GUIDELINESS OF OPERATIONAL STANDARD PROCEDURES IN LOWER LIMB ORTHOPEDIC SURGERY
Guideliness of operational standard procedures in lower limb orthopedic surgery

<table>
<thead>
<tr>
<th>Project title</th>
<th>Collaborative learning for enhancing practical skills for patient-focused interventions in gait rehabilitation after orthopedic surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project acronym</td>
<td>COR-skills</td>
</tr>
<tr>
<td>Title of the document</td>
<td>Report for the current state of art in the field of protocols for orthopedic surgical procedures and correspondant rehabilitation procedures</td>
</tr>
<tr>
<td>Elaborated by</td>
<td>Emergency Clinical Hospital Bucharest University of Medicine and Pharmacy Carol Davila Mersin University</td>
</tr>
<tr>
<td>Output</td>
<td>2</td>
</tr>
<tr>
<td>Dissemination level</td>
<td>PU</td>
</tr>
<tr>
<td>Date of the document Version 1</td>
<td>1.11.2016</td>
</tr>
<tr>
<td>Date of the document Version 2</td>
<td></td>
</tr>
</tbody>
</table>

Project financed by European Commission under the Erasmus + programme, KA2
This document reflects only the author’s view and that the NA and the Commission are not responsible for any use that may be made of the information it contains.
ABSTRACT

The guidelines aims to develop common surgical orthopedic procedures for VET.

The Document introduces a brief picture of selected standard orthopedic surgical operational procedures for lower limb aiming to develop basics skills for medical specialists in orthopedics (theoretical and practical skills for assessment, decision, treatment in different pathologies)
CONTENT

1.1. Scope
1.2. Methodology
1.3. Recommendations
1.4. Procedures

1.4.1. Anterior cruciate ligament reconstruction.
1.4.2. Total hip arthroplasty
1.4.3. Total knee arthroplasty
1.4.4. Hallux valgus
1.4.5. Osteonecrosis of the femoral head
1.4.6. Chondral / osteochondral defects of the knee
1.4.7. Acetabular fractures- posterior approach
1.4.8. Treatment of unstable trochanteric fractures with Gamma Nail
1.4.9. Treatment of distal femoral fractures using the DCS
1.4.10. Proximal Tibial fractures
1.4.11. Ankle fracture
1.4.12. Calcaneal fracture

Usefull links
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 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 speci. alists 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 orthopaedic surgery and to offer personalised support both for the learners but also for the clients (patiens). Implementation of individualised health care approaches is one of the major innovations of this project, encouraging critical thinking of the trainees, reinforced quality of medical services, increasing the level of health care, decreasing the rehabilitation time and health costs, development of inter-sectorial and international collaborative cultures by sharing of knowledge and ideas from teaching to work-place.

One major output in our project is the development of the Guideliness of operational standard procedures in lower limb orthopedic surgery. OrthoGuidelines is an online information resource providing up-to-date treatment
guidelines to orthopaedic surgeons and professionals. The guidelines contains 12 standard procedures for hip, knee and ankle surgery which will be proposed for implementation in the medical world of work from participant countries. The innovation consists in development of procedures that will allow to advance the physician-patient communications process and enhance the diagnosis and treatment of musculoskeletal conditions. The recommendations associated with each procedural step are aligned to the existent medical evidence, as for each procedure there are correspondent 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 skills development. Also the video material will create support for autonomous leaning practical skills for the trainees.

The easy to follow guidelines enable practitioners to look up a pathology and quickly see the recommended orthopaedic strategy. Phases of treatment are defined to clearly show goals, precautions, treatment strategies and criteria for surgery.

Each presented procedure includes:

- the rationale for the procedure
- role of diagnosis - advanced imaging and assessment
- treatment algorithm and alternatives
- preliminary recommendations, indications and contraindications for surgery; risk and harms
- preoperative planning and the preparation of the patients for surgery
- surgical procedure - step by step description (video)
- early postoperative care
- potential short term complications
- communication with patients (pre and post surgery).
1.2. Methodology

The present clinical guideline was 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 orthopedic surgery. It is not intended to be a fixed guideline as some patients may require more or less or individualised therapeutical approaches. Patient 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 3 countries with high qualified specialists in orthopedics and rehabilitation with a long standing reputation for providing student-centred 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 within The Clinical Emergency Hospital Bucharest, Romania, University of Medicine and Pharmacy Carol Davila Bucharest and Mersin University from Turkey, one of the
best known and most respected orthopaedic units in the correspondent countries.

The didactic team began working on this guideline 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 (http://www.who.int/hiv/topics/mtct/grc_handbook_mar2010_1.pdf) as follows:

<table>
<thead>
<tr>
<th>WHO recommended steps in technical guideline development</th>
<th>Action Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define the specific issues to be addressed by the guidelines</td>
<td>Completed</td>
</tr>
<tr>
<td>Undertake a systematic search for evidence</td>
<td>Completed</td>
</tr>
<tr>
<td>Review the evidence available</td>
<td>Completed</td>
</tr>
<tr>
<td>Develop recommendations linked to the strength of the evidence</td>
<td>Completed</td>
</tr>
<tr>
<td>Draft guidelines</td>
<td>Completed</td>
</tr>
<tr>
<td>Discuss and incorporate, where relevant, comments of external reviewers</td>
<td>Completed</td>
</tr>
<tr>
<td>Draft final version of the guidelines</td>
<td>Completed</td>
</tr>
<tr>
<td>Make recommendations on dissemination strategy</td>
<td>Completed</td>
</tr>
<tr>
<td>Document the process of guideline development</td>
<td>Completed</td>
</tr>
<tr>
<td>Test the guidelines through pilot evaluations</td>
<td>Completed</td>
</tr>
</tbody>
</table>

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 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, 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 both medical specialties (orthopaedics and rehabilitation), was used to develop the criteria in order to improve patient care and obtain the best outcomes while considering the individual approaches and distinctions necessary in making clinical decisions. We have to keep in mind that The field of orthopedics is an extremely competitive field. New technologies are constantly being introduced with the promise of improved patient outcomes, but often with limited information. Normal gait is essential for daily living and the number of pathologies that affect gait is increasing (accidents, aiging). In orthopedics in particular, after surgery, a long and difficult rehabilitation process follows in order to regain normal gait and requires interdisciplinary team approaches. More, each patient has its own particularities, so standard procedures are not all the time effective and need to be adapted.
1.3. Recommendations

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.

References:
http://www.sign.ac.uk/guidelines/published/notes.html)
1.4. Procedures

1.4.1. Anterior cruciate ligament reconstruction.

1. Anterior Cruciate Ligament (ACL), provides 85% of the stability to prevent anterior translation of the tibia relative to the femur. It also acts as a secondary restraint to varus angulation in extension of the knee. It may be injured during a non-contact pivoting stress. Patients generally feel the popping sensation and giving way. Hemarthrosis is common within the first hours. Meniscal tears and chondral injuries frequently accompany the lesion. After the acute inflammatory phase, i.e. first few weeks, patients complain of giving way and unreliability of the knee.

2. Role of diagnosis:
   - Physical examination findings are:
     - Hemarthrosis / effusion
     - Quadriceps avoidance gait – does not actively extend the knee
     - Lachman’s test
     - Positive when anterior edge of proximal tibia can be drawn anterior to femoral articular surface at 30 degrees of flexion.
     - Anterior Drawer test
     - Positive when anterior edge of proximal tibia can be drawn anterior to femoral articular surface at 90 degrees of flexion.
     - Pivot Shift
     - Tibia reduces at 20 degrees while extending from flexed position with valgus and external rotation stress.
   - Radiographs: Usually normal. Segond fracture, avulsion fracture of the proximal lateral tibia, is pathognomonic for ACL tear.
   - Magnetic Resonance Imaging: ACL best seen on sagittal views.

3. Treatment algorithm and alternatives:
   During the acute inflammatory phase (first 3-4 weeks)
After the inflammatory phase decide if the patient needs surgery. Decision is made considering the patient’s age, instability frequency, lifestyle, occupation, accompanying injuries and motivation. Younger patients with a more active lifestyle who experience instability frequently or require surgery for accompanying lesion are better candidates for surgical reconstruction of ACL.

4. **Single bundle anatomic ACL reconstruction with hamstring autograft:**

Repair of ACL has unacceptably high failure rates. When surgical treatment is indicated choice of method is reconstruction of the ligament using a graft. The graft choices are bone-patellar tendon-bone, hamstring, and quadriceps tendon autografts or allograft ligaments. Autografts are mostly preferred in primary cases and allografts in revision cases. Native ACL is formed of two bundles; anteromedial and posterolateral due to femoral attachment locations. Reconstruction methods may differ in femoral tunnel placement. Earlier tunnel placement was called over-the-top, where the tunnel was placed 1-2 mm anterior to the femoral posterior cortex very close to the top most point on the posterior notch. Later, because of remaining laxity, the tunnel was recommended to be placed lower lateral (10 / 2 o’clock). Currently reconstructing the two bundles separately or placing a single anatomic bundle is shown to deal best with the remaining laxity.

5. **Indications:**

- Young, active patient with episodes of giving way despite rehabilitation.
- Older active motivated patient

**Contraindications:**

- Limitation of motion
- Active local infection
Relative contraindications:
- Acute inflammatory phase – requires vigorous postoperative rehabilitation.
- Age <14 years – open physis.
- Age >40 years – increased arthrosis incidence?

6. Preoperative Planning
- MRI
  - Evaluate accompanying injuries like PCL, LCL lesions, meniscal tears, chondral / osteochondral injuries and be ready to manage during surgery.
- Evaluate
- Range of motion
- Quadriceps muscle and extensor mechanism.
- Graft site

7. See VIDEO for the surgical procedure

8. Early postoperative care:
- Partial or full weight bearing.
- Cryotherapy (ice)
- Full ROM exercises
- Quadriceps and hamstring strengthening exercises

9. Potential short term complications:
- Continued rotational instability
  - Cause: vertical femoral tunnel placement
- Tight flexion / loose extension
  - Cause: anterior femoral tunnel placement
- Tight extension / loose flexion
  - Cause: posterior femoral tunnel placement
- Tight flexion / impingement in extension
  - Cause: Anterior tibial tunnel placement
- Graft failure
  - Cause:
    - Graft screw divergence >30 degrees
- Over aggressive rehabilitation
- Infection
  - Treatment: immediate arthroscopic debridement
- Culture and antibiotics
- Multiple debridements
- Arthrofibrosis / Loss of motion
  - Cause:
    - Surgery during acute inflammatory phase
    - Misplaced tunnels
  - Treatment
    - Physical therapy
    - If longer than 12 moths, lysis of adhesions / manipulation under anesthesia
- Local nerve irritation
  - Saphenous nerve

10. Communication with patients

  **Preoperative**

  Patients should know that they might not be able to mobilize comfortably during the postoperative 6 weeks. They also should know that long term outcome of the procedure depends on their motivation about the rehabilitation period. ROM and muscle strength are the most important aspects of the ACL reconstructed knee rehabilitation. Patients should also be aware that return to sports may delay as long as 6 months.

  **Postoperative**

  Patients are allowed to bear weight on the operated extremity. Walking aids like crutches may be used for several weeks. Information about wound care, use of bathroom, analgesic medication, periodic follow-up visit times and procedures should be given. Immediate rehabilitation period should start with reconstitution of ROM and prevention of loss of muscle strength.
1.4.2. **Total hip arthroplasty**

1. **Degenerative joint disease of the hip;** which also is known as osteoarthritis of the hip is the most common disorder of the hip. It might be seen as the primary disease or develop secondary to developmental hip dysplasia, osteonecrosis, arthritis, femoroacetabular impingement, etc. Most common symptom is groin pain which may radiate to the knee anteriorly. Pain is aggravated with walking and may exist even during sleep.

2. **Role of diagnosis:**
   - Physical examination findings are:
     - Antalgic gait
     - Trendelenburg gait
     - Painful (especially internal rotation and flexion) and sometimes limited range of motion
     - Leg length discrepancy
     - Groin pain
     - Radiographs: Plain radiographs are usually satisfactory for diagnosis. Superolateral joint space narrowing, subchondral sclerosis, subchondral cysts, osteophytes may be seen.
     - Computed Tomography: Rarely required for diagnosis of osteoarthritis but may be helpful in determining the underlying cause as in femoroacetabular impingement.
     - Magnetic resonance imaging: Useful in determining early stages of the disease. Biochemical imaging techniques, such as the delayed gadolinium-enhanced MRI of cartilage (dGEMRIC) may detect early articular cartilage – damage.

