION MANAGEMENT OF FRACTURES

The management of post-traumatic rehabilitation is based on the RICE rule (Rest, Ice, Compress, Exercises).

The algorithm is divided into immobilization and post-immobilization periods of the PRM programme of care (PRM = physical and rehabilitation medicine). Some authors prefer the next classification of the rehab periods: Pre-operative (if planning of the operation); Early post-operative period; Middle post-operative period; Tardive rehabilitation (stabilization).

The goal of rehabilitation of individuals with fractures is to restore functional abilities of the individual (Salter). The duration and type of OT rehab required following a fracture are related to the associated soft tissue involvement, as well as the location and type of fracture and the method of stabilization (Chapman). Protocols for rehabilitation must be based upon stability of the fracture and fracture management (operative, nonoperative).

Rehabilitation emphasizes restoring full range of motion, strength, proprioception, and endurance, while maintaining independence in all activities of daily living (Bucholz). Cold and other modalities may be used in controlling pain and edema (Salter). The individual should be encouraged to continue functional activities to prevent complications of inactivity and bed rest. Depending on the stability of the fracture, range of motion exercises of the adjacent joints may be started immediately and progressed to strengthening exercises as indicated (Chapman).

Bone healing may occur within 6 to 20 weeks; however the bone strength and the ability of the bone to sustain a heavy load may take up to several years (Chapman). Once healing has occurred, the individual may resume full activities of daily living. Resumption of pre-injury status is the goal, with consideration of any residual deficit. The treating physician should guide the resumption of heavy work and sports; it is important to instruct the individual not to overload the fracture site until the bone has regained its full strength.

After either surgery, a period of non weight bearing for 6 to 8 weeks is recommended in a cast or cast boot. Weight bearing is started while the patient is in the boot if the X-rays look appropriate after 6 to 8 weeks. The amount of weight a patient can put on their foot, as well as the distance the patient is allowed to walk, is at the surgeon’s discretion. Impact activities, such as running and jumping, should be avoided until the hardware has been removed. A lot of ankle supports are applied: splints, braces, insoles, and ankle-foot orthosis orthoses.

Rehabilitation includes predominantly physiotherapy (hands on) procedures - active or passive kinesitherapy in combination with cryotherapy (cold application): range-of-motion exercises, strength exercises, analytic exercises with a gradual increase of the resistance, soft tissue techniques (post isometric relaxation, calf stretch, soleus stretch,
plantar fascia stretch, massages), **cryotherapy** (ice or cold packs), **hydro or balneo-kinesitherapy** (underwater exercises). The **ergonomic approach** and **ergotherapy** (**occupational therapy**) are obligatory for the quality of **gate rehabilitation**. In some countries a lot of **preformed physical modalities** with trophic and analgesic effects are applied: low frequency electric currents, low frequency low intensity magnetic field, laser therapy or laser puncture.

In every case a detailed and individually adapted **patient education** is included in the fracture management process.

### 3.7.2. REHABILITATION AFTER FEMUR FRACTURES

The goal of rehabilitation after a femur fracture is to restore function. The rehabilitation protocol depends on the type, location, and severity of the fracture, as well as the physician's protocol for treatment. Consideration must be given to the method for stabilizing the fracture (operative, nonoperative) and on the stability of the fractured bone. The individual's general condition prior to the fracture and the individual's weight-bearing status may influence the rehabilitation process.

Of primary importance during the early phase of recovery is ambulation, with weight bearing as advised, and assistive devices as needed. Depending on the procedure, partial weight bearing may be delayed until there is evidence of bony union, and full weight bearing may be restricted for an additional month (Whittle). The physical therapist should teach ankle exercises to promote circulation through the lower extremities and should advise individuals to perform these intermittently throughout the day.

As the individual increases his or her mobility, an occupational therapy evaluation may be beneficial to maximize independence with activities of daily living and to supply adaptive equipment, such as a raised commode or tub seat, to promote independence.

Once the fracture is stable, gentle range of motion and strengthening exercises can be started and progressed as indicated. The therapist should make sure that adjacent joints are exercised to prevent loss of motion and strength (Whittle). Both to complement supervised physical therapy and to be continued independently after the completion of rehabilitation, a home exercise program should be taught during this period.

Bone healing may occur within 6 to 12 weeks; however, the bone strength and the ability of the bone to sustain a heavy load may take up to several years (Chapman). Once healing has occurred, the individual may resume full activities of daily living. It is important to instruct the individual not to overload the fracture site until the bone has regained its full strength. The resumption of heavy work and sports should be guided by the treating physician.
PATIENT COMPLAINTS
- moderate pain and stiffness in the right hip and muscles around it
- difficulties in standing up, transfers and mobility,
- decrease in autonomy in activities of daily living (ADL).
- gait with crutches.

FUNCTIONAL ASSESSMENT
Goniometry of the correspondent hip joint
Before rehabilitation – difficulty in transfers, impossible normal gait, the patient can effectuate 10 meters walk test – with crutches and an assistant PT.
Evaluation of the rehabilitation potential
ICF assessment:
- impairments of body functions – hip pain, muscle weakness, and restricted hip ROM;
- changes in body structures;
- activity limitation - limited walking ability and problems with putting on socks and shoes;
- participation restrictions - reduced participation in leisure activities and in household chores;
- decrease of the patient’s level of function.
Evaluation of the physical performance:
- 10 meters walk test (10mWT) – before rehab;
- Timed Up and Go test (TUG) - before intervention;
- 6 Minutes Walk Test (6 MWT) - if possible - before and after rehabilitation.

OT rehab programme
GOAL – functional reeducation of the hip and related activities (walking, transfers)

TASKS:
- recovery of the stability and mobility of the lower limb joints, restoration of the muscle and ligament balance, accentuating on muscles around the hip joint; keeping the hip in the economic limb biomechanics;
- pain control; control of the cicatrix; control of joint ROM; control of possible complications;
- education of transfers, normal gait recovery with correction of eventual abnormal walking scheme;
- ADL (activities of daily living) training; amelioration of autonomy in everyday life;
- psycho-emotional stimulation , amelioration of the health-related quality of life.

METHODS:
- drugs – Fraxiparine daily; analgesics, chondral protectors,
✓ patient’s education;
✓ posture (activity modification),
✓ electrotherapy – interferential currents, laser therapy;
✓ cryotherapy - for the hip joint (cryo-massage and cryo-kinesitherapy);
✓ massage – classic massage (relaxing for the anterior group of muscles of the hip; stimulating for gluteal muscles),
✓ Individualized kinesitherapeutic programme - correct posture of lower limb, analytic exercises for gluteal muscles especially for gluteus medius muscle, lower limb joint mobilization (assistive active and active range of motion), post-isometric relaxation /PIR/ for iliopsoas muscle; stretching and strengthening in all muscles of the lower limb (accentuating on muscles around the hip joint), gait training with supporting walker, two crutches or two canes, then only with one cane when patient up and down the stairs.
✓ Ergotherapy & ADL training.

COMMON RESULTS OF THE EARLY REHABILITATION PROGRAMME

- Amelioration of the range of motion of the operated hip;
- Amelioration of the functional capacity;
- Amelioration of the neuro-muscular coordination;
- Independent verticalization (stand up) and transfers;
- Independent gait with crutches – in the room and the corridor ;
- Stabilization of the gait;
- Amelioration of the self-service.

