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Paper review

Complications in Primary Total Hip Arthroplasty

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ABSTRACT: Primary total hip arthroplasty is a surgery during which an orthopedic specialist removes damaged parts of hip and replaces them with parts usually built from metal, ceramics and very hard plastic. Modern technology, materials of good quality and an advanced operative technique enable quick postoperative recovery and total disappearance of pain that was present before the operation. Despite all preoperative and postoperative measures applied, some complications may occur, these include: infections, luxations, periprosthetic fractures, implant allergy, psoas impingement, deep vein thrombosis, neurological complications, allergy to metal implants as well as fatal outcome.

Keywords: complications, hip arthroplasty.

INTRODUCTION

Complications in primary total hip arthroplasty are the following:

- Infections
- Luxations
- Periprosthetic fractures
- Implant allergy
- Psoas impingement
- Deep vein thrombosis
- Neurological complications
- Allergy to metal implants
- Fatal outcome

INFECTIONS

Perioperative infections are among the most common compications in orthopedic surgery, complications that cause the greatset fear as far as the outcome of treatment is concerned. They are currently the leading cause of failiure of primary and revision hip and knee arthroplasties (Bozic et al., 2010). Periprosthetic infection is a catastrophic event for patient and a frustrating problem for surgeon. Unlike dislocation which is an instant problem and requests a quick solution, an infection is a long lasting, exhausting problem that causes prolonged stress reaction in patient and surgeon.

The beginning of this century and milenium was marked with a "biological big bang" in arthroplasty. A change in paradigm came about. The majority of great problems of mankind are biological, hence the solutions will be biological. What physics was in the 20th century, biology will be and already is in the 21st century. While the major problem of the 20th century in arthroplasty was tribology, in the 21st century it is biology. Periprosthetic infections are a typical example of biological problem that requires biological intervention. These infections are diagnostic, therapeutical and economical problem. They are biofilm infections and represent one of the most complex problems in the context of implants. It has been argued in more recent publications that these infections are third by frequency of complications after total hip arthroplasty, percentage wise 0.3-2.2 %. With increase in the number of hip arthroplasties, an increase in number of these infections is expected as well. Also, increase in percentage from 1.4 to 6.5 % is predicted (Usbeck & Scheuber, 2014).

Presence of foreign material increases pathogenicity of bacteria. Infections associated with implant develop in the presence of a small number of bacteria (e.g. 100 S.aures bacteria). The most common causes of these infections are coagulase-negative staphylococci (30-43 %), *Staphylococcus aureus* (12-23 %), mixed flora (10-11 %), streptococci (9-10 %), Gram-negative bacteria (3-6 %), enterococci (3-7 %) and anaerobes (2-4 %). High degree of microbial diversity requires microbiological identification, and an empirical therapy without it must be avoided (Ochsner et al., 2014).

Periprosthetic infection classification:

- Early infections (0-3 months). These infections are mostly caused by a very virulent pathogen such as S.aureus.
- Postponed infections (3-24 months). These infections mostly occur intraoperativly and include poorly virulent pathogens such as coagulase-negative staphylococci.
- Late infections (from 24 months). These infections almost always occur via hematogeneous route, most often as a result of skin infection (*Staphylococcus aureus*), respiratory tract infection (*Pneumococci*), intestinal infection (*Salmonella spp*.) and urinary tract infection (*Escherichia coli*).

An implant can be infected in three ways:

- Intreoperatively, via direct colonization of foreign material from air or from skin.
- Via hematogenous or lymphogenous transmission of pathogenous organisms from various infection foci (urinary tract, skin, lungs and other).
- Colonization can be the result of contact with neighbouring sites of infection (osteomyelitis, diabetic uleceration, hematoma and other).

Biofilm is an efficient strategy of microorganisms to improve their survival under harsh conditions such as nutrient deficiency. It is the result of adaptation of microorganisms to their soroundings. More than 80% of microorganisms in nature exist as biofilm. With the growing use of implants, medical profession is beeing confronted with these microorganisms that increasingly gain resistance to antibiotics.

Bacteria can exist in two forms:

- Planctonic form, metabolicaly active, with rapid replication.
- Biofilm-form, less metabolicaly active, in stationary growth phase.

Due to slow replication, bacteria in biofilms are up to a thousand times more resistant to antibiotics. A biofilm consists of 25-30 % bacteria and 70-75 % polymerized polysaccharide amorphous matrix (Ochsner et al., 2014).