3. **Treatment algorithm and alternatives:**
   At early stages of the disease conservative measures such as;
   - Weight reduction
   - Activity modification
   - Pain medication
   - Physical therapy modalities
Orthoses
- Injections (corticosteroids, hyaluronic acid)
- Glucosamine preparations
May be used to alleviate pain and slow progression.
When conservative treatment fails to control pain surgical treatment is indicated. Surgical treatment alternatives are:
- Femoral or periacetabular osteotomies
  - Are indicated for dysplastic hips and other disorders creating abnormal loading on the hip.
- Arthroscopic debridement
  - Femoroacetabular impingement or labral pathologies can be corrected arthroscopically.
- Arthrodesis
  - If total hip arthroplasty is contraindicated, there are untreatable septic foci, there is a muscular imbalance or if the patient is young and a heavy laborer, arthrodesis is a better choice.
- Girdlestone resection arthroplasty
  - Is the salvage procedure and mostly used as the last reserve.
- Hip resurfacing arthroplasty
  - Indicated mainly in young patients to preserve bone stock.
- Hemiarthroplasty
  - Although there is a theoretical and historical indication, total hip arthroplasty should be chosen over hemiarthroplasty in osteoarthritis cases.
- Total hip arthroplasty
  - Is the procedure of choice in most cases of osteoarthritis.

4. **Total hip arthroplasty**: Total hip arthroplasty is the most commonly performed reconstructive hip surgery in the adults. It reliably improves patient’s quality of life and relieves pain originating from the hip. It composes of an acetabular cup, insert, femoral stem and a femoral head. The prosthesis can be applied cemented or uncemented depending on the fixation method. Uncemented metals attach to bone either by ongrowth or ingrowth of bone. Bearing surfaces have polyethylene on metal, metal on metal, or ceramic on ceramic choices.
5. **Indications:** Main indication is “pain disturbing activities of daily living and existing at night”. This may be due to:

- Arthritis
- Degenerative joint disease (osteoarthritis)
- Osteonecrosis
- Pyogenic arthritis / osteomyelitis
- Tuberculosis
- Developmental dysplasia of the hip
- Hip fusion / pseudoarthrosis
- Failed reconstruction
- Bone tumors
- Hereditary disorders

There is a wide age range for total hip arthroplasty. Bilateral procedures are possible if general health status permits.

**Contraindications:**

- Systemic disorders contraindicating major elective surgery
- ACTIVE INFECTION

Relative contraindications

- Rapid bone destructing processes
- Neuropathic arthropathies
- Insufficiency of abductor musculature
- Progressive neurological diseases

6. **Preoperative Planning**

- Evaluate
- Local skin
- Possible source of infection
- Range of motion and strength (especially abductor musculature)
- Leg length discrepancy
- Actual source of pain
- Discontinue anti-inflammatory and antiplatelet medication 7 to 10 days before the operation
- Radiographs; At least
- Anteroposterior: Hip, pelvis, proximal femur
• Lateral: Hip, proximal femur
• Evaluate acetabulum for;
• Structural integrity
• Bone stock
• Size

**CT if required**
• Evaluate femur for;
• Size of medullary canal; *prepare special implant if too small*
• Angular deformity; *osteotomy may be required*
• Measure limb length shortening
• Ischium to lesser trochanteric distance
• Templating for estimated component size

7. See **VIDEO** for the surgical procedure

8. Early postoperative care:
• Remove drain at 24 to 48 hours.
• Anti-thrombotic prophylaxis for 10 to 21 days
• Antibiotic prophylaxis starting from 15 minutes before the operation to 24 hours after.
• Evaluate postoperative radiographs for
• Acetabulum
• Coverage
• Bony contact
• Medialization
• Screw placement
• Inclination and anteversion
• Femur
• Bony contact
• Limb length
• Lateral offset
• Impingement
• Varus / valgus
Patient is allowed to mobilize full weight bearing assisted by a walker starting from the 1st postoperative day.

9. **Potential short term complications:**
   - Thromboembolic disease
   - Prevention:
     - Prophylactic medication for 10 – 21 days
     - Anti-thrombotic socks / pump
     - Early mobilization
   - Treatment
   - Anti-thrombotic agents
   - Thrombolytic agents
   - Embolectomy
   - Infection
   - Prevention:
     - Meticulous wound care
     - Antibiotic prophylaxis
   - Treatment
   - Antibiotic treatment
   - Surgical debridement
   - Removal of hardware
   - Bleeding
   - Prevention:
     - Meticulous hemostasis
   - Discontinuation of causative medication preoperatively
   - Hemostatic agents
   - Treatment
   - Whole blood / plasma / thrombocyte transfusion
   - Surgical hemostasis / Hemostatic agents
   - Dislocation
   - Prevention:
     - Precise component placement and soft tissue balance
   - Intact hip abductors
   - Treatment
Closed or open reduction and abduction orthosis
Correction of the malpositioned component
Periprosthetic fracture
Prevention:
Precise component placement and soft tissue balance
Correct patient and prosthetics selection
Treatment of osteoporosis
Prevention of falls
Treatment
Open / closed reduction and open / closed fixation
Component replacement
Component failure
Prevention:
Precise component placement and soft tissue balance
Correct patient and prosthetics selection
Treatment of osteoporosis
Prevention of falls
Treatment
Revision surgery

10. Communication with patients
Preoperative
Most of the osteoarthritis patients are over 60 years of age. Presence of associated illnesses is common. Total hip 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 hip 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. These patients frequently have degenerative joint disease involving other joints and spine also. Expectations of the patient should be realistic. Patients should be aware that total hip arthroplasty will relieve pain originating from the hip only. Postoperative pain and management modalities should be described. Patients should be informed about mobilization time, need
for assistive devices, bathroom usage, possible return to regular life, and rehabilitation process.

- **Postoperative**
  After the operation the patients should be informed about the allowed and banned positions, use of bathroom, mobilization policy, wound care, medication and duration, periodic follow-up visits, antibiotic prophylaxis for dental and other procedures. Care for the prosthetics for longevity of the device should be told.
1.4.3. **Total knee arthroplasty**

1. **Degenerative joint disease of the knee:** is more commonly known as osteoarthritis of the knee. Osteoarthritis, besides back pain, is the most common chronic musculoskeletal disease worldwide. It is a leading cause for disability and impaired quality of life, and a significant burden to global health care budgets. Over 60 years of age one out of every 10 men and 5 women are affected by osteoarthritis. Knee is affected three times more than the other joints. Primary, traumatic or rheumatic, it ends up in painful joint destruction and deformity, and is still an incurable disease.

2. **Role of diagnosis:**
   - Physical examination findings are:
     - Knee pain
     - Joint effusion
     - Varus / valgus deformity
     - Instability / giving way
     - Reduced range of motion
     - Radiographs: Plain radiographs are usually satisfactory for diagnosis.
     - Narrowing of joint space
     - Osteophytes
     - Subchondral sclerosis
     - Bone cysts
     - Varus / valgus deformity
     - Periarticular osteopenia
     - Computed Tomography: Rarely required for diagnosis of osteoarthritis.
     - Magnetic resonance imaging: May be used to differentiate from other causes of knee pain. Meniscal tears, cartilage injury, anterior cruciate ligament discontinuity are frequently present in knee osteoarthritis.

3. **Treatment algorithm and alternatives:**
   At early stages of the disease conservative measures such as;
   - Weight reduction
   - Activity modification
   - Pain medication
• Physical therapy modalities  
• Orthoses  
• Injections (corticosteroids, hyaluronic acid)  
• Glucosamine preparations  

May be used to alleviate pain and slow progression.

When conservative treatment fails to control pain surgical treatment is indicated.

Surgical treatment alternatives are:

• Arthroscopic debridement  
o If meniscal tear is present.  
• Proximal tibial / distal femoral osteotomy  
o For younger patients with varus / valgus deformities.  
• Arthrodesis  
o Salvage procedure; Indicated if total knee arthroplasty is contraindicated, there are untreated septic foci, or if the patient is young and a heavy laborer.  
• Unicompartmental knee arthroplasty  
o For osteoarthritis confined to one compartment only.  
• Total knee arthroplasty  
o Is the procedure of choice in most cases of osteoarthritis.

4. **Total knee arthroplasty**: TKA is an effective procedure that has been shown to relieve pain and restore function to most patients with advanced arthritis of the knee, and is indicated for these patients when nonsurgical measures have failed. Survival rate of the prosthetics is over 95% in 15 years. When nonsurgical modalities fail to relieve symptoms of knee osteoarthritis total knee arthroplasty is indicated. Total knee prosthetics can be unconstrained (fixed or mobile bearing, posterior cruciate retaining or substituting), semi-constrained, constrained or hinged. Choice depends on the ligament and bone condition of the knee.

5. **Indications:**

• Main indication is; knee pain caused by arthritis, unresponsive to nonsurgical treatment.  
• Osteonecrosis with subchondral collapse  
• Chondrocalcinosis or pseudogout in the elderly with severe pain
• Severe patellofemoral arthritis
• Progressive deformity / laxity with moderate osteoarthritis

Bilateral procedures are possible if general health status permits.

**Contraindications:**
• Systemic disorders contraindicating major elective surgery
• Recent / current sepsis
• Source of active infection
• Extensor mechanism discontinuity
• Recurvatum deformity secondary to muscular weakness
• Well-functioning painless knee arthrodesis

Relative contraindications
• Severe hip osteoarthritis (should be treated first)
• Neuropathic arthropathies
• Significant atherosclerotic disease of the leg
• Venous stasis disease with recurrent cellulitis
• Skin disease, like psoriasis, at the operation site
• Morbid obesity
• Recurrent urinary tract infection
• History of osteomyelitis close to knee

6. **Preoperative Planning**
• Evaluate
• Local skin
• Possible source of infection
• Range of motion and strength
• Actual source of pain / patello-femoral pain
• Varus / valgus deformity
• Ligament laxity
• Patello-femoral tracking
• Discontinue anti-inflammatory and antiplatelet medication 7 to 10 days before the operation
• Evaluate cardiopulmonary reserve and blood supply of the leg
• Radiographs;
• Long-leg standing anteroposterior:
- Lateral
- Skyline patella
- Evaluate:
  - mechanical axis,
  - bowing of tibia,
  - bone defects
  - templating for estimated component size

7. See **VIDEO** for the surgical procedure

8. Early postoperative care:
- Remove drain at 24 to 48 hours.
- Anti-thrombotic prophylaxis for 10 to 21 days
- Antibiotic prophylaxis starting from 30 minutes before the operation to 24 hours after.
- Evaluate postoperative radiographs for
  - Femur
  - Component placement
  - Anterior notching
  - Flexion / extension and varus / valgus alignment
  - Mechanical axis
  - Patella position
  - Tibia
  - Cortical support under base plate
  - Coronal and sagittal plane alignment
  - Height of joint line
  - Patient is allowed to mobilize full weight bearing assisted by a walker starting from the 1st postoperative day.

9. **Potential short term complications:**
- Thromboembolic disease
- Prevention:
  - Prophylactic medication for 10 – 21 days
  - Anti-thrombotic socks / pump
• Early mobilization
• Treatment
• Anti-thrombotic agents
• Thrombolytic agents
• Embolectomy
• Infection
• Prevention:
• Meticulous wound care
• Antibiotic prophylaxis
• Treatment
• Antibiotic treatment
• Surgical debridement
• Removal of hardware
• Bleeding
• Prevention:
• Meticulous hemostasis
• Discontinuation of causative medication preoperatively
• Hemostatic agents
• Treatment
• Whole blood / plasma / thrombocyte transfusion
• Surgical hemostasis / Hemostatic agents
• Patello-femoral problems
• Prevention:
• Precise component placement and soft tissue balance
• Use of patellar component
• Treatment
• Muscle strengthening exercises
• Revision
• Periprosthetic fracture
• Prevention:
• Precise component placement and soft tissue balance
• Correct patient and prosthetics selection
• Treatment of osteoporosis
• Prevention of falls
10. **Communication with patients**

- **Preoperative**

  Most of the osteoarthritis patients are over 60 years of age. 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. These patients frequently have degenerative joint disease involving other joints and spine also. 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 should be described. Patients should be informed about mobilization time, need for assistive devices, bathroom usage, possible return to regular life, and rehabilitation process.

- **Postoperative**

  After the operation the patients should be informed about the allowed and banned positions, use of bathroom, mobilization policy, wound care, medication and duration, periodic follow-up visits, antibiotic prophylaxis for dental and other procedures. Care for the prosthetics for longevity of the device should be told.
1.4.4. Hallux valgus

1. **Hallux Valgus**, also known as bunion, is a complex deformity of the first ray of the foot which frequently is accompanied by deformity and symptoms in the lesser toes. Often the intermetatarsal angle between the 1\textsuperscript{st} and the 2\textsuperscript{nd} metatarsals is more than 9 degrees and the valgus angle of the 1\textsuperscript{st} metatarsophalangeal is more than 15 – 20 degrees. When this angle exceeds 30 – 35 degrees pronation of the greater toe occurs. Sesamoids displace laterally, bursal hypertrophy develops over the medial side of the metatarsal head, 2\textsuperscript{nd} toe presents a hammer toe like deformity. Hallux valgus is caused by both genetic predisposition and wear of unphysiological footwear.