RECOMMENDATIONS:  
Treatment plan after the dehospitalization:
Auto-PT at home:
kinesiotherapy every day at the 3-th month after the operation
Gait – with a walker or with two crutches
Next rehabilitation course at hospital – after 3 months
General HIP CONDITIONING PROGRAM – for lifelong protection after surgery

**Aim:** to stimulate the patient to return to daily activities, to sport and other recreational activities.

**Methods:**
- Strengthening exercises;
- Flexibility exercises – stretching the muscles for restoration of ROM and prevention of future injuries;
- Low frequency low intensity magnetic field;
- Deep Oscillation;
- Interferential currents;
- Cryotherapy;
- Underwater exercises.

**Target muscles for physiotherapy:**
- Gluteus maximus;
- Gluteus medius;
- M. Ilio-psoas;
- M. Piriformis;
- Hamstrings;
- Hip Adductors – after the month 6;
- Hip Abductors – from the beginning;
- Tensor fasciae latae.

**Length of the program -** every day for the first period – after the 6th post-op month (for one month minimum)
After that – maintenance program for lifelong protection (2 – 3 days a week)
Structure of the procedure:
  - Warm-up (5-10 minutes);
  - Stretch,
  - Strengthening exercises,
  - Stretching exercises.

Stretching exercises: Standing ilio-tibial stretch, Seated rotation stretch, Knee to chest, Supine hamstring stretch

Strengthening exercises: Hip Abduction, Hip Adduction, Hip extension (prone), Internal hip rotation, External hip rotation

Recommendations:
Exercises must be done without pain (or increase of current pain)
Patient can realize exercises at home, only if the therapist is sure that the application of exercises is correct!
3.8. INTERTROCHANTERIC FRACTURES: GAMMA NAIL/ DHS
INTERTROCHANTERIC FEMUR FRACTURES

Intertrochanteric fractures are considered one of the three types of hip fractures. The anatomic site of this type of hip fracture is the proximal or upper part of the femur or thigh bone.

An intertrochanteric fracture was described by Cooper in his treatise of 1851 as follows: “...fracture of the femur through the trochanter major, passes obliquely upwards and outwards from the lower portion of the neck but instead of traversing the neck completely, it penetrates the base of the trochanter major; the line of fracture being such as to separate the femur into two fragments, one of which is composed of the head, neck and trochanter major, and the other of the shaft with the remaining portions of the femur. Cooper's recommended treatment was "moderate extension and steady support of the limb in its natural position."

Current treatment of intertrochanteric fractures involves surgical intervention. **Open reduction and internal fixation (ORIF)** is indicated for all intertrochanteric fractures, unless the patient’s medical condition is such that any anesthesia, general or spinal, is contraindicated. Total hip arthroplasty has a limited role in treatment and is usually reserved for patients with coexisting severe symptomatic arthritis of the hip. External fixation is also rarely indicated but is useful as a quick procedure in patients who may not tolerate general or spinal anesthesia and can only tolerate local techniques. Medial displacement osteotomy and valgus reduction are no longer practiced, because of the severe deformities they produced and because of substantial advances in the understanding of fracture fixation.

The future of intertrochanteric fracture repair focuses, in part, on preventing such fractures by means of antosteoporosis treatments, including medications and health programs. Another focus includes fixation devices that require smaller incisions and are more forgiving, with retention of the fixation, regardless of whether the fracture is ideally reduced or has an element of instability. A final goal is to eliminate or substantially decrease the mortality and morbidity of postoperative deep vein thrombosis (DVT) and pulmonary embolism (PE) by developing a better understanding of the clotting mechanism and the genetic, metabolic, serologic, and hormonal factors that affect the likelihood of developing PE.

Rehabilitation begins in the first post-operative day. The early physiotherapy is oriented towards impairments in range of motion, knee extensor and hip abductor strength, and gait.

The PRM programme includes: respiratory exercises, active exercises for hip and knee muscles, gait training. Interventions are focused on immediate weight bearing and early progression of strengthening.
PATIENT COMPLAINTS
Important pain and stiffness in the correspondent hip and muscles around it; reduced length of the lower extremity – after a fall at home or at the ice (in winter).

After the operation – Difficulties in mobility (transfers), decrease in autonomy in activities of daily living (ADL); impossible gait.

Orthopedical exam: Limited range of motion of the operated lower extremity.

Exam of the the Post-operative cicatrix on the thigh (Prevent complications)

FUNCTIONAL ASSESSMENT
reduced length of the operated leg – centimetry for quantitative evaluation of the reduction of the relative length, complications of the post-operative cicatrix.

KINESIOLOGICAL ANALYSIS:
Goniometry of the hip joint
Gait – impossible.

ICF assessment:
• impairments of body functions – hip pain, muscle weakness, and restricted hip ROM;
• changes in body structures;
• activity limitation - limited walking ability and problems with putting on socks and shoes;
• participation restrictions - reduced participation in leisure activities and in household chores;
• decrease of the patient’s level of function.

Evaluation of the physical performance: if possible

POST-OP REHAB PROGRAMME

GOAL – functional reeducation

TASKS:
• recovery of the stability and mobility of the lower limb joints, restoration of the muscle and ligament balance, accentuating on muscles around the hip joint; keeping the hip in the economic limb biomechanics;
• pain control; control of the cicatrix; control of joint ROM; control of possible complications;
• education of transfers, normal gait recovery with correction of eventual abnormal walking scheme;
• ADL (activities of daily living) training; amelioration of autonomy in everyday life;
• psycho-emotional stimulation, amelioration of the health-related quality of life.
METHODS:

- **drugs** – Sintrom (schema); analgesics,
- **patient’s education**;
- **posture** (activity modification),
- **Pre-formed modalities**: low frequency low-intensity magnetic field, interferential currents;
- **cryotherapy** - for the hip joint (cryo-massage and cryo-kinesitherapy);
- **massage** – classic massage (relaxing for the anterior group of muscles of the hip; stimulating for gluteal muscles),
- **Individualized kinesitherapeutic programme** - correct posture of lower limb, analytic exercises for gluteal muscles especially for gluteus medius muscle, exercises contra resistance – for the muscles around the hip joint; post-isometric relaxation /PIR/ for iliopsoas muscle; stretching and strengthening in all muscles of the lower limb (accentuating on muscles around the hip joint).
- **Verticalization and training of the balance (in sitting and standing position); Transfers training**;
- **Gait education and training** – with a walker and with two crutches;
- **Ergotherapy & ADL training**.
General HIP CONDITIONING PROGRAM – for lifelong protection after surgery

Aim: to stimulate the patient to return to daily activities, to sport and other recreational activities.

Methods:
- Strengthening exercises;
- Flexibility exercises – stretching the muscles for restoration of ROM and prevention of future injuries;
- Low frequency low intensity magnetic field;
- Deep Oscillation;
- Interferential currents;
- Cryotherapy;
- Underwater exercises.

Target muscles for physiotherapy:
- Gluteus maximus;
- Gluteus medius;
- M. Ilio-psoas;
- M. Piriformis;
- Hamstrings;
- Hip Adductors – after the month 6;
- Hip Abductors – from the beginning;
- Tensor fasciae latae.

Length of the program - every day for the first period – after the 6th post-op month (for one month minimum)

After that – maintenance program for lifelong protection (2 – 3 days a week)
**Structure of the procedure:**

- **Warm-up** (5-10 minutes);
- **Stretch**;
- **Strengthening exercises**;
- **Stretching exercises**.