A biofilm gradually develops into a complex three dimensional structure with channels (primitive circulation) and chemical communication via molecular messengers. Recent controversy is on whether this is a case of multiple microorganisms joined together or one large complex organism. Biofilm development implies the following phases:

- Adhesion,
- Proliferation,
- Maturation and
- Dispersion.

The first step in develoment of this infection is adhesion of microorganisms onto foreign body i.e.

the implant. This occurs due to physical and chemical machanisms that act during the colonization. Floating planktonic bacteria get destroyed by antibodies and antibiotics, whereas adherent bacteria protected by the extracellular matrix survive. The surounding macrophages and granulocytes degranulate and lose their phagocytic function.

Atypical variants of microorganisms so called "small colony variants" can develop in close proximity to the implant. This subpopulation of staphilococci or other bacteria (*Pseudomonas*, *Escherichia coli*) have even slower degree of replication and growth, atypical morphology, and reduced metabolism. The phenotype is associated with even higher ability of biofilm formation which enables persistent infection. They are also resistant to antibiotics and therfore called "difficult-to-treat" bacteria.

Preoperative malnutrition is recognized as an independent risk factor for this infection. Besides, these patients recieve more transfusions and as such, they are at a higher risk of an infection.

An increased risk of hip implant polimicrobial infection after front mini-invasive aproach has been confirmed by research. Lateral approach which is further away from the groin is more recomended, especially in obese patients.

Clinical symptoms and diagnostic procedure

Acute pain, redness in wound area, swelling, warmth, increased temperature are classic signs which could indicate development of reinfection. Secondary secretion from wound, hematoma, increased inflammation parameters (secondary increased CRP) must be recognized in time. If an active surgical intervention is late by 3 weeks, a fistula usually forms and the infection can then be treated only by explantation of implant.

Signs of a postponed infection are fistulae, abscesses, nonspecific symptoms such as permanent postoperative pain and subfebrile. Symptoms of a late infection are often similar to those of an early infection. The greatest risk of a hematogenous periprosthetic infection is septicemia associated with S.aureus. Unfortunately, no single laboratory test (CRP, ESR, LE, procalcitonin, interleukin-6 or others) can confirm nor rule out a periprosthetic infection with certainty. Arthrocentesis is the key type of analysis. A good level of sensitivity and specificity is present in leukocyte counting from synovial fluid and in determining granulocyte percentage. Sensitivity of a culture to antibiogram is variable, especially if antibiotics had already been given.

Sonication method has the greatest sensitivity, especially if performed prior to antibiotic therapy.

X-ray imaging can show osteolysis around implant along with bone remodeling which are often also associated with aseptic processes. This diminishes the specificity of radiological signs. However, a classic X-ray image shows well the bone structure, whereas changes can be detected by comparison with earlier X-ray images. In an X-ray image there are no metal artifacts. The primary weakness of X-ray imaging is poor insight into soft tissues, fistulae and abscesses.

CT imaging also has its advantages:

- Short imaging period
- Good bone structure display
- The best sequester display
- Multiplanar reconstruction
- Absence of claustrophobia (compared to MRI)

And disadvantages:

- Relatively poor display of soft tissues
- Metal artifacts

- Radiation

Magnetic resonance imaging (MRI) can not be applied on patients with ferromagnetic implants. MRI can show changes in soft tissues better than X-ray and CT imaging. It is also better for visualization of anatomic details compared to scintigraphy. MRI shows acute inflamation, abscesses and fistulae with high sensitivity and specificity. On the other hand, specificity of the MRI is diminshed in case of a chronic infection and there is no differentiation between a chronic infection and a reparative scar.

Ultrasound examinations can be used in locating joint effusions or as a control during puncture and drainage of a joint.

Scintigraphy provides functional diagnosis of bone metabolism. Concentrations of radioactive substances necessary in scintography are significantly lower in comparison to contrast MRI and CT diagnostics. This group also includes PET/CT imaging.

Collection of microbiological samples requires a prior two week suspension of antibiotic therapy.

Histological testing and examination of explanted foreign bodies (sonication) are also significant diagnostic procedures in connection with periprosthetic infections.

Treatment algorithm

The primary aim of periprosthetic infection treatment is elimination of infection and correct implant functioning.