2. **Role of diagnosis:**
   - Physical examination findings are:
     - Lateral deviation of greater toe
     - Bunion formation
     - Hammer toe of lesser metatarsals
     - Corns
     - Calluses
     - Metatarsalgia
     - Osteoarthritis of the first metatarsophalangeal joint
     - Hypermobile 1\textsuperscript{st} tarsometatarsal joint
     - Radiographs: Standing dorsoplantar and lateral views, a nonstanding lateral oblique view, and axial sesamoid view.
       - Metatarsus primus varus
       - Hallux valgus
       - Sesamoid subluxation / dislocation
       - 1\textsuperscript{st} ray pronation
       - Bunion formation
       - Hallux valgus interphalangeus

3. **Treatment algorithm and alternatives:**
   At early stages of the disease conservative measures such as;
   - Shoe modification
- Activity adjustment
- Orthoses;
  - Interdigital separators
  - Adduction braces
  - Bunion protective soft shields

When conservative treatment fails to control pain surgical treatment is indicated. Only in the adolescent with progressive hallux valgus deformity cosmetic reasons may be considered an indication for surgery. Surgical treatment alternatives are:

- Bunionectomy
- Soft tissue procedures
- Combined soft tissue and bony procedures

Surgical treatment algorithm recommended by Mann RA:

- Hallux valgus <25 degrees
  - Congruent joint
    - Chevron osteotomy
    - Mitchell osteotomy
  - Incongruent joint
    - Distal soft tissue realignment
    - Chevron osteotomy
    - Mitchell osteotomy
- Hallux valgus 25 – 40 degrees
  - Congruent joint
    - Chevron osteotomy with Akin procedure
    - Mitchell osteotomy
  - Incongruent joint
    - Distal soft tissue realignment with proximal osteotomy
    - Mitchell osteotomy
- Severe Hallux valgus >40 degrees
  - Congruent joint
    - Double osteotomy
    - Akin and Chevron osteotomy
    - Akin and first metatarsal osteotomy
- Akin and first cuneiform opening wedge osteotomy
  - Incongruent joint
- Distal soft tissue realignment with proximal osteotomy
- First metatarsal crescentic osteotomy
- First cuneiform opening wedge osteotomy
  - Hypermobile first metatarsocuneiform joint
  - Distal soft tissue realignment and fusion of the first metatarsocuneiform joint

4. **Surgical correction of the hallux valgus complex: (Proximal metatarsal crescentic osteotomy and distal soft tissue alignment)**

When conservative measures fail to control pain and disability caused by hallux valgus surgical correction is indicated. There are more than 130 procedures recommended for this purpose. Before deciding which type of procedure would be most beneficial one must take into account the following structural components:

1. Valgus deviation of the great toe
2. Varus deviation of the first metatarsal
3. Pronation of the first ray
4. Hallux valgus interphalangeus
5. Degeneration of first metatarsophalangeal joint
6. Length of the first metatarsal relative to the others
7. Excessive mobility or obliquity of the first metatarsocuneiform joint
8. Bunion
9. Location of the sesamoids
10. Intrinsic and extrinsic muscle-tendon balance

On the standing dorso-plantar radiograph hallux valgus angle, intermetatarsal angle (first – second metatarsal shaft angle), metatarsal shaft distal joint surface angle and interphalangeal angle should be measured. Proximal crescentic osteotomy with distal soft tissue procedure can correct 20 – 25 degrees of the intermetatarsal angle and 40 – 50 degrees of the hallux valgus angle. It has 93% satisfaction rate.
5. **Indications:**
- Main indication is; pain and disability caused by hallux valgus unresponsive to other modalities.
- Fast progressing hallux valgus in the adolescent with family history
- Hallux valgus angle more than 35 degrees and intermetatarsal angle more than 10 degrees.

**Contraindications:**
- Degenerative changes in the joint
- Hypermobile metatarsocuneiform joint
- Hallux valgus angle less than 30 degrees and intermetatarsal angle less than 13 degrees. (May be treated with simpler techniques)
- Distal metatarsal articular angle more than 15 degrees.
- Inadequate vascularity or sensibility of the foot.

6. **Preoperative Planning**
- Radiographs;
  - Standing dorsoplantar and lateral views
  - Nonstanding lateral oblique view
  - Axial sesamoid view
- Evaluate
  - Hallux valgus angle
  - Intermetatarsal angle
  - Pronation of the first ray
  - Hallux valgus interphalangeus angle
  - Degeneration of first metatarsophalangeal joint
  - Length of the first metatarsal relative to the others
  - Excessive mobility or obliquity of the first metatarsocuneiform joint
  - Location of the sesamoids

7. See [VIDEO](#) for the surgical procedure

8. **Early postoperative care:**
- Use 1st web spacer support for 6 to 8 weeks.
- Patient can walk bearing weight on heel or lateral border as tolerated.
• Evaluate postoperative radiographs for
• Hallux valgus angle
• Intermetatarsal angle

9. **Potential short term complications:**
• Insufficient correction or loss of correction - hallux valgus
• Secure fixation
• Choice of correct procedure
• Protect hallux from valgus stress for at least 3 months.
• Malunion / Nonunion
• Secure fixation
• Hallux varus
• Avoid overcorrection to prevent
• Dorsiflexion malunion of the osteotomy site with transfer Metatarsalgia
• Avoid dorsal displacement of the distal fragment
• Secure fixation
• Limitation of motion

10. **Communication with patients**

    • **Preoperative**
    Although the patients are allowed to bear weight as tolerated, they should be informed that this period might require use of walking aids. Return to work may be delayed 6 to 8 weeks. Patients should be informed about specific complications like insufficient correction or loss of correction, malunion, nonunion, hallux varus (overcorrection), and limitation of motion. Especially deformities in adolescent or young adults tend to recur and satisfaction rates are lower in these groups of patients.

    • **Postoperative**
    Patients are allowed to bear weight on the heel or the lateral border of the operated foot. Walking aids like crutches may be used for several weeks. Information about wound care, use of bathroom, analgesic medication, periodic follow-up visit times and procedures should be given.
1.4.5. Osteonecrosis of the femoral head

1. Osteonecrosis is the reason of 10% of all the total hip arthroplasties. It affects mostly middle aged men and is 80% bilateral. Steroid use, alcoholism, and sickle cell disease are the most frequent causes, but it also may be idiopathic. Temporary or permanent circulation block of the femoral head results in necrosis of the osteocytes and the bone marrow elements. Inability of the osteocytes to provide continuity of the bone matrix results in collapse of the femoral head, loss of congruence and development of osteoarthritis. Treatment results best when diagnosed prior to collapse and prevented. Steinberg modification of Ficat and Arlet staging system is used:

Stage 0: Normal radiographs and normal MR
Stage 1: Normal radiographs and osteonecrosis in MR
Stage 2: Cystic or sclerotic changes in radiographs and osteonecrosis in MR
Stage 3: Crescent sign (subchondral collapse) in radiographs and osteonecrosis in MR
Stage 4: Flattening of femoral head in radiographs and osteonecrosis in MR
Stage 5: Narrowing of joint in radiographs and osteonecrosis in MR
Stage 6: Advanced degenerative changes in radiographs and osteonecrosis in MR

2. Role of diagnosis:

- Patients complain of groin pain which especially exacerbates during night. Internal rotation may be limited due to pain.
- Physical examination findings are:
  - Groin pain
  - Antalgic gait
  - Radiographs: Normal during the first few months. After this period cysts and sclerotic areas. Crescent sign shows subchondral collapse has started. Femoral head collapse, loss of sphericity, loss of joint space, subchondral sclerosis, osteophytes, subchondral cysts.
  - Magnetic Resonance Imaging: Necrotic bone confined to the superolateral head area surrounded with an edematous ring – double density sign.
  - Bone scan: Sensitivity close to MR but specificity less.
3. **Treatment algorithm and alternatives:**

- Nonoperative
  - Bisphosphonates: May prevent collapse in early stages
- Core decompression with or without grafting
  - For pre-collapse stages and small lesions.
  - 10 mm single or 3.2 mm triple holes are drilled to the femoral head
  - Relieves intraosseous compartment pressure
  - Triggers angiogenesis and healing
  - Can be grafted (autograft (fibula or iliac crest), synthetic graft or allograft)
- Rotational osteotomy
  - Small lesions
  - Diseased part of head rotated away so healthy part carries weight.
  - Technically difficult
- Curettage and bone grafting
  - Through articular surface: trapdoor
  - Through femoral neck: light bulb
- Vascularized free fibula transfer
  - Wider indication
  - Difficult
  - More complications
- Post collapse stages
  - Total hip replacement
  - Total hip resurfacing
  - Hip arthrodesis

4. **Core Decompression with synthetic grafting.**

Traditional core decompression method drills a 10mm diameter hole through the trochanteric region, the neck and into the necrotic area of the head. The hole relieves intraosseous pressure which in turn provides immediate pain relief. This procedure is especially recommended for pre-collapse and smaller lesions. The core decompression method can be augmented with structural or non-structural, grafts or substitutes. These also can be loaded with different kinds of growth and promoting factors.
5. **Indications:**
   - Stage 1 or 2 osteonecrosis of the femoral head

**Relative contraindications:**
- Collapsed femoral head
- Arthritic changes

6. **Preoperative Planning**
- Radiographs and MRI
- Determine stage of the disease.
- Calculate total volume of necrosis
- Determine the location of necrosis. Imaginary necrotic area will be required to be found on fluoroscopy.

7. See [VIDEO](#) for the surgical procedure

8. **Early postoperative care:**
   - Ambulate using crutches without bearing weight for 6 weeks.

9. **Potential short term complications:**
   - Collapse and failure
   - There is 30% risk of total hip arthroplasty.

10. **Communication with patients**
   - **Preoperative**
     
     Due to the cause of the necrosis, the extent of injury, and the stage of the disease the prognosis varies. Patients should know that after this procedure there is 30% risk of total hip arthroplasty requirement during the following 5 years. The disease is 80% of the times bilateral. So the contralateral hip may require the similar procedure. Similar procedure may be done to the contralateral side 3 months after the index operation.

   - **Postoperative**
     
     Patients are not allowed to bear weight on the operated extremity for 6 weeks. Walking aids like crutches are be used. Information about wound care, use of bathroom, analgesic medication, periodic follow-up visit times and procedures should be given. The core decompression procedure itself has low risk of complications but the disease is prone to progress.
1.4.6. Chondral / osteochondral defects of the knee

1. Chondral injury may result either from acute trauma or chronic repetitive overload. Articular cartilage injuries affect 5 to 10% of people over 40 years of age. Defective cartilage area increases the load carried by the intact cartilage resulting in enlargement of the defect and arthrosis. Cartilage injuries, if calcified cartilage layer is intact, tend not to heal. Full thickness injuries may heal with fibrous cartilage. Better quality cartilage is required to bear weight. Outerbridge arthroscopic grading system and ICRS systems are used commonly to grade injuries.

**Outerbridge Arthroscopic Grading System**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal cartilage</td>
</tr>
<tr>
<td>I</td>
<td>Softening and swelling</td>
</tr>
<tr>
<td>II</td>
<td>Superficial fissures</td>
</tr>
<tr>
<td>III</td>
<td>Deep fissures, without exposed bone</td>
</tr>
<tr>
<td>IV</td>
<td>Exposed subchondral bone</td>
</tr>
</tbody>
</table>

**ICRS (International Cartilage Repair Society) Grading System**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal cartilage</td>
</tr>
<tr>
<td>1</td>
<td>Nearly normal (superficial lesions)</td>
</tr>
<tr>
<td>2</td>
<td>Abnormal (lesions extend &lt; 50% of cartilage depth)</td>
</tr>
<tr>
<td>3</td>
<td>Severely abnormal (&gt;50% of cartilage depth)</td>
</tr>
<tr>
<td>4</td>
<td>Severely abnormal (through the subchondral bone)</td>
</tr>
</tbody>
</table>

2. Role of diagnosis:

- Physical examination findings are:
  - Knee pain
  - Locking / catching
  - Effusion
  - Tenderness at the joint line
  - Radiographs: Usually normal. Only viewable if the bony part is large enough.
Magnetic Resonance Imaging: Mostly seen as edematous bony area in neighborhood of the articular cartilage. Biochemically enhanced views such as dGEMRIC (delayed gadolinium-enhanced MRI for cartilage) or gradient echo MR’s might demonstrate better.