**Stretching exercises:** Standing ilio-tibial stretch, Seated rotation stretch, Knee to chest, Supine hamstring stretch

**Strengthening exercises:** Hip Abduction, Hip Adduction, Hip extension (prone), Internal hip rotation, External hip rotation

**Recommendations:**

*Exercises must be done without pain (or increase of current pain)*

*Patient can realize exercises at home, only if the therapist is sure that the application of exercises is correct!*
3.9. DISTAL FEMORAL FRACTURE

FEMUR SHAFT FRACTURES
Fractures of the femoral shaft often result from high energy forces such as motor vehicle collisions. Complications and injuries associated with midshaft femur fractures in the adult can be life-threatening and may include hemorrhage, internal organ injury, wound infection, fat embolism, and adult respiratory distress syndrome. Femoral shaft fractures can also result in major physical impairment due to potential fracture shortening, malalignment, or prolonged immobilization of the extremity with casting or traction [2]. The art of femoral fracture care involves a balancing act between anatomic alignment and early functional rehabilitation of the limb.

DISTAL FEMUR FRACTURES
Defined as fractures from articular surface to 5 cm above metaphyseal flare.
Two types of mechanisms are described:
- *In young patients - high energy with significant displacement*,
- *older patients - low energy in osteoporotic bone with less displacement*.

Descriptive classification – supracondylar or intercondylar;

OTA classification:
A: extraarticular,
B: partial articular - portion of articular surface remains in continuity with shaft, or: 33B3 is in coronal plane (Hoffa fragment),
C: complete articular - articular fragment separated from shaft.

Non-operative Treatment: hinged knee brace with immediate ROM, NWB for 6 weeks

Operative treatments includes: open reduction internal fixation, retrograde IM nail, distal femoral replacement

Surgical techniques:
- ORIF Approaches (anterolateral, lateral parapatellar, medial parapatellar, medial/lateral posterior);
- Blade Plate Fixation;
- Dynamic Condylar Screw Placement;
- Locked Plate Fixation;
- Non-fixed angle plates;
- Retrograde interlocked IM nail.
COMPLICATIONS

Symptomatic hardware
- **lateral plate** - pain with knee flexion / extension due to IT band contact with plate;
- **medial screw irritation**:
  - excessively long screws can irritate medial soft tissues
  - determine appropriate intercondylar screw length by obtaining an AP radiograph of the knee with the leg internally rotated 30 degrees

Malunions:
- most commonly associated with plating,
- functional results satisfactory if malalignment is within 5 degrees in any plane;

Nonunions: treatment with revision ORIF and autograft indicated (consider changing fixation technique to improve biomechanics).

REHABILITATION must be initiated ASAP after the operation.

Hospitalization in the PRM Department / Clinic after surgery

PATIENT COMPLAINTS
Moderate pain and stiffness in the right tight (tight muscles); reduced mobility. Difficulties in activities of daily living (ADL) – transfers and self-service. Impossible autonomic gait.

CLINICAL EXAM:
- **Limited range of motion of the correspondent lower extremity.**
- **Splint for the right tight & knee;**
- **Exam of the post-operative cicatrix – presence of complications.**

FUNCTIONAL ASSESSMENT
- reduced length of the operated leg – absolute & relative length,
- post-operative cicatrix – complications;
- KINESIOLOGICAL ANALYSIS:
  - **Goniometry**;
  - **Exam of ADL** : difficulty and pain during movements in bed, standing, impossible gait or possible with assistant and with / without technical aids – walker or crutches;
GLOBAL EVALUATION OF THE REHABILITATION POTENTIAL - poor, limited, good, very good.

ICF assessment:
- Impairments of body functions – leg pain, muscle weakness, and restricted hip, knee & ankle ROM;
- Changes of body structures;
- Activity limitations – impossible walking, problems with self-service of the legs;
- Participation restrictions - reduced autonomy in ADL;
- Decreased level of function.

- Impossible or possible evaluation of the physical performance.

CONSIDERATION OF CO-MORBIDITIES OF THE PATIENT, especially Ischemic heart disease, arterial hypertension, cardiac and respiratory insufficiency; cerebro-vascular disease.

REHABILITATION PROGRAMME


TASKS:
- recovery of the stability and mobility of the lower limb joints,
- restoration of the muscle and ligament balance, accentuating on muscles around the tight and the knee joint; keeping the leg in the economic limb biomechanics;
- pain control;
- control of the cicatrix;
- control of joint ROM;
- control of possible complications;
- education of transfers,
- normal gait recovery with correction of eventual abnormal walking scheme;
- ADL (activities of daily living) training;
- amelioration of autonomy in everyday life;
- psycho-emotional stimulation,
- amelioration of the health-related quality of life.

METHODS:
- drugs – Sintrom – decreasing schema; Xarelto; analgesics,
- patient’s education;
- Verticalization and training of the balance,
- stabilization of the posture (activity modification),
- Pre-formed modalities: low frequency pulsed magnetic field; IFC, DO;
✓ cryotherapy - for the distal part of the tight and for the knee joint (cryo-massage and cryo-kinesitherapy);
✓ massage – classic massage (relaxing for the anterior group of muscles of the tight);
✓ Post-isometric relaxation (PIR) for the ilio-psoas muscle, the rectus femoris muscle and soleus muscle;
✓ Individualized kinesitherapeutic programme - correct posture of lower limb, analytic exercises for tight muscles especially for vastus medialis and vastus lateralis muscles, lower limb joint mobilization (passive, assistive active and active range of motion exercises), stretching and strengthening in all muscles of the lower limb (accentuating on muscles around the knee joint), gait training with supporting walker, after – with two crutches, training of gait up-stairs and down-stairs.
✓ Ergotherapy & ADL training.

Example

General KNEE CONDITIONING PROGRAM

After surgery

Aim – to stimulate the patient to return to daily activities

Strengthening exercises

Flexibility exercises – stretching the muscles for restoration of ROM and prevention of future injuries

Target muscles:

✓ Quadriceps (front of the thigh);
✓ Hamstrings (back of the thigh);
✓ Abductors (outer thigh);
✓ Adductors (inner of the thigh);
✓ Gluteus medius & maximus (buttocks).

Length of the program - 4-6 weeks
After that – maintenance program for lifelong protection of knees (2 – 3 days a week)

**Structure of the procedure:**
- Warm-up,
- Stretch,
- Strengthening exercises,
- Stretching exercises.

**Do not ignore pain**

**Ask questions** – to be sure that the exercise is well done

**Stretching exercises**
- Heel cord stretch
- Standing quadriceps stretch
- Supine hamstring stretch

**Strengthening exercises**
- Half squats
- Hamstring curls
- Calf raises
- Leg extensions
- Straight leg raises
- Straight leg raises (prone)
- Hip abduction
- Hip adduction
- Leg presses
1. Epi-metaphyseal proximal Schatzker VI fracture of the tibial plateau

Low and high-energy fractures of the tibial plateau (a complex group of injuries that involve knee - one of the major weight-bearing joints in the human body) present a spectrum of soft tissue and bony injuries that account for 1.3% of all fractures and affect young adults or the ‘third age’ population, males more commonly than females.