Five different types of intervention are possible in treatment of periprosthetic infections:

- Surgical debridement with retention of implant,
- "One-stage" revision,
- "Two-stage" revision with use of a spacer,
- Explantation of implat without reimplatation ("hanging hip"),
- Suppressive long-term antibiotic therapy without surgical intervention.

Antibiotic therapy

Prior to introduction of antibiotic therapy, it is necessary to verify bacteria and its degree of resistance. Antibiotic therapy is defined well and clear for the case of perioprosthetic infection by staphilococcus. Rifampicin should be given in combination with quinolones (ciprofoxacin, levofloxacin). An oral therapy with penicilins and cephalosporins is not recomended, neither is a monotherapy with rifampicin nor with quinolones against staphilococci (Ochsner et al., 2014).

Prevention of perioperative infections

Prevention of perioperative infections can be preoperative, intraoperative and postoperative.

<u>Preoperative prevention:</u>

- If patient has either systematic or local bacterial infection, then it must be treated and the elective surgery postponed.
- If patient has diabetes, the blood glucose level must be under optimal control.
- The risk of infection is increased in patients who smoke.
- Washing with antiseptics before operation lowers density of microorganism colonies on the skin of patient. Research, however has not succeeded to confirm significant reduction in the rate of infection. Therefore, duration and the way of decolonization are not yet based on evidence.
- Before first operation, surgical team should wash hands such that no visible uncleanness is present.
- Surgical team must disinfect hands by an accepted routine procedure. The procedure must be

fixed without changes. Artificial nails are not allowed.

- Hands are disinfected before every next operation.
- Patient's skin in surgical field area must be washed, then manually cleaned.
- Shaving of surgical field is done right before the operation if possible.
- All staff in operating theatre must be vaccinated against hepatitis B.
- Staff must be reporting about eventual transmissible diseases.
- Preoperative stay in hospital should be as short as possible.

Intraoperative:

- Patient must be well oxygenated and must not be hypothermic.
- Doors on operating theatre must be closed, or their opening should be as rare as possible.
- Surgical masks, coats and gloves still have an irreplaceable role in infection prevention, and advancements in their making are necessary and possible.
- Surgeon needs to change gloves prior to insertion of definitive impalnt even though there is no strong evidence for this recomendation.
- Surgeon can lower the risk of infection if there is maximum respect for patient, respect towards tissue, atraumatic technique, meticulous hemostasis, ability to estimate which tissue should be saved and which should be removed.
- Drains are let out through special incisions distant from operative wound. The use of closed drainage systems is compulsory. A recent practice that does not include the use of drains has been emerging whose advocates refer to quicker recovery, lower rates of infection and lesser need for transfusion. However, there is still the problem of hematoma as the base for an infection that needs to be solved.
- Only necessary staff should be in theatre during operation. "OR traffic" or motion in the theatre should be regulated without unnecessary repeats, crossings or colisions. From operator to assisting worker, everyone should be doing a strightly defined task like at a formula 1 "pit-stop". In this way preparation for operation, surgery and transport of patient from theatre will be maximally quick and effective. The old surgical saying goes: "a good surgeon operates slowly and finishes quickly". Similar meanings have language constructions "proficient surgeon" and "High Volume Surgeon".

Postoperative:

- Application of compression bandages lowers the risk of deep vein thrombosis, hematoma and infection.
- Wound dressing change is done 24h after operation by disinfected hands or wearing gloves.
- Drain is taken out as early as possible.
- Education of patient about wound care and recognizing signs of infection is necessary.

LUXATIONS

A hip endoprosthesis luxation appears in 1-3 % of primary and in up to 20 % of revision and tumorous hip endoprostheses. The risk factors are patient and surgeon (Factor patient: sex, age, diagnosis, obesity (BMI) and Factor surgeon: experience, institution, approach, implant).

Characteristics of the implant relevant to luxation are: type, components position, head size, head-neck relation, neck geometry, offset, length, fixation, design. The landmark for the version of cup is the transverse acetabular ligament. In majority of cases, it is preserved and available during operation. In the course of operation, it is necessary to perform tests on stability of prosthesis. It is impossible for a prosthesis to be stable after operation if it was unstable on operating table. It is required to determine direction of dislocation, which is sometimes difficult without "opening".

Etiology of dislocation:

- Malposition
- Abductor insufficiency
- Soft tissue or bone impingement
- Undefined

Dislocation treatment can be nonoperative or operative. It is difficult to determine the borderline of when to give up with nonoperative and to indicate operative treatment. An operative treatment is reserved for non-readjustable, luxation prone and multiple luxated prostheses.