3. **Treatment algorithm and alternatives:**

Old age / small defect
- Rest
- Ice
- Compression
- Elevation
- Range of motion exercises
- Quadriceps and hamstring strengthening exercises
- Loss of weight

Younger age / larger defect

Operative treatment
- Debridement and removal of loose body
  - Relieves mechanical symptoms
- Fixation of fragment
  - For fragments with considerable bony component and young patients
- Bone marrow stimulation techniques
  - Suitable for lesions less than 2cm$^2$
  - Microfracture, abrasion, drilling are most widely used techniques.
- Osteochondral Autograft Transfer – Mosaicplasty
  - Most of the defect is filled with articular cartilage
  - Suitable for defects smaller than 5 cm$^2$ and with intact cartilage borders
- Autologous Chondrocyte Implantation (ACI) / Matrix induced ACI (MACI)
  - Cell therapy for larger defects
  - Results in hyaline-like cartilage
- Osteochondral Allograft Transplantation
  - For very large defects

4. **Microfracture:** Microfracture is one of the bone marrow stimulation techniques. Calcified cartilage layer is removed and multiple holes are made in
the subchondral bone to allow bone marrow elements to migrate into the defect. Bone marrow is rich in mesenchymal stem cells. These cells fill the defect with fibrous cartilage. Although fibrous cartilage is biomechanically inferior to articular cartilage, it satisfactorily fills small and contained defects. Defects less than 2 cm² in area which are surrounded with healthy cartilage shoulders respond well to microfracture.

5. **Indications:**
   - Isolated chondral defect.
   - Contained defect.
   - Defect smaller than 2 cm²

**Contraindications:**
- Non contained defect
- Chondral damage on the opposite side of the joint (tibia)
- Osteoarthritis

**Relative contraindications:**
- Defect larger than 2 cm².

6. **Preoperative Planning**
   - MRI
   - Evaluate location, size and depth of the defect, presence of a fixable loose body, necessity for bone grafting, and accompanying lesions of the menisci and ligaments.
   - Radiographs
   - Correction of angular deformity of the knee using osteotomies are recommended to decrease loading of the injured cartilage

7. See **VIDEO** for the surgical procedure

8. **Early postoperative care:**
   - Ambulation without bearing weight for 6 weeks.
   - CPM (Continuous passive motion) or Range of Motion exercises
   - Quadriceps and hamstring strengthening exercises

9. **Potential short term complications:**
- Failed healing of articular cartilage
  - Proceed with higher class treatment modalities
- Over healing
  - Catching or locking sensation starts after one year.
  - Shaving of the over healed tissue

10. Communication with patients

- Preoperative
  Patients should be informed about the long healing times of the cartilage healing. Healing may take 6 to 9 months and sometimes longer. Failure to fill the defect is another possibility. Sometimes the defect fills but the tissue continues to grow causing a catching sensation.

- Postoperative
  Patients are allowed to mobilize without bearing weight for 6 weeks. CPM and range of motion exercises are started early to promote cartilage growth. Information about wound care, use of bathroom, analgesic medication, periodic follow-up visit times and procedures should be given.
1.4.7. Acetabular fractures - posterior approach

1. **Acetabular fractures** are classified, according to Letournel, into 12 types:
   - Anterior wall
   - Posterior wall
   - Anterior column
   - Posterior column
   - Transverse
   - Both columns
   - Posterior columns with posterior wall
   - Transverse with posterior wall
   - T-shaped
   - Anterior column with posterior hemi-transverse

From these, the posterior approach is indicated only for the posterior components, mainly affecting posterior wall and posterior column. Posterior wall fractures (the most common type of acetabular fracture accounting for 25% of all acetabular fractures) are characterized by the following:
   - There is a separation of posterior articular surface, but most of the posterior column is undisturbed.
   - Are often comminuted and associated with posterior femoral head dislocation.
   - The posterior wall fragment is best visualized on the obturator oblique view. The AP will reveal a disruption only in the posterior rim shadow, with the obturator oblique view showing the size and the multifragmentary nature of the fracture.
   - “Marginal impaction” is often present in posterior fracture-dislocations, rotated and impacted osteochondral fragment that is displaced as the femoral head dislocates and the wall fractures, with a fragment of articular cartilage impacted into underlying cancellous bone. This situation is recognised by CT scan and has been documented in about 46% of posterior wall fractures.

Posterior column fractures represent about 3 to 5% of acetabular fractures and have the following characteristics:
- They involve detachment of the entire ischioacetabular segment from the innominate bone.
- The fracture begins at the posterior border of the innominate bone near the apex of the greater sciatic notch, it descends across the articular surface, quadrilateral surface, ischiopubic notch and across the inferior ramus at the level of the obturator foramen.
- On the AP radiograph the ilioischial line, the posterior rim and the inferior ramus are disrupted.
- In widely displaced fractures it is common to find the neurovascular bundle in the posterior column fracture site and it must be carefully extracted before reduction to prevent iatrogenic injury.
- Medial displacement of the femoral head can occur.
- It is best seen on the iliac oblique view.

Posterior columns with posterior wall associate two patterns, thus resulting the following:
- The posterior wall is usually markedly displaced/rotated in relation to the posterior column.
- Posterior column fracture begins in the cavity created by posterior wall fracture.
- This injury represents one pattern of posterior hip dislocation that is frequently accompanied by injury to the sciatic nerve.
- Central displacement or dislocation of femoral head frequently associated.
- Displacement of posterior wall usually greater than posterior column.

2. **Role of diagnosis:**
   - Anamnesis: indirect mechanism ("dashboard injury") is typical for a posterior acetabular fracture.
   - Physical examination findings are atypical, as multiple types and amounts of displacement can be associated; although it is to be underlined that a posterior acetabular fracture must be suspected whenever a posterior dislocation of the hip occurs. Therefore, the following must be checked and described:
     - Posterior pain at the level of the buttock.
     - Leg length discrepancy with shortened distance from the ASIS (Anterosuperior iliac spine) to the patella compared to the non-injured limb.
• Abnormal position with adduction and internal rotation (typical for posterior dislocation), especially when irreducible with gentle external rotation, situation which completely forbids any other maneuver until positive diagnosis is established
• Sciatic nerve complete or partial paralysis
• Radiographs: AP pelvic X-ray is completed by the
• Obturator view for the posterior wall and anterior column
• Iliac view for the posterior column and anterior wall
• If a pelvic injury is suspected, inlet and outlet views are recommended
• Computed Tomography with 3D reconstruction is mandatory for these fractures since it reveals the main elements which establish the treatment indication:
  • The congruency of the joint- which can be impaired due to displacements or by intra-articular fragments, capsular interpositions, depressions or associated femoral head fractures, including depressed areas
  • The stability of the joint, affected when the acetabulum is not continent any more due to large displaced fragments
  • The potential mobility of the joint, which can be affected by intra-articular fragments
  • Magnetic resonance imaging does not bring supplementary elements in posterior acetabular fractures

3. Treatment algorithm and alternatives:
Treatment of posterior acetabular fractures depends on their impact upon the three main characteristics of the hip joint mentioned before: congruency, stability and mobility; so, when these are maintained, the treatment is conservative, non-surgical
Traction (at the supracondylar level) may be indicated or not (especially due to its demonstrated impact upon the knee joint)
Surgical treatment is indicated when the fracture affects the stability the congruency or the mobility of the joint, and it
4. **Surgical treatment** consists of:

- Posterior approach Kocher Gibson Langenbeck: the patient is in prone position or lateral decubitus; the skin incision is centered over the greater trochanter, with the proximal branch is directed toward the posterior superior iliac spine, ending 4-6 cm short to this bony landmark. Distally the incision extends 15 cm along the midlateral aspect of the thigh. The fascia lata is incised and the gluteus maximus in dissected toward the posterior superior iliac spine with care to the inferior gluteal nerve. The insertion of the gluteus maximus into the femur is released, in maximal internal rotation, and the sciatic nerve is found along the posterior surface of the quadratus femoris muscle. Then the short external rotators and piriformis tendon are divided and tagged with sutures, then incised in maximal internal rotation as well. Retraction of this muscles allows visualization of the posterior column and retroacetabular space while protecting the sciatic nerve. If additional superior and anterior extension of the exposure is required, to secure buttress plate fixation of a superior posterior wall fracture, anterior extension of the exposure can be achieved by using a standard or a flip osteotomy of the greater trochanter. In this approach, for avoiding damage, the sciatic nerve must be visualized and protected. Typically the nerve runs deep to the piriformis muscle, appearing in the buttock at the inferior border of this muscle, but potential anatomic variations may exist.

- Reconstruction of the acetabular articular surface- The posterior wall fracture fragments must be delineated and cleared of debris. The femoral head is distracted and free osteochondral fragments are removed from the joint. Impacted fragments are extracted and the subjacent space filled with grafts

- Stabilization using screws or plate with screws: the small articular fragments can be held in place using temporary Kirschner wires. The use of lag screws must be supplemented with a buttress plate that spans the posterior wall fragments from the ischium to the intact ilium. The plate should be slightly undercontoured so as to provide compression to the posterior wall when tightened. The plate is best placed parallel and close to the rim of the acetabulum, where it can provide the best buttress for the wall fragments. Ideally, three screws are placed cephalad to the fracture fragments and two placed distal, with one of them being a long screw into the ischium. Due to the importance of this issue upon the outcome of the loint, intra-operative
fluoroscopic control of screw position (so as to avoid joint penetration) is strongly recommended. Suture include muscular restoration as much as possible, especially that of the external rotators, so as to prevent any further negative impact upon weight-bearing and gait.

5. **Indications:** stabilization using the posterior approach is indicated when the posterior acetabular rim is affected by one of the following:

- hip joint instability and/or incongruity;
- fragments of bone or soft tissue incarcerated within the hip joint;
- fracture displacement in the weight-bearing dome;
- irreducible hip dislocation;
- recurrent hip dislocation following reduction despite traction;
- associated vascular injury;
- open fractures;
- ipsilateral femoral neck fracture;

**Contraindications:**

- Systemic disorders contraindicating major surgery, including post-traumatic organ failure, ARDS, coagulopathy
- ACTIVE INFECTION
- Contraindications of lateral or prone position (pulmonary injury for lateral position, sternal fracture or myocardial contusion)

5. **Preoperative Planning** refers to the fracture, to the patient and to the facility

- Evaluate
- Thrombo-embolic, bleeding and infectious risk
- Neurological status (sciatic nerve)- a plastic surgeon should be included in the team if the nerve is to be approached
- The fracture- prepare the implant
- The skin- dermatitis, decubitus
- Discontinue antiplatelet medication according to the anaesthesia recommendation
- Radiographs: AP pelvis, oblique obturator and iliac
• CT scan - evaluate acetabulum for displacements, intra-articular fragments, impaction
• Plan the length and the position of the plate
• Check the radiology facility and the radio-lucent table

6. See VIDEO for the surgical procedure

7. Early postoperative care:
• Remove drain at 24 to 48 hours.
• Elastic stockings on both lower limbs before, during and after surgery
• Anti-thrombotic prophylaxis for at least 3 weeks, until full mobilization of the patient
• Antibiotic prophylaxis starting concomitant with anaesthesia induction, then according to the local protocol and patient’s outcome
• Slight abduction of the legs
• Traction is debatable due to increased risk of complications affecting the knee
• Evaluate postoperative radiographs for fracture reduction and position of the implants
• Depending on post-operative result, active movements can be immediately started, but with full weight bearing not early than 3 months, provided that the post-operative CT indicates a favorable outcome

8. Potential short term complications:
• Sciatic nerve injury
• Prevention
• Gentle dissection
• Careful manipulation of electro-coagulating devices
• Gentle maneuvers upon the femoral head when dislocating it
• Treatment
• Avoid equines
• Sustained rehabilitation therapy
• Neuro-protective medication
- Neuro-stimulation
- Surgical treatment if indicated
- Thromboembolic disease
- Prevention: anti-thrombotic prophylaxis including
  a. elastic bandages,
  b. intermittent pressure compression devices,
  c. liquid intake,
  d. quit smoking
  e. early mobilization
  f. pharmacological prophylaxis for at least 3 weeks, up to the moment when the thromboembolic risk factors have been amended
- Treatment
- Anti-thrombotic agents
- Thrombolytic agents
- Embolectomy
- Infection
- Prevention:
  - Aseptic surgery—follow the rules for reducing surgical site infection
  - Proper antibiotic prophylaxis
- Treatment
- Antibiotic treatment
- Surgical debridement
- Removal of hardware in late infections
- Bleeding
- Prevention:
  - Meticulous hemostasis
  - Discontinuation of causative medication preoperatively
- Hemostatic agents
- Treatment
  - Whole blood / plasma / thrombocyte transfusion
  - Surgical hemostasis / Hemostatic agents
- Implant failure—secondary dislocation
- Prevention:
  - Proper reduction and stable fixation
47

- Intact hip abductors
- Treatment
- Total hip arthroplasty
- Heterotopic ossifications
- Prevention:
- Avoid invasive approaches
- Indomethacin intra-rectal
- Physio-therapy
- Treatment
- Surgical
- Post-traumatic osteoarthritis
- Prevention:
- Pearly proper reduction and stabilization
- Adequate rehabilitation and weight bearing strategy
- Proper Body Mass Index
- Treatment
- Total hip arthroplasty

9. **Communication with patients**

**Preoperative**

Most of the patients with this type of fractures are young, with associated traumatic injuries which considerably increase the anaesthetic and surgical risk, as well as that of septic and thrombo-embolic complications. All these, together with the demanding surgical technique must be known by the patient; the impairment generated by the injury upon the joint must be described, so as the patient can realize the significant risk of late arthritic complications, regardless of the results of surgery. Patients frequently are reluctant in accepting these risks in a young age, but their expectations should be realistic. Patients should be aware that regardless of the immediate results of surgery, late complications are not excluded, and that failure to respect the medical recommendations decrease the free interval before post-traumatic osteoarthritis occurs. Patients must be explained that this type of injury have major consequences upon their life quality, that they must adapt their lifestyle to this circumstance; adequate diet,
Quitting smoking and adequate rehabilitation programme are mandatory for decreasing the morbidity in these situations.