The Schatzker classification system for the tibial plateau fractures is most commonly used and is based on the location and extent of the fracture and associated depression of the bone. Type VI fractures are bicondylar fractures with dissociation of the diaphysis from the metaphysis (distal oblique metaphyseal / shaft fractures) and are the most challenging subgroups, with an incidence ranging from 20-40% of all tibial plateau fractures. These complex injuries produced by high-energy trauma can produce permanent disabilities. One-third of type VI fractures are open, and frequently (86%) there is extensive soft-tissue injury with increased risk of compartment syndrome, postoperative inflammation, wound problems and infections. Various surgical approaches and fixation techniques have been developed to treat Schatzker type VI fractures. Open reduction and internal fixation (ORIF) treatment is the gold standard. Limb alignment and restoration of articular congruity and stability, allowing early knee motion, are the main goals of complex treatment.

2. Role of complete diagnosis / assessment (etiopathogenical, clinic, laboratory - screening laboratory, imaging examination and functional assessment):

c. The *etiopathogenical and clinical assessment* included:

- usually, the Schatzker type VI fractures are seen in
  - road traffic accidents (the most common mechanism of injury),
  - work-related accidents,
- fall from a height,
- higher-energy trauma in sports,
- the osteoporotic bone, with low-energy injurie.

The mechanism of injury is believed to be a combination of axial loading and bending forces resulting in several fracture patterns, the most common being either a multifragmentary wedge fracture or articular surface depression. The magnitude of the force determines both the degree of fragmentation and the degree of displacement.

- general physical state and local examination (system examination including skin and sensory evaluation);
- musculoskeletal examination – somatoscopic exam, appreciation of the range of motion and manual muscle testing of the all uninjured lower limb joints;
- immediate, severe pain is typically the first symptom; decreased knee function;
- the soft tissue surrounding the knee joint - bruising, swelling around the knee, tenderness, knee deformity (joint may look "out of place"), open wounds;
- inability to stand or walk on the injured leg; pain is worse when weight is placed on the affected leg; limited bending of the joint; gait exam, pace and dynamics; it cannot be tested in most cases as the joint may be swollen, painful, fractured or dislocated;
- assessment of neurovascular status of the limb - the nerve and blood supply to injured leg and foot; the presence of distal pulses does not exclude an arterial injury.

d. Imaging examination

- **X-rays** (anteroposterior, lateral and oblique views) - provide clear images of bone; can show whether a bone is intact or broken, the type of fracture and where it is located within the tibia;
- **Computerised tomography** (CT) scanning - allows more detailed examination of the bony; has been shown to increase the accuracy of fracture classification and surgical planning;
e. **Magnetic resonance imaging (MRI) scanning** - is an effective diagnostic tool for ruling out internal derangement of the knee; is useful if ligamentous or other soft tissue injuries are suspected. It is important to have a high index of suspicion for vascular injuries, especially in cases involving a high energy mechanism. **Functional assessment**
- the VAS - Visual Analogue Scale (from 0 to 10, 0 = absence of pain and 10 = maximum pain score, other values between 0 and 10 is directly proportional with the intensity of pain, depending on the individual pain threshold);
- the Knee Injury and Osteoarthritis Outcome Score (KOOS);
- the Lower Extremity Functional Scale.

3. **Rehabilitation program (RP)**
Correct management includes surgical treatment and rehabilitation program, after intervention. The goals of surgical treatment are anatomical reconstruction of the joint surface, restoration of the limb axis, fixation spanning the metaphyseal comminuting and further minimization of morbidity to an already traumatized soft tissue envelope.

**Objectives** of RP:
- relief of symptoms; painful status control;
- improvement of the affected joint (full extension and 90° of flexion, as soon as possible) and ensure bone and joint survival;
- regain the important functions of knee (muscle mass gain, improved motor control, adhesions prevention, knee stabilization) to restore gait;
- improvement of quality of life (returning to full function with a painless mobile knee and maintaining independence in all activities of daily living).

**Methods** of RP:
- non-pharmacological modalities:
  - educational - restricted patient weight bearing with the use of crutches, walker or cane, dietary (weight reduction), addressing known risk factors (smoking, alcohol abuse, monitor steroid use), rest (activity modification, to restrict patient physical activity);
  - knee orthosis - long-leg splint for 2 weeks after the operation, than hinged brace with ROM 0–90° for 6 weeks; brace during sleep for 6 weeks;
  - kinetic measures, especially after orthosis removal:
range-of-motion (ROM) exercises, for all joint of both lower limbs;
- progressive weight bearing (PWB) should begin at 6 - 8 – 12 weeks, depending on the stability of the fixation and the state of the soft tissues, with full weight bearing (FWB) by 12 weeks; high-energy, unstable fracture patterns are best kept non weight bearing (NWB) until signs of union are visible, usually around 8 to 12 weeks postoperatively;
- strengthening exercises;
- proprioception exercises;
- gait training - using appropriate assistive devices;
- functional activities – to prevent complications of inactivity and bed rest;
  o physical therapy provides only symptomatic control and also does little to alter disease progression, can be used to stimulate bone growth (thermotherapy – cold packs and electrotherapy - magnetodiaflux, TENS, interferential current, ultrasound, whirlpool, electrical stimulation);
  o massage – classic and special massage, particularly for soft tissues;
  o occupational therapy – teaching how to do ADLs, to rebuild general endurance;
- pharmacological modalities - analgesics, narcotic pain medication, nonsteroidal anti-inflammatory drugs, blood thinners.

Components of rehabilitation program are mentioned in Table 1.

4. Communication with patients

a. Preoperative
- Early infection (wound dehiscence and wound healing problems) and later (secondary knee osteoarthritis, loss of reduction, collapse of articular fragments, malunion and nonunion) complications after surgery and management modalities / rehabilitation program should be described.
- Patients should be informed about mobilization time, need for assistive devices, and possible return to regular life (work).
- It is important to instruct the patient not to overload the fracture site until the bone has regained its full strength. The resumption of heavy work and sports should be guided by the physician.

b. Postoperative
• Pain, stiffness, weakness and swelling are all barriers to overcome for successful rehabilitation. Pain after surgery is a natural part of the healing process.
• It is important to consider patient factors, particularly their ability to use a temporary immobilization device and their compliance with exercise regimes. If the bone was fractured in many pieces or the bone is weak, it may take longer to heal, and it may be a longer time before doctor recommends motion activities.
• Postoperatively it is important to start early ROM exercises, because it has been shown that long term immobilization can cause decreased function of the knee joint.
• Patient / family education should include importance of maintaining NWB and progression of WB as appropriate, safety with assistive device as well as instruction in home exercise program.