Luxation of total hip endoprosthesis is the most common reason for operation after primary arthroplasty. Preoperative planing and preparation are required for operation success. It is necessary to identify and understand the problem before the actual operation. A smaller mistake in the version of acetabular component can be corrected with change from a standard to an asymmetric insert. As far as the inclination of cup is concerned, it must not be less than 30 degrees. Soft tissue and bone impingement must be solved by additional debridement of soft tissue and bone resection on the edges of acetabulum. Based on results of numeorus studies, optimal position of acetabular component is 45 degrees inclination and 20 degrees anteversion.

Correct implant position is the best dislocation prevention after operation, which is the most common early complication after total hip arthroplasty. It is a huge problem for patient and surgeon. The patient is dissatisfied, clinical results are worse, and additional treatment costs are significantly higher. A large number of dislocations require repositioning in general anasthesia or even reoperation.

The main cause of dislocation is malposition of implant components, whereby malposition of acetabular component is by far more frequent cause of dislocation in comparison to femoral component.

Picture 1. X-ray images of luxated total endoprostheses

Correct orientation of acetabular component is also of crucial importance for the range of motion after surgery. This finding is clinically significant since many surgeons strive to reduce inclination of acetabular cup in hope of increasing stability. Reduction in angle of inclination below 30 degrees causes impingement with flexion which leads to subluxation or dislocation even when the cup is adequately anteverted. Mistakes that occur during placement of acetabular component can not be compensated with correction of anteversion of femoral component.

Correct position of implant extends the lifetime of implant. If the position is incorrect, this increases pressure on additionally strained zones of acetabulum which causes friction and wear on the polyethylene cup. Irregular kinematics and irregular arrangement of active forces leads to faster wearing of implat and bone tissue in additionally strained places.

One of the future aims is to produce such an implant that will preserve kinematics aligned with other kinematic chains in organism and significantly improve life quality of patient.

PERIPROSTHETIC FRACTURES

Periprosthetic fractures are a complication that can significantly compromise the result of operation. If they occur during operation, this changes the plan of operation and extends its duration. If they occur after operation, the plan of rehabilitation gets changed, its duration prolonged, and most often a new operation is necessary.

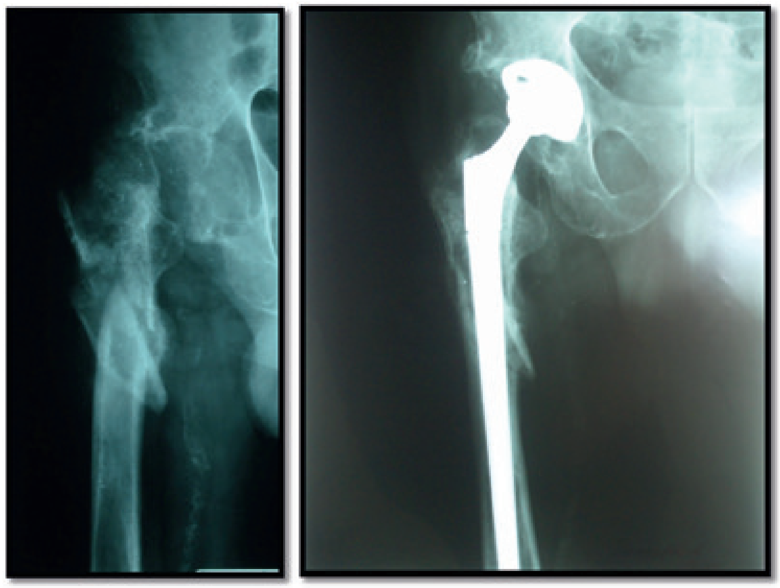
Diagnosis of this type of fracture is sometimes quite difficult and oversights are also common. In that case, a look at postoperative X-ray image causes big surprise and frustration in surgeons. Therfore, it is important to conside the possibility of occurance of this complication. This way, the surgeon can "see" it before it "sees" him. The risks for occurance of periprosthetic fractures are: cementless fixation, minimally invasive surgery, female sex.

It is necessary to estimate fracture and implant stability, then determine the way of treatment and the type of operation accordingly. The options for operative treatment are revision arthroplasty and/or open reposition and internal fixation. Decision about the type of revision surgery is influenced by: fracture localization, stem stability, bone mass quality and patient's general condition.