- **Postoperative**

After the operation the patients should be informed about the aspects detected intra-operative which complete the image of the injury, especially about the aspect of the femoral head and that of the acetabular cartilage, which have a major role in late post-traumatic outcome. They should also been informed about allowed and banned positions, use of bathroom, mobilization policy, wound care, medication and duration, periodic follow-up visits, attitude towards other medical procedures or pathologic circumstances (such as urinary or gastro-intestinal infections).
1.4.8. Treatment of unstable trochanteric fractures with Gamma Nail

1. Trochanteric fractures affect the region containing the greater and the lesser trochanter, between the basilar neck insertion of the capsule and the inferior border of the lesser trochanter, thus being extra capsular fractures. Their incidence is roughly the same as femoral neck fractures, with a higher incidence in the female population. In elderly people, they can occur due to low energy falls in osteoporotic patients, while at younger people they are the result of high energy trauma.

Several criteria have been used to classify these fractures, but the main are:
- The stability of the fracture, thus being described stable and unstable fractures
- The morphology of the fracture: simple or comminuted
- The anatomical structures involved, thus resulting:
  - isolated fractures of the greater or lesser trochanter- are not going to be addressed in this chapter, due to their extremely low incidence
  - pertrochanteric fractures (according to AO classification) with an oblique aspect, starting from the greater to the lesser trochanter
  - intertrochanteric fractures (according to AO) with a horizontal aspect in-between the greater and the lesser trochanter
  - fractures involving more than one anatomical landmark (ex- pertrochanteric associated with lesser trochanter)

2. Role of diagnosis:
- Physical examination: the amount of clinical deformity reflects the degree of fracture displacement. Patients with a nondisplaced fracture may have no clinical deformity, those with a displaced fracture exhibit the classic presentation of a shortened and externally rotated extremity. There may be tenderness to palpations in the area of the greater trochanter. Range-of-motions testing of the hip is usually painful and should be avoided. Intertrochanteric fractures in younger individuals are usually the result of a high-energy injury, such as a motor vehicle accident of fall from a height. In these instances, assessment must be made of possible associated head, neck, chest and abdominal injuries.
- Shortened and externally rotated limb
- Painful (especially internal rotation and flexion)
- Tenderness to palpations in the lateral part of the hip
- Radiographs: recommended views:
  - AP pelvis;
  - Full length femur radiographs;
- Computed Tomography useful if radiographs are negative but physical exam consistent with fracture or if they do not allow a complete description of the fracture.

3. Treatment algorithm and alternatives:

   **Nonoperative** treatment - exceptional indications,
   - increased mortality rate produced by bed resting complications

   **Surgical treatment** - routinely applied; alternatives:
   - Dynamic Hip Screw
     - indicated for stable intertrochanteric fractures. The outcomes are equal when compared to intramedullary hip nails for stable fracture patterns.
   - Intramedullary Nailing (Gamma Nail)
     - indicated in stable and unstable fracture patterns, revers obliquity patterns, subtrochanteric extensions and lack of integrity of femoral wall. The outcomes are equivalent to sliding hip screw for stable fracture patterns.
   - Arthroplasty
     - Is indicated only in severely comminuted fractures extended to the femoral neck or in cases of arthritis, either preexisting symptomatic degenerative arthritis or after failed osteosynthesis with cutting out.

4. Gamma Nail technique:

   Gamma nails are indicated both for stable and unstable fractures, due to their superior force distribution resulting from the intramedullary position.

   After thorough preoperative planning, the appropriate length for the implant is chosen. Fracture reduction as anatomically as possible should be obtained by placing the patient on the fracture table and using fluoroscopy.

   Through an incision just above the greater trochanter, the entry point is located and the medullary canal is opened using an awl. Then, the medullary canal is prepared, using flexible reamers or just a one-step conical reamer, depending on
the operator's preferences. The targeting device with the Gamma nail is assembled and introduced in proper position under image intensification. The next step is the lax screw insertion, after appropriate measuring and preparation of the bone. The last step is distal screw locking using free hand technique under AP and lateral repeated imaging.

5. Indications:
- Stable fracture patterns
- Unstable fracture patterns, defined basically by the comminution of the posterolateral cortex; this means that the fracture will collapse into varus and retroversion when loaded without proper fixation.
- Reverse obliquity fractures
- Fractures with subtrochanteric extension (long nail recommended)
- Lack of integrity of femoral wall

6. Contraindications:
- Patients at high risk for perioperative mortality
- Active infection

7. Preoperative Planning
- Evaluate
- Risk factors for infection and thrombo-embolic complications
- Local skin
- Leg length discrepancy
- Hip joint status
- Radiographs; At least
- Anteroposterior: Hip, pelvis, proximal femur
- Evaluate acetabulum for arthritis (limited adduction)
- Evaluate femur for;
- Size of medullary canal;
- Angular deformity;
- Measure limb length shortening
- Templating for estimated component size
8. See VIDEO for the surgical procedure

9. Postoperative care:
   - Remove drain at 24 to 48 hours.
   - Anti-thrombotic prophylaxis including
     a. elastic bandages,
     b. intermittent pressure compression devices,
     c. early mobilization
     d. pharmacological prophylaxis
   - Antibiotic prophylaxis starting from anaesthesia induction depending on the local protocols and the risk factors.
   - Evaluate postoperative radiographs for
   - Femur
   - Position of the neck screw
   - Position of the locking screws
   - Limb length
   - Varus / valgus
   - Passive and active movements started post-operative
   - Early mobilization of the patient
   - Weight bearing strategy according to the stability of the fracture and the recommendations of the manufacturer, as full weight bearing should not be allowed until callus signs are visible

10. Potential complications:
   - Intra-operative mechanical complications, especially in osteoporotic bone:
   - Femoral neck fracture
   - Femoral diaphysis fracture (medial cortex)
   - Thromboembolic disease
   - Prevention:
     a. elastic bandages,
     b. intermittent pressure compression devices,
     c. liquid intake,
     d. quit smoking
e. early mobilization
f. pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended

- Treatment
- Anti-thrombotic agents
- Thrombolytic agents
- Embolectomy
- Infection
- Prevention:
  - Aseptic surgery - follow the rules for reducing surgical site infection
  - Proper antibiotic prophylaxis

- Treatment
- Antibiotic treatment
- Surgical debridement
- Removal of hardware (late infections)
- Bleeding
- Prevention:
  - Meticulous hemostasis
  - Avoid invasive approaches, perform closed reduction
  - Careful reaming

- Treatment
- Whole blood / plasma / thrombocyte transfusion
- Surgical hemostasis / Hemostatic agents
- Implant failure
- Prevention:
  - Proper position of the neck screw (Baumgartner index)
  - No full weight bearing until 6 weeks postoperative or callus formation x-ray in unstable fractures
- Prevention of falls
- Treatment of osteoporosis
- Treatment
- Corrective surgery, if the joint is not affected
- Total hip arthroplasty, if arthritis occurred
11. Communication with patients

- **Preoperative**
  Most of the patients are over 60 years of age. Presence of associated illnesses is common. Before the operation the patients should be informed about the potential complications of surgery, specific complications and their treatment policies, possibility of transfusion, and use of medication. Patients should also know the implant options, and available treatment options. These patients frequently have degenerative joint disease involving other joints and spine also. Expectations of the patient should be realistic. Postoperative pain and management modalities should be described. Patients should be informed about mobilization time, need for assistive devices, bathroom usage, possible return to regular life, and rehabilitation process.

- **Postoperative**
  After the operation the patients should be informed about the allowed and banned positions, use of bathroom, mobilization policy, wound care, medication and duration, periodic follow-up visits, antibiotic prophylaxis for dental and other procedures.
1.4.9. Treatment of distal femoral fractures using the DCS

1. Distal femoral fractures can occur in two main circumstances: in young patients, after high energy trauma, producing comminuted displaced fracture, sometimes associated with other skeletal or extra-skeletal injuries, or in geriatric population, as fragility fractures, after low energy trauma (such as fall from standing), in osteoporotic bone, usually with less displacement. Several classifications have been used, most of them reflecting the same parameters as the AO classification:
- 33A- extra-articular fractures (metaphyseal)
- 33B- partial articular fractures
- 33C- complete articular fractures

2. Role of diagnosis:
Physical examination: the amount of clinical deformity reflects the degree of fracture displacement.
- Pain, deformity, swelling localizing to distal thigh or knee
- Evaluate skin integrity to exclude an open fracture; usually, the distal part of the proximal fragment id displaced anteriorly and threatens the skin on the anterior aspect of the distal thigh
- Tenderness to palpations in the distal thigh or knee
- Vascular evaluation: potential for injury to popliteal artery if significant displacement of the distal fragments which is displaced posteriorly posteriorly
- Full trauma evaluation if high energy mechanism; although it is not easy to perform, other knee injuries should be checked for: knee dislocation, associated proximal tibial injuries, as well as hip injuries on the same side
- Radiographs- better performed after traction:
- AP and lateral traction views can help characterize injury but are painful for patient
- In elderly patients, must evaluate for any pre-existing knee DJD
- Full length femur radiograph to exclude hip injuries (better pelvic Xray)
- Other views to rule out associated injuries
- Views of contralateral femur for pre-operative planning and templating if necessary;
Computed Tomography if an articular fracture has to be evaluated, including a coronal plane fx (Hoffa fracture) must provide frontal and sagittal reconstructions

- Magnetic Resonance Imaging- used for
- Establishing intra-articular involvement
- Identifying separate osteochondral fragments in the area of the intercondylar notch
- Identifying capsular and ligamentous injuries
- Angiography- limited indications
- Indicated when diminished distal pulses after gross alignment restored
- Consider if associated with knee dislocation

3. Treatment algorithm and alternatives:

**Orthopaedic, nonoperative** treatment

Indications (limited)
- Nondisplaced fractures
- Patients with significant comorbidities and high risk for perioperative mortality
- Imobile patients before trauma

Methods- cast followed by hinged knee brace with NWB for 6-8 weeks, depending on the fracture

Outcomes
- Secondary displacements of the fracture
- Malunion
- Complications under the cast-blisters, compressions, erosions
- High rates of pneumonia, urinary tract infections, decubiti, and DVT

**Surgical treatment** consists of reduction and stabilization. The goals of treatment in distal femoral fractures are:
- Provide anatomical reduction and absolute stability of the articular fracture
- Restore the femoral length and rotation, as well as the physiological axis of the knee referred to the other joints of the lower limb
Reduction can be:
- closed, when the fracture can be reduced by external manoeuvres or
- open, when due to interposition, the fragments must be cleaned and the
  fracture reduced by direct manipulation of the fragments

Stabilization can be performed by:
- External fixation - temporary stabilization, indicated in:
  - Open fractures
  - Unstable patients,
  - Soft tissue injuries not allowing primarily definitive fixation

Care must be taken so to avoid pin placement in area of planned plate placement if possible
- Internal fixation, using:
  - Paracortical devices, which can be:
    a. 90 degrees implants: DCS and angle blades, or
    b. Plates: conventional plates or angular stability plates, used in an open
       manner or MIPO
  - Intramedullary nails - retrograde nails

4. Dynamic condylar screw technique: Reduction of the articular surface is done by direct measures, afterwards provisional fixation with Kirschner wires is carried out. Definitive articular fixation is done by inserting lag screws (4.5 or 6.5 mm) in the periphery of the articular surface. All these procedures are done with X-ray control of each step. Distal femur epiphysis has a trapezoidal shape, it tapers from the posterior to the anterior, when a K-wire or screw is seen penetrating the far cortex on an AP-view that means that the implant is too long. It should be taken an oblique 30 medial inclination X-ray to assess the correct length of the implant.