Table 1. Components of the rehabilitation program applied for patients after surgical intervention

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7 – 14 days (weeks 1 and 2) = Acute care period</strong></td>
<td></td>
</tr>
<tr>
<td>1. Relieving any pain, swelling and inflammation</td>
<td>1. Bandage and elevate posture - 0º knee extension; 2. Cryotherapy – several times a day the patient has an ice treatment 3. Pain medication 4. At two weeks, the dressings were removed, the sutures were removed. 5. Long-leg splint for 2 weeks after the operation; brace during sleep for 6 weeks;</td>
</tr>
<tr>
<td>2. Restore / consolidate the ROM of lower limbs</td>
<td>1. Continuous passive motion (CPM) machine; ROM to increase from 15º to 70º 2. Active assistive range of motion (AAROM) exercises, as incision healing allows; gentle bending of the knee in the brace, as far as the patient can go with no pain, many repetitions at a time (tens of repetitions)</td>
</tr>
</tbody>
</table>
**3. Initiate patella mobility drills full passive / active knee range of motion exercises**

4. Bed ROM exercises of all other joints of both lower limbs

<table>
<thead>
<tr>
<th>3. Restore / consolidate the strength muscles</th>
<th>Operated lower limb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Isometric contraction exercises in lying (Quadriceps setting)</td>
<td></td>
</tr>
<tr>
<td>2. Stretching – passive and active (hamstring and calf muscles)</td>
<td></td>
</tr>
<tr>
<td>3. Multi-plane open kinetic chain straight leg raising</td>
<td></td>
</tr>
</tbody>
</table>

**Opposite lower limb and upper extremities**

1. Exercises that involve the entire lower limb; putting a towel under the knee of a straight leg, and trying to press down on it – straightening the leg;

2. Exercises used of Theraband or weights

<table>
<thead>
<tr>
<th>4. Maximizing patient independence</th>
<th>1. NWB gait training with walker or crutches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Maintain NWB on the affected leg with assistive device (walker or crutches)</td>
</tr>
<tr>
<td></td>
<td>on activity of daily living modification, transfers and short distance ambulation</td>
</tr>
</tbody>
</table>

**14 – 28 days (weeks 3 - 4) post surgical intervention**

<table>
<thead>
<tr>
<th>1. Control edema</th>
<th>1. Brace for 6 weeks in full extension; hinged knee brace;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Gentle lower limb massage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Consolidate ROM of limbs</th>
<th>1. All previous ROM exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. AAROM /passive range of motion (PROM) of the knee joint - 90° flexion in 4 wks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Consolidate the strength muscles and restore motor control</th>
<th>1. Initiate global lower extremity stretching program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Manual Muscle Testing of joints proximal and distal to the knee</td>
</tr>
<tr>
<td></td>
<td>3. Multi-plane ankle strengthening, quad sets and SLR (without weights)</td>
</tr>
<tr>
<td></td>
<td>4. Manual lower extremity PNF (proprioception neuromuscular) patterns- Kabat diagonals and EMG biofeedback quadriceps</td>
</tr>
<tr>
<td></td>
<td>5. Upper extremities and uninvolved lower limb exercises for strength (isometric and isotonic contraction of hip and knee muscle, closed kinetic chain multi-plane hip strengthening, body strengthening)</td>
</tr>
</tbody>
</table>
4. **Gait training**
   1. Ability to maintain balance with NWB using an assistive device
   2. Reassess gait, balance activities

### 5 – 8 weeks post surgical intervention

| 1. Control edema | 1. Gentle retrograde lower limb massage  
|                 | 2. Brace for 6 weeks in full extension |
| 2. Consolidate the ROM of lower limbs | 1. All previous ROM exercises  
|                 | 2. Normal patellar mobility and tibial-femoral mobility once fracture is healed |
| 3. Consolidate the strength muscles and endurance | 1. All previous muscle strength exercises must performed  
|                 | 2. Resistive exercises in sitting position  
|                 | 3. Stationary bike program |
| 4. Balance and proprioception, gait training | 1. Continue proprioception training  
|                 | 2. Assess as appropriate in uninvolved leg, and in involved leg once beginning weight bearing or as appropriate  
|                 | 3. Balance on the involved lower extremity is equal to the uninvolved lower extremity, using single leg stance time to measure.  
|                 | 4. Begin PWB gait at 25% of body weight and increase by 25% approximately every 3 days. May progress to one crutch at 7 weeks as tolerated, gradually wean off of crutches by week 8 |

### After 8 weeks post surgical intervention

| 1. Maximize ROM of lower limbs | Increase flexion to within normal limits; may remove brace for sleep at 8 weeks |
| 2. Maximize balance and proprioception | 1. Exercises that work the muscles while in standing are most effective for improving balance, walking and stair climbing  
|                 | 2. Theraband strengthening in closed kinetic chain (stand on involved leg and perform hip flexion / extension / abduction / adduction with uninvolved limb)  
|                 | 3. Advance stationary bike program; begin treadmill walking and elliptical trainer; 4. Assess as appropriate in uninvolved leg, and in involved leg once beginning weight bearing or as appropriate |
|   | 3. Gait training on surfaces, level, hills, stairs | 1. Continue previous gait training  
2. Normalize gait pattern (FWB - start at 25%, progress up to 100% by week 10)  
3. Initiate closed kinetic chain exercises, progressing bilateral to unilateral  
4. Avoid running and impact activity |
|---|---|---|
|   | 4. Maximize patients’ functional independenc e | 1. Independent transfers, ambulation and reciprocal stair climbing  
2. Exercises that simulate the specific everyday activities of daily living and any recreational activities that patient may want to return to  
3. Home exercise program  
   - stretching  
   - Theraband strengthening exercises  
   - gym strengthening-beginning bilateral progressing to unilateral (leg press, heel raises, hamstring curls, squats, lunges, knee extensions - 30° to 0° progressing to full range)  
   - bilateral plyometric activity progressing to unilateral as tolerated  
   - cardiovascular training, and flexibility. |
3.11. BIMALLEOLAR FRACTURE

REHABILITATION PROGRAM IN A PATIENT WITH SURGICAL TREATMENT OF BIMALLEOLAR FRACTURE BY OPEN REDUCTION AND INTERNAL FIXATION

1. Bimalleolar fractures

The upper part of the ankle joint comes from the tibia and the fibula. The ends of these bones are called malleoli. Ankle fractures are the most common fractures involving joint and occur when the malleoli are broken. Bimalleolar fractures are more common in women, people over 60 years of age, and patients with existing comorbidities. The prevalence of such fractures has increased over the last two decades in both young, active patients and the elderly people.

It is very important in all the ankle fractures that a definitive diagnosis is made based on clinical evaluation of history, mechanism of injury, degree of immediate disability and obtaining proper radiograph to demonstrate lesion. Most ankle fractures are complex injuries that are difficult to manage. A bimalleolar fracture is a debilitating injury, especially if the fracture is unstable and has the potential to produce significant long-term disability and complications in the form of pain, instability, and early degenerative arthritis. The treatment of choice for an unstable ankle fracture is open reduction and internal fixation (ORIF). Slight variation from normal alignment of joint is incompatible with adequate function. Therefore it is essential to obtain anatomic reduction and stability following such fracture. Recently, emphasis has been placed on functional outcome and rehabilitation. Faster return of function and return to work are related to rehabilitation strategy.

2. Role of complete diagnosis / assessment (etiopathogenical, clinic, laboratory - screening laboratory, imaging examination and functional assessment):

f. The etiopathogenical and clinical assessment included:
   - The bimalleolar fractures are most often occurred during a:
     o road traffic accidents,
slip while walking or getting down from stairs,
fall from a height,
twisting injury in sports.

There are two different mechanisms of injury. One occurs with a twisting mechanism where the body rotates around the foot, and the other occurs with a crushing mechanism following an impact to the foot (a motor vehicle accident). Great majority of ankle injuries are caused by indirect violence.