Modular revision stem implies distal cementless fixation and modularity of endoprosthesis' neck. Monolithic cylindrical stems, "megaprostheses" and Wagner stem (often applied in Europe) have higher risk from stress shielding and descending.

Picture 2. Modular cementless revision stem (Source:Internet)

Iatrogenic fractures occur due to inadequate approach and operational technique, stem malposition, cortical osteolysis or damage to calcar and lesser trochanter. Postoperative fractures occur mainly as a consequence of falls and other types of accidents. Postoperative periprosthetic fractures of femur occur in less than 1 % of primary hip arthroplasties and in between 1.5 % and 18 % of revision hip arthroplasties (Wendy et al., 2017).



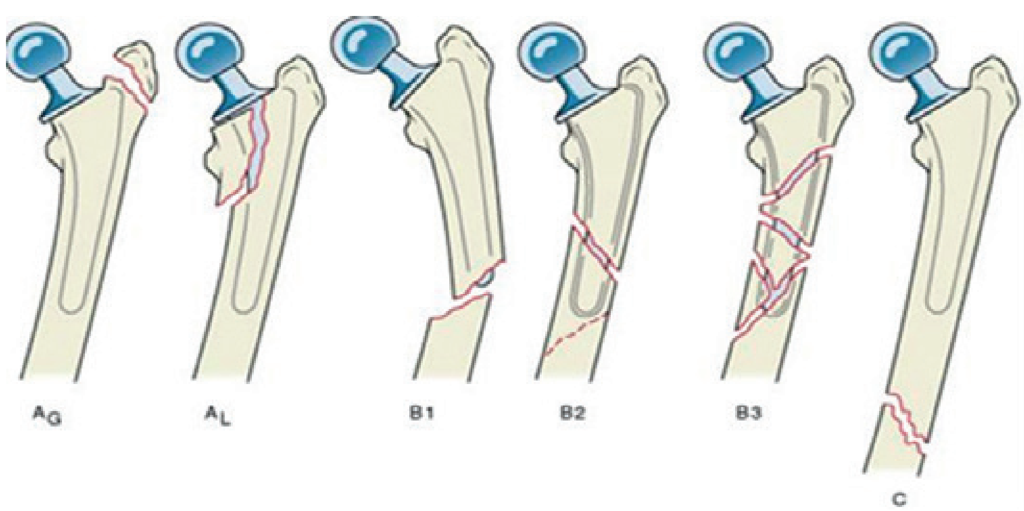
Picture 3. Preoperative and postoperative images of a periprosthetic fracture B3 type treated in two acts due to infection (Source: author's personal archive)

There are algorithms in treatment of these fractures, however it is sometimes required to make changes to these due to the individual parameters. It is necessary to know and to have a wide palette of tools and techniques available to solve every individual periprosthetic fracture.

Types:

- Simple and complicated
- Intraoperative and postoperative
- Cement and cementless
- Perforations, longitudinal and dislocated

In classification of these fractures, the most commonly used is Vancouver classification. It defines place of fracture, stem fixation quality and bone quality.



Picture 4. Vancouver classification of periprosthetic fractures – Scheme (Source:Internet)

Type A: Fracture at trochanter level; Type B1: Fracture around stem or directly below with good stem fixation; Type B2: Fracture around stem or directly below, stem loosening, with proximal bone kept in good condition; Type B3: Fracture around stem or directly below with poor quality proximal bone, multiple proximal fractures; Type C: Fracture below the prosthesis (stem) level.

The goal of surgical tretament is to provide:

- Fracture stability
- Implant stability

IMPLANT ALLERGY

Materials for osteosynthesis and artificial joint replacements – especially artificial hip and knee joints – are installed in more than 300 000 cases annually in Germany alone. In case of complications, mechanical causes and infections are mainly suspected on.

Prevalence of allergy symptoms due to metal implants is less than 0.1 %. Skin reaction to metals is frequent, however rections of deep tissues to metals are rare. Association between skin hypersensitivity and clinicaly relevant reactions from deep tissues is not clear. There is still lack of reliable epidemiological data about hypersensitivity to orthopedic implants. In Germany, there is a register for hypersensitivity to implants where information on patient characteristics and long term results after revision operation are stored.