The ideal entry point for the DCS is at 2cm proximal of the articular surface, at the junction of the anterior and medial third of the femur seen from profile, parallel to the tibio-femural articular surface and to the femur-patellar articular surface.

First is inserted a guide wire, respecting the radiological markers from above, its insertion depth is measured, afterwards with the DCS triple reamer fixed at the correct depth you ream over the guide wire. Then if the patient has a good quality of the bone it should be tapped, if it is an osteoporotic bone, this step
could be omitted. The DCS is inserted over the guide wire, at the end of the insertion the T-handle must be parallel to the long axis of the femur in order for the plate barrel to slide over the screw. The plate is connected to the DCS screw, with the impactor the plate is brought to the bone, sliding over the screw. If further compression is needed, the compression screw could be used. Another screw is inserted through the first distal hole of the plate, to assure rotational stability of the distal fragment. Afterwards the metaphyseal part of the fracture is reduced and screws are inserted in the proximal fragment. The wound is closed, drainage is applied. Post-operative treatment includes thrombo-prophylactic agents, elastic bandage, early rehabilitation procedures, starting when appropriate with passive continuous movements using special devices.

5. Indications:
- Type A and C fractures according to AO Fracture Classification, provided that the goals of the treatment can be obtained
- Irreducible fractures, needing open reduction
- Distal femoral periprosthetic fractures

Advantages:
- Definitive procedure
- The articular surface can be reduced
- Restoration of the mechanical axis
- Restoration of the femoral rotation
- Fracture stabilization allows early patient mobilization
- Can be used in cases of pulmonary associated injury
- Reduced risk of osteoarthritis

Disadvantages:
- Demanding surgical procedure
- Risk of infection
- Risk of implant related complications
- Greater blood loss

6. Contraindications:
- Patients at high risk for perioperative mortality
7. Preoperative Planning

- Evaluate local and general conditions
- Risk factors for infection and thrombo-embolic complications
- Status of the skin and soft tissue
- Bone stock
- Graft availability, if necessary
- Leg length discrepancy
- Discontinue associated (such as anti-inflammatory, antiplatelet medication according to anaesthetic recommendations)
- Prepare the implant Radiographs: traction views:
  - Traction views
  - CT scan
- Evaluate for any pre-existing knee DJD
- Measure limb length shortening
- Templating for estimated component size

8. See VIDEO for the surgical procedure

9. Early postoperative care:

- Elastic stockings or bandage during surgery on the healthy limb and on both limbs immediate after surgery for at least 4 weeks, depending on the local conditions
- Remove drain at 24 to 48 hours.
- Anti-thrombotic prophylaxis including elastic bandages, intermittent pressure compression devices, liquid intake, quit smoking and pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended
Antibiotic prophylaxis starting concomitant with anaesthesia induction; afterwards, according to local protocols and the risk factors of the patients

- Evaluate postoperative radiographs for
- Reduction of fracture
- Limb length
- Varus / valgus

Passive motions using continuous mobility devices can be started 24 hours after surgery provided that the local outcome is within normal limits

- Active movements of the operated knee can be started 24-48 hours after surgery depending on the local status
- Non-weight bearing should be indicated depending on the degree of comminution and of the involvement of the articular fractures, going up to 8-12 weeks in cases with articular comminution

10. Potential short term complications:

- Thromboembolic disease
- Prevention: anti-thrombotic prophylaxis including
  a. elastic bandages,
  b. intermittent pressure compression devices,
  c. liquid intake,
  d. quit smoking
  e. early mobilization
  f. pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended

- Treatment
- Anti-thrombotic agents
- Thrombolytic agents
- Embolectomy
- Infection
- Prevention:
  - Respect the rules of aseptic surgery
  - Meticulous wound care
• Antibiotic prophylaxis
• Treatment- depending on the moment of onset
• Antibiotic treatment
• Surgical debridement
• Removal of hardware in late chronic infections
• Bleeding
• Prevention:
  • Meticulous hemostasis
  • Discontinuation of causative medication preoperatively
  • Hemostatic agents
• Avoid invasive approaches
• Treatment
  • Whole blood / plasma / thrombocyte transfusion
  • Surgical hemostasis / Hemostatic agents
• Implant failure
• Prevention:
  • Efficient stabilization
  • Avoid bone defects
  • No full weight bearing until 6 weeks postoperative or callus formation xray.
• Prevention of falls
• Treatment of osteoporosis
• Treatment
• Closed or open reduction and surgical correction
• Correction of the malpositioned implant
  • grafting
  • Malunions
• Prevent
• Correct fracture reduction and anatomic reduction of the articular fracture
• Treatment
• Surgical correction of the incorrect reduction if functional consequences occur
• Non-unions, most commonly in metaphyseal area, with articular portion healed
• Prevent
• Correct fracture reduction and anatomic reduction of the articular fracture
• No full weight baring until 12 weeks postoperative or callus formation xray.
• Treatment
• Revision ORIF and autograft

11. Communication with patients

• Preoperative
Most of the patients are young patients with high functional demand. Presence of associated illnesses is uncommon. Before the operation the patients should be informed about the potential complications of surgery, specific complications and their treatment policies, possibility of transfusion, and use of medication. Patients should also know the implant options, and available treatment options. Elderly patients frequently have degenerative joint disease involving the knee joint, other joints and spine also. Expectations of the patient should be realistic. Postoperative pain and management modalities should be described. Patients should be informed about mobilization time, need for assistive devices, bathroom usage, possible return to regular life, and rehabilitation process.

• Postoperative
After the operation the patients should be informed about the allowed and banned positions, use of bathroom, mobilization policy, wound care, medication and duration, periodic follow-up visits, antibiotic prophylaxis for dental and other procedures.
The patient will start as soon as the general and local evolution permit, the ROM exercises, with touch-weight baring until 12 weeks.
1.4.10. Proximal Tibial fractures

1. Proximal tibial fractures are commonly classified according to Schatzker into the following types:
   I- Lateral plateau split
   II- Lateral split + depression
   III- Focal depression of articular surface, no associated split
   IV- Medial tibial plateau fracture
   V- Bicondylar tibial plateau fracture
   VI- Tibial plateau (medial, lateral/both) fracture with diaphyseal discontinuity

The most severe of all these are Schatzker type VI, 20% of all tibial plateau fractures; usually produced by a high energy mechanism with combined varus + valgus, are often accompanied by neurovascular injuries, compartment syndrome, injuries of menisci, ACL, LCL, and LCM, as well as an increased risk of post-operative local complications. Treatment goal in this type of fractures is restoration of the stability and congruity of the knee joint, by:
- Anatomical reduction of the tibial articular surface and fixation so as to obtain absolute stability
- Restoration of the normal position of articular tibial surface relative to the femoral and tibial diaphysis, that is the normal metaphyso-dyaphyseal angle
- Restoration of the medial and lateral columns (bicortical support)

Various surgical approaches and fixation techniques have been developed to treat Schatzker VI fractures, and depending on the status of the soft tissues, several methods of fixation can be used, including unilateral fixation with a single plate, dual-plate, a hybrid external fixator or a less invasive stabilizing system (LISS). All of these techniques have strengths and weaknesses and there is no clear consensus on which leads to the best outcomes.

1. Role of diagnosis:
Anamnesis reveals the direction of the traumatic force, thus providing indirect information regarding the damaged structures.
Subjective elements include:
- pain at the level of the knee,
- limited motion of the knee
- impossibility to walk on the injured leg
- neuro-vascular complications are suggested by paresthesia/ anesthesia and paralysis

Objective elements consist of:

Inspection - swollen knee, possibly with axial deformity
- Palpation reveals the site of the pain, as well as:
  1. Bone crepitation and abnormal movements, with lateral instability of the knee
  2. Presence of liquid within the knee joint
  3. Neuro-vascular evaluation must complete the examination
- Radiographs: AP and lateral view of the knee, including the distal part of the thigh and the proximal part of the shank
- Computed Tomography with 3D reconstruction is mandatory for these fractures since it reveals the main elements which establish the treatment indication:
  1. The injuries of the articular surface
  2. The extent of the fracture on the diaphysis
- Magnetic resonance imaging is to be performed when associated capsular or ligamentous injuries are suspected; these injuries must be fully evaluated so to be included in the pre-operative planning

2. Treatment algorithm and alternatives:

Orthopaedic treatment is indicated in undisplaced fractures: it consists of cast for 3-4 weeks, followed by rehabilitation, without full weight bearing for up to 3 months for articular fractures

Surgical treatment is indicated for displaced fractures, referring especially to articular fractures (more than 5 mm displacement at the level of the cartilage has to be approached surgically).
3. **Surgical treatment** consists of:
- Reduction of the articular surface- regardless of the type of the incision (lateral or medial), the articular surface has to be properly visualized. As in Schatzker YI fractures arthroscopy is not indicated due to increased risk of compartment syndrome (possible because the metaphyseal fracture line might allow the intra-articular washing fluid to penetrate into the muscles of the calf, thus increasing their volume and the intra-compartmental pressure), arthrotomy allows complete visualization of the intra-articular structures, including the menisci, the ligaments and the articular cartilage. The fragments are reduced, either by direct or indirect manipulation (including the Zanolli device) until the articular surface is restored; this is not always easy, especially when small fragments are found or when osteochondral defects are discovered.
- Preliminary fixation with Kirschner wires maintains the articular fragments in place until the screws will be placed so as to support the restored articular surface.
- Bicolumnar stabilization of the proximal tibia can be obtained by using:
  - Two conventional plates (one medial, one lateral)
  - A conventional plate on one side and an ExFix on the other side
  - An angular stability implant on one side, with the condition that complete bone contact is assured by this method, which will be further described. If metaphyseal comminution diminishes the stability, bone grafting must be considered.

4. **Indications:** angular stability plates are indicated in:
- displaced proximal tibial fractures with altered bone stock due to osteoporosis and comminution
- closed fractures or type I open fractures whenever soft tissue allow plate coverage after osteosynthesis

**Relative contraindications:**
- Soft tissue injuries with difficulties in implant coverage, such as crushing, compartment syndrome
- Coexistence of infection
- Skin pathology at the incision site
Increased risk factors for skin necrosis and infection - diabetes, smoking
Incapacity of respecting the weight bearing interdiction

5. **Preoperative Planning** refers to the fracture, to the patient and to the facility
   a. Evaluate
      - Neuro-vascular status, including the intra-compartmental pressure
      - Thrombo-embolic, bleeding and infectious risk
      - The skin-dermatitis, decubitus
      - The soft tissue status
   b. The fracture - prepare the implant according to the CT
   c. Discontinue antiplatelet medication according to the anaesthesia recommendation
   d. Radiographs: AP and lateral
   e. CT scan
   f. Plan the type, the length and the position of the plate
   g. Check the radiology facility and the radio-lucent table

6. See **VIDEO** for the surgical procedure

7. **Early postoperative care:**
   a. Evaluate postoperative radiographs for fracture reduction and position of the implants
   b. Remove drain at 24 to 48 hours.
   c. Knee splint, then starting passive movements of the knee using a continuous passive movement device, depending on the aspect of the wound
   d. Elastic stockings/bandage before, during and after surgery, depending on the aspect of the wound
   e. Anti-thrombotic prophylaxis for at least 3 weeks, until full mobilization of the patient
   f. Antibiotic prophylaxis starting concomitant with anaesthesia induction, then according to the local protocol and patient’s outcome
Depending on post-operative result, active movements can started, but with full weight bearing not earlier than 3 months, provided that the post-operative CT indicates a favorable outcome.