- general physical state examination (system examination including skin and sensory evaluation);
- musculoskeletal examination – somatoscopic exam, appreciation of the range of motion and manual muscle testing of all uninjured lower limb joints;
- immediate, severe pain is typically the first symptom; it is accompanied by bruising, swelling, tenderness, joint deformity;
- inability to weight bear, although patients do sometimes walk on ankle fractures;
- assessment of neurovascular status - sensation over the dorsal and plantar surfaces of the foot, measuring capillary refill in all digits, and palpating the distal pulses;
- gait exam, pace and dynamics; it cannot be tested in most cases as the joint may be swollen, painful, fractured or dislocated.

g. Imaging examination

- X-rays (anteroposterior, lateral and mortise views can be taken; for the mortise view, the foot is rotated about 15° internally; if one injury is seen on X-ray, always look for a second) - are used to determine whether the malleoli are broken and whether the bones are displaced and to what degree.
- Computed tomography (CT) scans and MRI scanning - will produce a more detailed, cross-sectional image of the patient ankle and can provide about the severity fracture; are sometimes needed for fracture diagnosis and assessment of ligamentous or intra-articular injuries.

h. Functional assessment
• the VAS - Visual Analogue Scale (from 0 to 10, 0 = absence of pain and 10 = maximum pain score, other values between 0 and 10 is directly proportional with the intensity of pain, depending on the individual pain threshold);
• the WOMAC scale, other quality of life generic scales.

3. Rehabilitation program (RP)

Bimalleolar fracture is considered to be an unstable ankle fracture. Correct management includes operative treatment and rehabilitation program, after intervention. Surgery usually consists of open reduction and internal fixation, followed by casting or splinting.

Objectives of RP:
• relief of symptoms; painful status control;
• regain the important functions of ankle (increase dorsiflexion) to restore gait;
• improvement of the affected joint and ensure bone and joint survival;
• improvement of quality of life (returning to full function with a painless mobile ankle and maintaining independence in all activities of daily living).

Methods of RP:
• non-pharmacological modalities:
  o educational - restricted patient weight bearing with the use of a cane or crutches, dietary (weight reduction), addressing known risk factors (smoking, alcohol abuse, monitor steroid use), rest (activity modification, to restrict patient physical activity);
  o orthosis – removable boot cast, cast or splint;
  o kinetic measures, especially after orthosis removal:
    ▪ range-of-motion (ROM) exercises, for all joint of both lower limbs;
    ▪ progressive weightbearing should begin at 8 weeks, with full weightbearing by 12 weeks (bone healing may occur within 10 to 12 weeks);
    ▪ strengthening exercises;
    ▪ proprioception exercises;
    ▪ gait training - using appropriate assistive devices;
    ▪ functional activities – to prevent complications of inactivity and bed rest;
  o physical therapy provides only symptomatic control and also does little to alter disease progression, can be used to stimulate bone growth (thermotherapy
- cold packs and electrotherapy - magnetodiaflux, TENS, interferential current, ultrasound, whirlpool, electrical stimulation);
  o massage – classic and special massage, particularly for soft tissues;
  o occupational therapy – teaching how to do ADLs, to rebuild general endurance;
- pharmacological modalities - analgesics, narcotic pain medication, nonsteroidal anti-inflammatory drugs, blood thinners.

  **Components of rehabilitation program** are mentioned in **Table 1.**

4. **Communication with patients**

i. **Preoperative**
  - Early and later complications after surgery and management modalities / rehabilitation program should be described.
  - Patients should be informed about mobilization time, need for assistive devices, and possible return to regular life (work).
  - It is important to instruct the patient not to overload the fracture site until the bone has regained its full strength. The resumption of heavy work and sports should be guided by the physician.

j. **Postoperative**
  - Pain, stiffness, weakness and swelling are all barriers to overcome for successful rehabilitation; ankle swelling will generally persist for about 1 year or less. The ankle starts to feel comfortable after 3 months postsurgical intervention.
  - Patients with intra-operative evidence of osteoporosis or osteomalacia will be non weight bearing for an extended period of time (generally 8 - 10 weeks).
  - Frequently the patients are placed in a removable cast boot, to maintain the anatomic reduction and prevent development of tibiotalar joint arthritis. The post operative cast immobilization will not cause restriction of range of motion of ankle and it aids in better healing of soft tissue.
  - It is important to consider patient factors, particularly their ability to use a temporary immobilization device and their compliance with exercise regimes.
  - Patient can drive if the left ankle is fractured by 5-7 days, but much later if it is the right ankle.
Table 1. Components of the rehabilitation program applied for patients after surgical intervention

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7 – 14 days (weeks 1 and 2) = Acute care period</strong></td>
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<tr>
<td>1. Relieving any pain, swelling and inflammation</td>
<td>1. Bandage, splint or cast and elevate posture - the foot and calf is elevated; 2. Cryotherapy – several times a day the patient has an ice treatment to reduce inflammation, swelling and pain. 3. Pain medication 4. At two weeks, the dressings were removed and the wound assessed. The sutures were removed. 5. Removable boot cast (example – Controlled Ankle Motion Walker Boot)</td>
</tr>
<tr>
<td>2. Restore / consolidate the ROM of lower limb</td>
<td>1. Early basic non-weight bearing ROM exercises, after the surgical incision has begun healing, usually 10-12 days after surgery – movement of the ankle out of the removable boot cast 3. Bed ROM exercises of all joints above surgical site</td>
</tr>
<tr>
<td>3. Restore / consolidate the strength muscles</td>
<td><strong>Operated lower limb</strong> 1. Isometric contraction exercises in lying <strong>Opposite lower limb and upper extremities</strong> 1. Exercises that involve the entire lower limb 2. Exercises used of Theraband or weights</td>
</tr>
<tr>
<td><strong>14 – 42 days (weeks 3 - 6) post surgical intervention</strong></td>
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<tr>
<td>2. Consolidate the ROM of lower limbs</td>
<td>1. Active ROM exercise for ankle, subtalar, midtalar joints with pain tolerance – ankle pumps, inversion / eversion, toe crunches, alphabets, figure eights (with ankle brace) 2. Stationary bike – without resistance 3. Should be walking on a treadmill with wean up to 3.5 mph, after 4 weeks</td>
</tr>
</tbody>
</table>
3. **Consolidate the strength muscles**
   1. All previous muscle strength exercises must performed – isometric exercises for dorsiflexion, plantar flexion, inversion, eversion.
   2. Progressive stretching for dorsiflexion muscles
   3. Upper extremities and uninvolved lower limb exercises for strength (isometric and isotomic contraction of hip and knee muscle, body strengthening)

4. **Gait training**
   1. Partial weight bearing with crutches
   2. Full weight bearing in removable boot with or without cane

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### 6 – 8 weeks post surgical intervention

1. **Control edema**
   1. Gentle retrograde lower limb massage

2. **Consolidate the ROM of lower limbs**
   1. All previous ROM exercises
   2. Grade 1-2 joint mobilizations ankle and subtalar joints
   3. Passive ROM exercises into restricted ranges
   4. Leg extension, curl, press
   5. Stationary bike – without resistance

3. **Consolidate the strength muscles and endurance**
   1. All previous muscle strength exercises must performed
   2. Wall stretch with knee flexed and extended
   3. Theraband in dorsiflexion / plantar flexion / inversion / eversion in open chain
   4. Manual resistance in open chain for dorsiflexion / plantar flexion / inversion / eversion and multiplanar motions
   5. Exercises for intrinsic foot musculature – seated towel toe crunches, push aways
   6. Treadmill with progressive resistance

4. **Gait training**
   1. Full weight bearing; removable boot is discontinued
   2. Standing heel raise, minisquat, one leg balance on floor
## After 8 weeks post surgical intervention