Corrosion and abrasive particles lead to release of metal. In that context nickel, chromium, and cobalt as well as occasionally components of bone cement are described to cause allergy to implants (type IV allergic reactions). Increased rates of allergies to metal (nickel, chromium and/or cobalt) were recorded in hip arthroplasty patients of old generation (1975 – 1990) in metal-metal arthroplasty (e.g. McKee-Farrar) or in metal-to-plastic arthroplasty (Charnley). A study published in 2005, was comparing patients of hip arthroplasty (ceramic, metal to plastic, metal to metal), of whom 53 had stable and 104 loosened hip replacements. The study showed that allergies to metal or bone cement were not directly associated with implant failure, but with worse ten-year survival rate of implant, (41.3 % compared to 50.5 %).

PSOAS IMPINGEMENT

Incidence of psoas impingement after total hip arthroplasty (THA) is even 4.3 %. Although psoas muscle can be irritated by bolts for acetabular fixation that penetrated through iliac bone, the most common place of iliopsoas impingement is located on the front rim of acetabulum. This could be caused by squeezing out of cement and / or by acetabular component sticking out, or by armature ring that is either too large for native acetabulum or is in reversed or side position. Irritation of psoas after THA can also be caused by reasons other than impingement with movement, such as increased motion or significant leg lengthening.

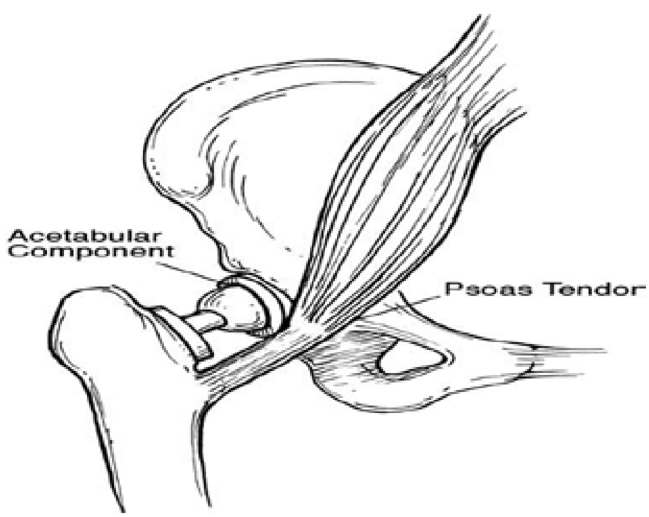
Iliopsoas impingement diagnosis should be considered in patients that report pain in the groin during activities that require active hip bending, such as walking up or down a flight of steps and leg lifting while getting in and out of car. A physical examination with careful attention to signs of psoas irritation, and visualisation of acetabular component prominence over the front aspect of rim visible from side view or from CT scans is often enough to confirm diagnosis.

Acetabular component characteristics associated with psoas impingement after THA:

- An oversized acetabular component – Researchers have identified that in comparison with asymptomatic patients, those with iliopsoas impingement after total hip arthroplasty have significantly higher difference in native femoral head diameter relative to implanted acetabular component. They discovered a 26 times higher probability of groin pain linked to iliopsoas impingement with acetabulum in patients with > 6 mm size difference of head to acetabular component.
- Acetabulum angle of inclination – It has been reported that inclination of acetabulum in coronal plane spans between 35 and 50 degrees normal, although Odri and co-workers reported 40-50 degrees as optimal range. Their research showed significantly lower inclinations of acetabula in patients with psaos impingement after total hip arthroplasty, compared to control group without

pain. The medium angle of inclination at the lowest end of normal range was - 40 ° (20-56 ° range) in those with impacted iliopsoas, in comparison with 46 ° (20-75 ° range) in those without pain. Excessive inclination of acetabulum towards down will result in greater overhang of acetabulum relative to native acetabulum, and greater pressure on iliopsoas above.