8. **Potential complications:**

   a. Vascular complications- compartment syndrome

      i. Prevention
         1. Avoid tighten sutures of the fascia and skin
         2. Careful timing of the tourniquet
         3. Avoid tighten bandages
         4. Elevated post-op position
         5. Anti-inflammatory and anti-thrombotic therapy

      ii. Treatment
         1. Pharmacological treatment
         2. Fasciotomy, if the disturbances persist

   b. Thromboembolic disease

      i. Prevention: anti-thrombotic prophylaxis including
         a. elastic bandages,
         b. intermittent pressure compression devices,
         c. liquid intake,
         d. quit smoking
         e. early mobilization
         f. pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended

      ii. Treatment
         1. Anti-thrombotic agents
         2. Thrombolytic agents
         3. Embolectomy
         c. Infection

      i. Prevention:
         1. Aseptic surgery- follow the rules for reducing surgical site infection
         2. Proper antibiotic prophylaxis

      ii. Treatment
1. Antibiotic treatment
2. Surgical debridement
3. Removal of hardware in late infections
d. Bleeding
i. Prevention:
1. Meticulous hemostasis
2. Discontinuation of causative medication preoperatively
3. Hemostatic agents
ii. Treatment
1. Whole blood / plasma / thrombocyte transfusion
2. Surgical hemostasis / Hemostatic agents
e. Implant failure- secondary dislocation
i. Prevention:
1. Proper reduction and stable fixation
2. Adequate rehabilitation and weight bearing protocol
ii. Treatment
1. Revision surgery
2. Knee arthroplasty if osteoarthritis occurred
f. Malunion
i. Prevention:
1. Proper reduction and stabilization
2. Adequate rehabilitation and weight bearing protocol
ii. Treatment
1. Surgical- revision surgery or knee arthroplasty
g. Post-traumatic osteoarthritis
i. Prevention:
1. Early proper reduction and stabilization
2. Adequate rehabilitation and weight bearing strategy
3. Proper Body Mass Index
ii. Treatment
1. Physio-therapy
2. Osteotomy
3. Total knee arthroplasty
9. **Communication with patients**

10. **Preoperative**

Regardless the age of the patients and their age, they should be informed about the irreversible potential damage of the articular cartilage, which is usually followed by osteoarthritis (irrespective of the surgical result) and cannot be fully assessed, since neither the imagistic nor the intra-operative aspects are completely relevant for the deep structural injuries. The potential infectious and thrombo-embolic risks, as well as those induced by the associated traumatic injuries must be discussed with the patients. Patients frequently are reluctant in accepting these risks in a young age, but their expectations should be realistic. Patients should be aware late complications are not excluded, no matter which is the immediate result of surgery, and that failure to respect the medical recommendations decrease the free interval before post-traumatic osteoarthritis occurs. Patients must be explained that this type of injury have major consequences upon their life quality, that they must adapt their lifestyle to this circumstance; adequate diet, quitting smoking and adequate rehabilitation program, as well as monitoring bone density and treating osteoporosis are mandatory for decreasing the morbidity in these situations.

**b. Postoperative**

After surgery the patients should be informed about the aspects which were detected intra-operative and which complete the image of the injury, especially about the aspect of the articular cartilage, with a major role in late post-traumatic outcome, and that of the bone quality. They should also be informed about allowed and forbidden movements, use of bathroom, rehabilitation strategy, wound care, medication and duration, periodic follow-up visits, attitude towards other medical procedures or pathologic circumstances (such as urinary or gastro-intestinal infections), progressive weight bearing and maintenance of bone stock.
1.4.11. Treatment of ankle fractures

1. Ankle fractures represent 10% of all fractures, making these the second most common lower limb fractures, after hip fractures. They are typically low-energy injuries with the majority occurring due to simple falls of sport.

Ankle fractures can be classified according to anatomy, mechanism of injury or stability. Whilst multiple classification systems have been developed, only a few are currently used, such as:

a. The Danis-Weber Classification - based on the location of the lateral malleolar fracture related to the tibio-peronier syndesmosis
   a. Type A- infra-syndesmotic
   b. Type B-intra-syndesmotic
   c. Type C- supra-syndesmotic

Based on this, the AO-OTA classification was developed based upon the location of fractures lines and degree of comminution, it describes the severity and the degree of instability associated with each particular fracture pattern

b. The Lauge-Hansen classification system is based on the mechanisms, thus being described
1. Supination - adduction that corresponds to Weber A
2. Supination - exorotation that corresponds to Weber B
3. Pronation- exorotation that corresponds to Weber C
4. Pronation – abduction, also corresponding to Weber C

The combined classification of Danis-Weber and Lauge-Hansen looks like this:

- \textit{Weber A} = \textit{Infrasyndesmotic}
  1. Avulsion of the lateral malleolus
  2. Oblique or vertical fracture of the medial malleolus (uncommon);
     can be associated with tibial plateau impaction in the medial corner
- \textit{Weber B} = \textit{Transsyndesmotic}
  1. Rupture of the anterior syndesmosis
  2. Oblique fracture of the fibula at the level of the syndesmosis
3. Rupture of the posterior syndesmosis
   or - fracture of the malleolus tertius
4. Avulsion of the medial malleolus -
   or - rupture of the deltoid ligament
   • Weber C = Suprasyndesmotic

1. Avulsion of the medial malleolus
   or - ligamentous rupture
2. Rupture of the anterior syndesmosis
3. Fibula fracture above the level of the syndesmosis
4. Avulsion of the malleolus tertius
   or - rupture of the posterior syndesmosis

As for the Pronation-Abduction mechanism, it produces:
1. Transverse fracture of the internal malleolus or deltoid ligament rupture
2. Rupture of the anterior syndesmosis
3. Transverse or short oblique fracture of the peroneum above the level of the syndesmosis (possible with an intermediate “butterfly-like” fragment; it can associate a lateral impaction of the tibial plafond, due to the impact of the talus)

2. Role of diagnosis:
Physical examination: the amount of clinical deformity reflects the degree of fracture displacement.
• In order to differentiate a fracture from an ankle sprain, a complete and thorough examination of the involved extremity is needed
• Pain, deformity, swelling (especially perimalleolar) localizing to the ankle
• Evaluate skin integrity to exclude an open fracture
• Vascular evaluation
• Check presence and quality of pulse of the posterior tibial artery. A hand-held Doppler can be useful to document arterial patency
• Check presence and quality of pulse of dorsalis pedis artery (congenitally absent in 10-15% of the population)
• Document the time for capillary refill
• Palpate for focal bony tenderness, especially along the medial and lateral malleoli and posterior aspect of the joint.
• Assess passive and active range of motion of the ankle joint, noting limitations and instability. During the immediate acute phase, most patients ankles are too tender to cooperate with stress testing of the joint.
• Examine the ipsilateral knee and foot, particularly documenting the condition of the proximal fibula and proximal fifth metatarsal
• Radiographs- performed according to Ottawa rules, on both ankles especially when doubts exist referring to the syndesmosis or joint space width
• AP and lateral views of the ankle
• External rotation stress radiograph to assess competency of deltoid ligament
• A medial clear space of >5mm with external rotation stress applied to a dorsiflexed ankle is predictive of deep deltoid disruption
• 15 degrees of internal rotation (mortise view)
• X-ray of the knee (Maisoneuve fracture)
• Other views to rule out associated injuries
• Radiographic measurements: talocrural angle measured by bisection of line through tibial anatomical axis and another line through the tips of the malleol
• shortening of lateral malleoli fractures can lead to increased talocrural angle
• Computed Tomography in complex injuries, usseful with 3D reconstruction to completely asses all fracture patterns.
• Magnetic Resonance Imaging- although not routinely performed, it is useful for
• Establishing intra-articular involvement
• Identifying separate osteochondral fragments in the area of the talus
• Identifying capsular and ligamentous injuries

3. Treatment algorithm and alternatives:

    Orthopaedic, nonoperative treatment:

Indications:
• Isolated nondisplaced medial malleolus fracture or tip avulsions
Isolated lateral malleolus fracture with <3mm displacement and no talar shift
- Posterior malleolar fracture with <25% joint involvement or <2mm step-off
- Patients with significant comorbidities and high risk for perioperative mortality

Methods - cast - type and duration depending on the fracture

Complications
- Secondary displacements of the fracture
- Malunion
- Thromboembolism
- Complications under the cast - blisters, compressions, erosions

Surgical treatment consists of open reduction and internal fixation. The goals of treatment in ankle fractures is stable anatomic reduction of talus in the ankle mortise (1mm shift of talus leads to 42% decrease in tibiotalar contact area).

Indications:
- Any talar displacement
- Displaced isolated medial malleolar fracture
- Displaced isolated lateral malleolar fracture
- Bimalleolar fracture and bimalleolar - equivalent fracture
- Posterior malleolar fracture with >25% or >2mm step-off
- Bosworth fracture-dislocations
- Open fractures

Stabilization can be performed by:
- **External fixation** - temporary stabilization, indicated in:
  - Open fractures
  - Unstable patients,
  - Soft tissue injuries not allowing primarily definitive fixation
- **Internal fixation**, using:
  - 1/3 third tubular conventional or angular stable plates.
  - Lag screws
  - Kirschner wires
  - Tension band wiring
Outcome:
- Overall success rate of 90%
- Worse outcome associated with smoking, decreased education, alcohol use, increased age, presence of medial malleolar fracture
- In Lauge-Hansen supination-adduction fractures, restoration of marginal impaction of the anteromedial tibial planfon leads to optimal functional results after surgery

4. Bimalleolar fracture ORIF technique: To start surgery, the patient is placed supine with a bolster under the ipsilateral hip to allow the foot to lie vertically. A tourniquet may be applied to reduce bleeding. A radiolucent box or platform holding the injured ankle above the level of the other side is helpful, allowing lateral fluoroscopy without the need to move the limb. The medial malleolus is addressed first through a small incision centered over the tip of the malleolus. The soft tissue is dissected and the fracture site exposed. The soft tissue interposition is addressed and the fracture ends cleaned of any remaining periosteum. Then the fracture is anatomically reduced and fixed with 4.0mm cancellous lag screws or tension band wiring.

Then the lateral malleolus is addressed through a longitudinal incision placed directly over the fibula and centered on the fracture. Blunt dissection is performed through subcutaneous fat to avoid damage to the superficial peroneal nerve. The fracture is identified and periosteum and ligamentous attachments are debrided back from the fracture clearly. The fracture itself is distracted gently to allow irrigation and curettage of clot and small bone fragments. Reduction is achieved and held by the application of a serrated „lobster claw” clamp. The reduction may be assisted with a number of manoeuvres, such as, a gentle torsion movement with the clamp, or if more force is needed, distraction and inversion of the foot and ankle will assist in regaining fibular length.

The next stage is to place a lag screw across the fracture in an orientation as close to perpendicular on the fracture as possible. The lag screw may be placed in either an AP or PA direction. A 3.5 mm gliding hole is drilled in the first cortices and a 2.5 mm pilot hole is then drilled through a cantering device, followed by a countersinking, measuring and screw placement. A one third tubular plate is selected of sufficient length to allow the placement of three screws above and below the fracture. Often a seven-hole plate is needed to avoid...
conflict with the lag screw. The plate is precontoured and then applied to the bone with three bicortical screws in the proximal diaphysis and three cancellous screws in the distal metaphysis. These distal screws are unicortical and extend to the second cortex, but not through it. Their pull-out strength can be improved by varying their orientation, typically in a triangular construct. As an alternative, the tip of the plate can be bent sharply to allow a long screw to be placed in a retrograde manner.

Stabilization of syndesmosis may be achieved by placing one or two screws between tibia & fibula to hold syndesmosis in position until syndesmotic ligament healing can occur;

- syndesmotic screw is a positioning screw that is used to hold but not compress the syndesmosis;
- it is sometimes necessary to position the screw thru the fibular plate;
- in these cases, place plate along posterolateral fibular border, inorder to facilitate entry of syndesmotic screw into tibia.

5. Indications:

- Any talar displacement
- Displaced isolated medial malleolar fracture
- Displaced isolated lateral malleolar fracture
- Bimalleolar fracture and bimalleolar - equivalent fracture
- Posterior malleolar fracture with >25% or >2mm step-off
- Bosworth fracture-dislocations
- Open fractures

Advantages:
- Definitive procedure
- The articular surface can be reduced
- Restoration of the mechanical axis
- Restoration of the talus position in the mortise
- Fracture stabilization allows early patient mobilization

Disadvantages:
- Demandig surgical procedure
- Risk of infection
• Risk of implant related complications
• Greater blood loss

6. Contraindications:
• Patients at high risk for perioperative mortality
• Polytrauma patient in unstable condition
• Severe soft-tissue problems in surgical area (pressure sores, infection, burns, etc)

7. Preoperative Planning
• Evaluate local and general conditions
• Risk factors for infection and thrombo-embolic complications
• Status of the skin and soft tissue
• Bone stock
• Discontinue associated (such as anti-inflammatory, antiplatelet medication according to anaesthetic recommendations)
• Prepare the implant Radiographs:
• CT scan
• Templating for estimated component size

8. See VIDEO for the surgical procedure

9. Early postoperative care:
• Elastic stockings or bandage during surgery on the healthy limb and on both limbs immediate after surgery for at least 4 weeks, depending on the local conditions
• Remove drain at 24 to 48 hours.
• Anti-thrombotic prophylaxis including elastic bandages, intermittent pressure compression devices, liquid intake, quit smoking and pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended
• Antibiotic prophylaxis starting concomitant with anaesthesia induction; afterwards, according to local protocole and the risk factors of the patients
• Evaluate postoperative radiographs for
• Reduction of fracture
• Varus / valgus
• Immediately after surgery the ankle should be immobilized in a neutral splint or orthosis. The lower limb must be elevated above the level of the heart in order to reduce edema. Local ice can be used.
• Active movements of the operated ankle can be started 72 hours after surgery depending on the local status
• Non-weight bearing should be indicated depending on the degree of comminution, going up to 4-6 weeks.