1. **Maximize balance and proprioception, full ankle and subtalar flexibility**
   
   1. Exercises that work the muscles while in standing are most effective for improving balance, walking and stair climbing
   
   2. Theraband strengthening in closed kinetic chain (stand on involved leg and perform hip flexion / extension / abduction / adduction with uninvolved limb)
   
   3. Standing balance progress floor - eyes open/closed, level incline/decline, with knee flexed/extend
   
   4. Standing on one foot or balancing on an stable, then unstable surface, eyes open/closed

2. **Gait training on surfaces, level, hills, stairs**
   
   1. Continue previous gait training
   
   2. Various gait exercises - toe-walking, ascending and descending stairs
   
   3. Agility gait exercises - lateral shuffles, tandem walking, lateral stepping, backwards walking

3. **Maximize patients’ functional independence**
   
   1. Exercises that simulate the specific everyday activities of daily living and any recreational activities that patient may want to return to
   
   2. Home exercise program
      - Theraband strengthening exercises
      - mini squats, toe raises (bilateral and unilateral)
      - stretching
      - unilateral standing balance (eyes open, eyes closed)
   
   3. Sport and job – specific training; initiate sport specific drills with gradual return to athletics at or after 16 weeks

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**Please see video**
3.12. CALCANEUS (HEEL BONE) FRACTURES

REHABILITATION PROGRAM IN A PATIENT WITH SURGICAL TREATMENT OF CALCANEUS FRACTURE

3.12.1. Calcaneus fractures
Fractures of the calcaneus (heel bone that has an important function of supporting the foot and making normal walking possible; the joint above the calcaneus, allows the foot to rotate inwards and outwards) commonly occur after a fall from a height (when the heel is crushed under the weight of the body) or car accident. Calcaneus fractures are uncommon, can be a painful and disabling quite severe injury; the heel can widen, shorten, and become deformed. Damage to the articular cartilage covering the joint may cause long-term complications such as chronic pain, arthritis, and loss of motion.

The calcaneus fractures frequently occur in young adult men (2.4 times more frequently in males than females) and account for 2-3% of all fractures of the body and 50 - 60% of all tarsal fractures. In females, a gradual increase in incidence towards the post-menopausal year was described.

The severity of a calcaneus injury depends on several factors (the number of fractures, the amount and size of the broken bone fragments, the amount each piece is out of place, the injury to the cartilage surfaces in the subtalar joint, the injury to surrounding soft tissues, such as muscle, tendons, and skin).

Treatment of these fractures may require surgery to reconstruct the normal anatomy of the heel and restore mobility so that patients can return to normal activity.


3.12.2.1. The etiopathogenical and clinical assessment included:
- The calcaneus fractures are most often occurred during a:
  - fall from a height,
o twisting injury to the ankle,
o car injury (a force of a head-on car collision, may result in the comminuted fracture),
o being the outcome of an ankle sprain,
o a stress fracture caused by overuse, usually seen in athletes.
Similar fractures can result from different mechanisms; generally, the greater the impact, the more the calcaneus is destroyed.
  • general physical state examination (system examination including skin and sensory evaluation);
  o musculoskeletal examination – somatoscopic exam, appreciation of the range of motion and manual muscle testing of the lower limb;
  o pain is typically the first symptom; it is accompanied by bruising, swelling, heel deformity;
  o check the pulse at key points of the foot to be sure that there is a good blood supply to the distal lower limb (foot and toes);
  o check to see if the patient can move his toes, and can feel things on the bottom of your foot;
  o gait exam, pace and dynamics; patient has the inability to put weight on the heel or walk.

3.12.2.2. Imaging examination
  • X-rays (a lateral x-ray and an axillary heel views) - are used to determine whether the heel bone is broken and whether the bone is displaced and to what degree.
  • Computed tomography (CT) scans - will produce a more detailed, cross-sectional image of patient foot and can provide about the severity fracture.

3.12.2.3. Functional assessment
  • the VAS - Visual Analogue Scale (from 0 to 10, 0 = absence of pain and 10 = maximum pain score, other values between 0 and 10 is directly proportional with the intensity of pain, depending on the individual pain threshold);
  • the WOMAC scale.
3.12.3. Rehabilitation program (RP)

3.12.3. 1. Non-operative rehabilitation program – see Table 1

Are generally treated conservatively:

- extra-articular fractures - !! exceptions include fractures of the sustentaculum tali with displacement of more than 2 mm, posterior avulsion fractures, and significant fractures of the calcaneal body;
- calcaneal stress fracture;
- patient with comorbid conditions (diabetes, poor blood flow), elderly patient, concurrent injuries;
- comminuted intra-articular fractures if the pieces of broken bone have not been displaced by the force of the injury;
- severely comminuted intra-articular fractures;

Objectives of RP:

- relief of symptoms; painful status control;
- regain the important functions of calcaneus;
- improvement of the affected joint and ensure bone and joint survival;
- improvement of functionality (returning to full function with a painless mobile ankle and maintaining independence in all activities of daily living).

Methods of RP:

- non-pharmacological modalities:
  - educational - restricted patient weight bearing with the use of a cane or crutches, dietary (weight reduction), addressing known risk factors (smoking, alcohol abuse, monitor steroid use), rest (activity modification, to restrict patient physical activity);
  - orthopedic measure - closed reduction may be attempted by plantarly displacing both the forefoot and the hindfoot to reverse the mechanism of injury, which allows for elevation of the posterior facet;
  - short leg casting and no weightbearing for 2 weeks; compressive wrapping to control the swelling (edema) for 2 to 3 weeks;
  - kinetic measures, especially after cast removal:
    - range-of-motion (ROM) exercises, for all joint of both lower limbs;
    - progressive weightbearing should begin at 8 weeks, with full weightbearing by 12 weeks (bone healing may occur within 10 to 12 weeks);
strengthening exercises;
proprioception exercises;
gait training - using appropriate assistive devices;
functional activities – to prevent complications of inactivity and bed rest;
  physical therapy provides only symptomatic control and also does little to alter disease progression, can be used to stimulate bone growth (thermotherapy - cold packs and electrotherapy - magnetodiaflux, TENS, interferential current, ultrasound, whirlpool, electrical stimulation); shock wave therapy in an attempt to get the bone to heal;
  massage – classic and special massage, particularly for soft tissues;
  occupational therapy – teaching how to do ADLs, to rebuild general endurance;
  return to demanding job duties – after 4 to 6 months.
pharmacological modalities - analgesics, narcotic pain medication, nonsteroidal anti-inflammatory drugs, blood thinners.

3.12.3. 2. Postoperative period – see Table 2.
The most patients need surgical treatment for various types of fractures such as:
  minimally invasive percutaneous screw fixation;
  open reduction techniques and internal fixation may be performed by using medial, lateral or combined approaches, depending on the extent of injury and the location of the fracture.

3.12.4. Communication with patients
a. Preoperative
  Postoperative pain and management modalities / rehabilitation program should be described.
  Patients should be informed about mobilization time, need for assistive devices, and possible return to regular life (work).
  Smoking affects both bone and wound healing. With or without surgery, injured bone may take longer to heal if patients smoke.
  It is important to instruct the patient not to overload the fracture site until the bone has regained its full strength. The resumption of heavy work and sports should be guided by the physician.
b. **Postoperative**

- If the injury is minor, such as a crack in the bone with little muscle damage, patient may be able to resume normal activities from 3 to 4 months after surgery. If the fracture is severe, however, it may take from 1 to 2 years before recovery is complete (there will be moderate swelling of the ankle and leg for about 6 – 9 months).