10. Potential short term complications:

• Thromboembolic disease
• Prevention: anti-thrombotic prophylaxis including
  a. elastic bandages,
  b. intermittent pressure compression devices,
  c. liquid intake,
  d. quit smoking
  e. early mobilization
  f. pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended
• Treatment
• Anti-thrombotic agents
• Thrombolytic agents
• Embolectomy
• Infection
• Prevention:
• Respect the rules of aseptic surgery
• Meticulous wound care
• Antibiotic prophylaxis
• Treatment- depending on the moment of onset
• Antibiotic treatment
• Surgical debridement
• Removal of hardware in late chronic infections
• Bleeding
  • Prevention:
  • Meticulous hemostasis
  • Discontinuation of causative medication preoperatively
  • Hemostatic agents
  • Avoid invasive approaches
  • Treatment
  • Whole blood / plasma / thrombocyte transfusion
  • Surgical hemostasis / Hemostatic agents
  • Implant failure
    • Prevention:
    • Efficient stabilization
    • Avoid bone defects
    • No full weight bearing until 4-6 weeks postoperative or callus formation xray.
• Prevention of falls
  • Treatment of osteoporosis
  • Treatment
  • Closed or open reduction and surgical correction
  • Correction of the malpositioned implant
  • Grafting
  • Malunions
  • Prevent
  • Correct fracture reduction
  • Treatment
  • Surgical correction of the incorrect reduction if functional consequences occur
• Post-traumatic arthritis
  • Prevent
  • Anatomic reduction of the fracture
  • No full weight baring until 4-6 weeks postoperative or callus formation xray.
• Treatment
Corrective osteotomy requires anatomic fibular and mortise correction for optimal outcomes

11. Communication with patients

- Preoperative

Most of the patients are young patients with high functional demand. Presence of associated illnesses is uncommon. Before the operation the patients should be informed about the potential complications of surgery, specific complications and their treatment policies, possibility of transfusion, and use of medication. Patients should also know the implant options, and available treatment options. Elderly patients frequently have degenerative joint disease involving other joints and spine also. Expectations of the patient should be realistic. Postoperative pain and management modalities should be described. Patients should be informed about mobilization time, need for assistive devices, bathroom usage, possible return to regular life, and rehabilitation process.

- Postoperative

After the operation the patients should be informed about the allowed and banned positions, use of bathroom, mobilization policy, wound care, medication and duration, periodic follow-up visits, antibiotic prophylaxis for dental and other procedures. The patient will start as soon as the general and local evolution permit, the ROM exercises, with touch-weight barring until 4-6 weeks.
1.4.12. Calcaneal fracture

**1. Calcaneus fractures** remain among the most challenging for the orthopaedic surgeon. Calcaneal fractures account for approximately 2% of all fractures, with displaced intra-articular fractures comprising 60% to 75% of these injuries. Calcaneal fractures are most commonly the result of a high energy motor vehicle crash or a fall from a height.

Although several classifications were described, the most comprehensive is the one established by Sanders, based on the CT evaluation:

**Type 1:** includes all intraarticular fractures that have less than 2mm of articular displacement, regardless of the number of fracture lines/fragments present.

**Type 2a:** involves one primary fracture line that courses through the lateral aspect of the posterior facet; the primary fracture usually assumes a "y" shaped configuration as it exits medially and laterally out of the calcaneal body; this fracture is often accompanied by one or more accessory fracture lines that do not involve the posterior articular facet.

**Type 2b:** involves one primary fracture line that courses through the central aspect of the posterior facet; the primary fracture usually assumes a "y" shaped configuration as it exits medially and laterally out of the calcaneal body; this fracture is often accompanied by one or more accessory fracture lines that do not involve the posterior articular facet.

**Type 2c:** involves one primary fracture line that courses through the medial aspect of the posterior facet and is accompanied by a transverse fracture through the body of the calcaneus; this fracture is often accompanied by one or more accessory fracture lines that do not involve the posterior articular facet.

**Type 3ab:** involves two primary fracture lines, one coursing through the lateral aspect of the posterior facet and the second through the central aspect; this subtype usually presents with depression of the central fragment; the two primary fracture lines may be accompanied by additional accessory fracture lines that do not involve the posterior articular facet.

**Type 3ac:** involves two primary fracture lines, one coursing through the lateral aspect of the posterior facet and the second through the medial aspect; this subtype usually presents with depression of the central fragment. The two
primary fracture lines may be accompanied by additional accessory fracture lines that do not involve the posterior articular facet.

**Type 3bc:** involves two primary fracture lines, one coursing through the central aspect of the posterior facet and the second through the medial aspect; this subtype usually presents with depression of the central fragment; the two primary fracture lines may be accompanied by additional accessory fracture lines that do not involve the posterior articular facet.

**Type 4:** involves three or more primary fracture lines with greater than 2mm of articular displacement, and are therefore severely comminuted.

### 2. Role of diagnosis:
Anamnesis suggests a calcaneal fracture when the mechanism is falling from height, followed by pain in the calcaneal region making weight bearing on that leg impossible
Physical examination can provide pathological elements especially when the fracture is displaced.
- The posterior part of the foot is swollen and painful, sometimes blisters appear early, even in undisplaced fractures, if significant bleeding from the fractured bone occurs
- Widening of the calcaneal region in displaced fractures
- Disappearance of the external submalleolar groove
- Plantar ecchymosis appear some time after trauma
- Radiographs- lateral and axial view are mandatory and usual suggestive
- Computed Tomography is mandatory in order to properly assess the morphology of the fracture

### 3. Treatment algorithm and alternatives:
**Orthopaedic, nonoperative** treatment:

**Indications:**
- Non-displaced fractures
- Severely comminuted fractures when surgery is not viable

**Methods - cast** – type and duration depending on the fracture

**Complications**
- Malunion with walking impairment
Complications under the cast-blisters, compressions, erosions

**Surgical treatment** consists of open reduction and internal fixation the goals of treatment in calcaneal fractures is to restore the articular congruency, remove the conflict between the external fragment and the external malleolus and restore the normal aspect of the plantar region

Indications:
- Displaced calcaneal fractures
- Patients with no risk factors

4. **Open reduction and osteosynthesis of the calcaneus**

The patient is placed in the lateral decubitus position; a pneumatic thigh tourniquet is used in all cases, and an Esmarch elastic bandage can be used to empty the blood from the limb and provide a dry operative field. All patients should receive preoperative prophylactic antibiotics prior to surgery, and an additional dose of antibiotics can be administrated following deflation of the tourniquet.

The incision which creates less necrotic complications is a curved one, starting approximately 2 cm above the tip of the lateral malleolus, just lateral to the Achilles tendon, continuing vertically toward the plantar surface of the heel, and curves anteriorly “surrounding “the tip of the external malleolus, aiming anteriorly ideally centering over the middle of the calcaneocuboid joint, or carried straight to the base of the fifth metatarsal. It is recommended to create a flap that contains skin and the subcutaneous layer in order to avoid skin necrosis. Once the flap is raised, the peroneal tendons are dissected of the peroneal tubercle and then freed from the anterior calcaneus. They are slightly subluxated anterior of the lateral malleolus.

When considered useful, the calcaneal tuberosity is predrilled, and a short Schantz pin is placed from lateral to medial. Using the Schantz pin, the tuberosity is pulled plant ward and distracted into varus. The lateral fragment is elevated in one piece, then the articular surface is evaluated. A small elevator is used to get underneath the fragment, and the fragments are disimpacted gradually. Then the posterior tuberosity is disimpacted from the sustentaculum, which restores the height and length of the calcaneus.
The articular fragments should be repositioned such that height, rotation and varus-valgus alignment are correct. After reduction the surgeon should obtain intraoperative lateral, Broden and axial fluoroscopic views.

The lateral wall remnant is placed back and an appropriately sized, low profile lateral plate is selected and positioned. The plate position is verified on a lateral fluoroscopic view and the secured with cancellous 4.0 mm screws. The antero-superior screw hole is filled first, followed by the posterior-superior and posterior-inferior screw holes over the posterior tuberosity. The anterior process, the posterior tuberosity and the posterior facet articular surface are secured to the plate with two screws placed into each component. The final reduction is verified fluoroscopically.

5. **Indications:**

- Displaced calcaneus fracture with articular step of over 2 mm
- Patients with no risk factors
- Fractures which allow reconstruction of the calcaneus

- **Advantages:**
  - The articular surface can be reduced
  - Restoration of the mechanical axis
  - Restoration of the plantar anatomy and prevention of post-traumatic flat-foot
  - Fracture stabilization allows early patient mobilization

- **Disadvantages:**
  - Demandig surgical procedure
  - Risk of skin necrosis and infection

6. **Relative contraindications:**

- Heavy smokers
- Diabetes (especially associated with neuropathy and arteriopathy)
- Uncompliant patients
- Skin diseases
- Severe soft-tissue problems in surgical area
7. Preoperative Planning

- Evaluate local and general conditions
- Risk factors for infection and skin necrosis
- Status of the skin and soft tissue
- Bone stock
- Dimension of the fragments
- Discontinue associated (such as anti-inflammatory, antiplatelet medication according to anaesthetic recommendations)
- Prepare the implant
- Radiographs:
  - CT scan

8. See VIDEO for the surgical procedure

9. Early postoperative care:

- Immediately after surgery the ankle should be immobilized in a neutral splint or orthosis. The lower limb must be elevated above the level of the heart in order to reduce edema. Local ice can be used.
- Elastic stockings or bandage during surgery on the healthy limb and on both limbs immediate after surgery for at least 4 weeks, depending on the local conditions
- Remove drain at 24 to 48 hours.
- Anti-thrombotic prophylaxis including elastic bandages, intermittent pressure compression devices, liquid intake, quit smoking and pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended
- Antibiotic prophylaxis starting concomitant with anaesthesia induction; afterwards, according to local protocol and the risk factors of the patients
- Evaluate postoperative radiographs for fracture reduction and implant positioning
- Active movements of the operated ankle can be started 72 hours after surgery depending on the local status
- Non-weight bearing should be indicated depending on the degree of comminution, going up to 4-8 weeks.
10. Potential complications:

- Skin necrosis
  - Prevention:
  - Avoid straight angles of the approach
  - Avoid plan-to-plan dissection
  - Avoid tractions
  - Improve the local vascular conditions
  - Treatment- needs cooperation with plastic surgeons

- Infection
  - Prevention:
  - Respect the rules of aseptic surgery
  - Meticulous wound care
  - Antibiotic prophylaxis
  - Treatment- depending on the moment of onset
  - Antibiotic treatment
  - Surgical debridement
  - Implant removal
  - Thromboembolic disease
  - Prevention: anti-thrombotic prophylaxis including
    - a. elastic bandages,
    - b. intermittent pressure compression devices,
    - c. liquid intake,
    - d. quit smoking
    - e. early mobilization
    - f. pharmacological prophylaxis for at least 3 weeks, up to the moment when the thrombo-embolic risk factors have been amended
  - Treatment
  - Anti-thrombotic agents
  - Thrombolytic agents
  - Embolectomy
  - Malunions
  - Prevent
Correct fracture reduction
Treatment
Surgical correction of the incorrect reduction if functional consequences occur
Post-traumatic arthritis
Prevent
Anatomic reduction of the fracture
Adequate full-weight bearing
Treatment
Corrective osteotomy
Arthrodesis

11. Communication with patients

Preoperative
Most of the patients are young patients with high functional demand. Presence of associated illnesses is uncommon. Before the operation the patients should be informed about the potential complications of surgery, specific complications and their treatment policies. Expectations of the patient should be realistic. Patients should be informed about the proper life style- avoid obesity, quit smoking, avoid prolonged standing, wear elastic stockings, etc.

Postoperative

After the operation the patients should be informed about other aspects, such as the quality of the bone, the quality of the fixation and thus the rehabilitation program should be structured based on each patient’s characteristics. The importance of avoiding negative circumstances should be emphasized, as the onset of complications has a disastrous impact upon the patient’s quality of life.
Usefull links

- Management of hip fracture in older people
  [http://www.sign.ac.uk/pdf/sign111.pdf](http://www.sign.ac.uk/pdf/sign111.pdf)
  American Academy of Orthopaedic Surgeons - Guideliness


- Treatment of Osteoarthritis (OA) of the Knee - Guidelines