- The exercises will temporarily increase the foot pain. However, these exercises are an essential part of the rehabilitation program.

- Common problems that may persist after rehabilitation program are: skin irritation, altered gait (problems walking on grassy surfaces, hill), pain.

- Despite the best efforts of the doctor and patient, normal foot and ankle motion is rarely regained after a severe fracture and patients do not typically resume their pre-injury level of function. A patient who is not very active might tolerate a foot that is not normal.

- Patient may need to wear a heel pad, lift or shoe cup, as well as special shoes with extra depth in the toe compartment.
Table 1. Components of the rehabilitation program applied in non-operative calcanean fractures

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
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</thead>
<tbody>
<tr>
<td>7 – 14 days (weeks 1 and 2) = Acute care period</td>
<td></td>
</tr>
</tbody>
</table>
| 1 | Relieving any pain, swelling and inflammation | 1. Cryotherapy – several times a day the patient has an ice treatment to reduce inflammation, swelling and pain.  
2. Immobilization. A cast, splint, or brace will hold the bones in injured foot in proper position while they heal and sometimes in slight eversion. Patient may has to wear a cast for 6 to 8 weeks — or possibly longer. During this time, patient will not be able to put any weight on foot until bone is completely healed.  
3. Electrotherapy – TENS, dyadic current, ultrasound in the foot and ankle  
4. Massage - gentle around the soft tissues of the foot and ankle  
5. Rest - The affected foot must rest and the patient is not allowed to use the foot. |
| 2 | Mention the ROM of other joints of the lower limbs | 1. Standard mobilization of the opposite lower limb – passive and active ROM exercises of toe, leg, ankle, knee and hip (20 minutes / three times / daily)  
2. Standard mobilization of the hip, knee and toes of affected lower limb  
3. Gait without weight bearing in the affected heel bone; teaching how to safely use the crutche or a cane |
| 15 – 42 days (weeks 3 – 6) = Partial weight-bearing gait | |
| 1 | Increase / mention the range of motion of lower limbs | 1. Daily range of motion exercises aimed at optimizing the amount of motion in the ankle, subtalar, and transverse tarsal joints  
2. Active mobilization of all other joints, in all plans of motion (20 min. / 3X / daily)  
3. Assisted stretching of any tight muscles around the previous joints |
| 2 | Increase muscle strength of lower limbs | 1. Isometric contraction – bed exercises aimed at mention the strenght of thight and calf muscles (6 – 10 seconds / contraction; 1 session = 6 – 10 contractions; 6 sessions / daily)  
2. The neuromuscular electric stimulation of muscles  
3. Isotonic contraction of hip muscles (abductors, flexors, extensors), quadriceps and calf muscles, with constant low resistance weight tied on the ankle (example - daily knee extension with sandbags strapped to the ankle, leg press and knee extension) 3 sets by 10 repetitions / set, daily |
| 3 | Regain the balance and proprioception | 1. Balancing exercises  
2. Gait with partial weight bearing in the affected heel bone; used the cane in the opossite hand |
| After 42 days = Complete weight – bearing gait | |
| 1 | Returning to advanced activity | 1. Flexibility exercises for lower limbs  
2. Balancing and proprioception exercises  
3. Gait with complete weight bearing in the affected heel bone |
Table 2. Components of the rehabilitation program applied for patients with surgical intervention

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rehabilitation components</th>
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<tr>
<td>7 – 14 days (weeks 1 and 2) = Acute care period</td>
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</tbody>
</table>
| 1. Relieving any pain, swelling and inflammation | 1. Posture - the foot is elevated with the ankle in the standard neutral position of a 90° angle between the foot and the tibia; this position is maintained for up to 72 hours to reduce postoperative swelling.  
2. Cryotherapy – several times a day the patient has an ice treatment to reduce inflammation, swelling and pain.  
3. Cast with ankle in neutral / slight eversion (orthosis is necessary to prevent gastrocnemius-soleus contracture). |
| 2. Restore / consolidate the ROM of lower limb | 1. Early basic non-weight bearing ROM exercises, after the surgical incision has begun healing, usually 10-12 days after surgery, in order to limit the hindfoot stiffness – gentle subtalar active ROM and passive / active assistive ROM toes  
3. Bed ROM exercises of all joints above surgical site |
| 3. Restore / consolidate the strength muscles of lower limbs | Operated lower limb  
1. Isometric contraction exercises in lying  
2. Stretching into dorsiflexion at MTPs with MTs stabilized  
Opposite lower limb and upper extremities  
1. Exercises that involve the entire lower limb, such as squats on both legs at the same time, or just on one leg, will be prescribed.  
2. Exercises used of Theraband or weights |
| 14 – 56 days (weeks 3 - 8) post surgical intervention (sutures are removed at 2-3 weeks) | |
| 1. Control edema | 1. Compression stocking and  
2. Gentle scar massage |
| 2. Consolidate the ROM of lower limbs | 1. Active ROM exercise in operated foot in all directions may be initiated (tibial, subtalar, midtarsal, toe joints); passive and active assistive ROM forefoot and toes  
2. Daily exercises – ankle pumps, alphabets, figure eights, inversion / eversion |
| 3. Consolidate the strength muscles | 1. All previous muscle strength exercises must performed  
2. Progressive resisted strengthening of the gastrocnemius muscles is done by weighted exercises  
3. Upper extremities and uninvolved lower limb exercises for strength (isometric |
and isotonic contraction of hip and knee muscle, body strengthening)

4. Gait training
Partial weight bearing after 6 weeks – with crutches, cane, walker

<table>
<thead>
<tr>
<th>9 – 12 weeks post surgical intervention</th>
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<tbody>
<tr>
<td><strong>1.</strong> Regain balance and proprioception</td>
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<tr>
<td><strong>2.</strong> Gait training</td>
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<tr>
<td><strong>3.</strong> Maximize patients' functional independence</td>
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</table>

**After 12 weeks post surgical intervention**

| **1.** Maximize balance and proprioception | 1. Progress and monitor the subtalar joints ability to adapt for gait on all surfaces |
|                                         | 2. Exercises that work the muscles while in standing are most effective for improving balance, walking and stair climbing – ankle and subtalar isometric / isotonic strengthening |
|                                         | 3. Standing on one foot or balancing on an stable, then unstable surface |
|                                         | 4. Soft tissue mobilization – theraband strengthening in all planes |
| **2.** Gait training                     | 1. Various gait exercises - toe-walking, ascending and descending stairs |
|                                         | 2. The normal full weight bearing after 12 weeks |
| **3.** Maximize patients’ functional independence | 1. Exercises that simulate the specific everyday activities of daily living and any recreational activities that patient may want to return to |
|                                         | 2. Home training exercises – calf stretching, exercise bicycle, progressive elastic band strengthening, single leg stance activities, step-ups stairs, squats |

Please see video
REFERENCES

USEFUL BIBLIOGRAPHIC SOURCES

1. Beaupre LA, Davies DM, Jones CA, et al.: Exercise combined with continuous passive motion or slider board therapy compared with exercise only: a randomized controlled trial of patients following total knee arthroplasty. Phys Ther 2001, 81:1029-1037


USEFUL LINKS