- Acetabulum retroversion – Acetabular version measured in axial plane by CT is usually greater than 0 ° and less than 25 ° anteversion, i.e. acetabular component is usually turned ralatively more forward, just as an average native acetabulum. Acetabular component that is in retroversion (turned backward) usually results in overhanging of acetabular component towards front, predisposing psoas impingement in relation to acetabular component. Natural amount of version of native acetabulum is relevant, since Park and co-workers discovered that larger difference in anteversion between native acetabulum and acetabular component will result in greater volume of iliopsoas being exposed to acetabular component.
- Depth of psoas valley – Psoas valley or notch is a dent in the upper part of acetabular rim, between iliopectineal eminence and SIAI. Iliopsaos passes from the pelvic cavity through this dent or velley over the head of thigh bone, then to its place of insertion on lesser trochanter. This means that a certain degree of incosistency between native and prosthetic acetabulum will occur naturally since prosthetic acetabulum is completely round, while native acetabulum has a dent at the front. This can result in relative uncovering of acetabular component at the front if psoas valley is naturally deep and if it is not taken into cosideration during acetabular component placement. Kuroda and co-workers have warned about the essential importance of preoperative and intraoperative esimation of psoas valley for avoiding prominence of the front area of acetabulum relative to native acetabulum and subsequent iliopsoas impingement after total hip arthroplasty. (Picture 5.).



Picture 5. Iliopsoas and acetabular component relation. Accessible at: https://www.arthroplastyjournal.org/article/S0883-5403(02)00229-2/fulltext

DEEP VEIN THROMBOSIS (DVT)

Deep vein thrombosis (DVT) occurs with formation of a blood clot in one of the deep veins inside body. It can happen if the vein becomes damaged or if the blood flow inside slows down or stops. Although, there is a number of risk factors for progress of DVT, two most common are lower body part trauma and operations which include hips or legs. DVT can have serious consequences. If blood clot gets released, it could travel with blood stream and block the blood flow to lungs. Although it is rare, this complication known as pulmonary embolism could be fatal. Even if the blood clot does not get released, it could lead to permanent damage of vein valves. These damages can lead to longlasting leg problems, such as pain, swellings and ulcers on legs. In many cases, DVT occurs without apparent symptoms and is very hard to discover. Consequently, medical practitioners focus on preventing development of DVT by applying various types of therapy, depending on the needs of patient.

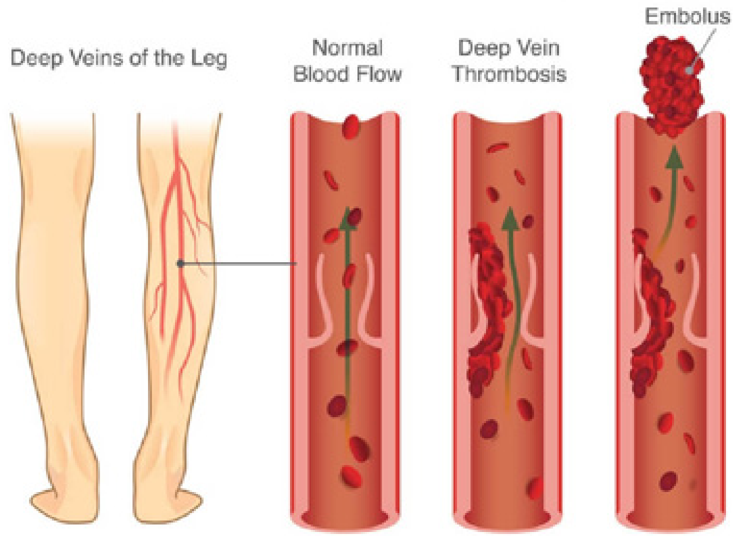
Three primaty factors contribute towards development of blood clots in veins (Virchow triad): slowed down blood flow, hypercoagulability and vein damage.

- Slowed down blood flow (stasis) – Walls of veins are smooth. This helps in free blood flow and mixing with natural agents (anticoagulants) in blood which prevent blood clotting. Blood that does not flow freely and mix with anticoagulants has higher probability for blood clot formation. Therefore, it is important to watch out for signs of DVT in people who are resting in bed, immobilized in splint or plaster cast, or unable to move for longer periods of time.
- Hypercoagulability – Blood clots or coagulates around matters that do not belong to veins. Matters like tissue debris, collagen or fat can get released into blood system and cause blood coagulation during operation. Besides that, bone preparation for accepting prosthesis during total hip replacement can incite the body to release chemical matters called antigens into the blood system. These antiganes can also encourage clot development.
- Damage to the walls of veins – Medical practitioner has to relocate or pull soft tissues, muscles or tendons during surgery to be able to approach the area to be operated on. This can in some cases release natural substances that encourage blood clotting.

Without prophylaxis, DVT occurs in 80 % of cases after THA and in 10 - 20 % of cases, occurence of PE is present. With prevention, only just 0.4 % of cases exhibit occurance of DVT with primary THA and 0.7 % of cases with revision surgery, while PE occurs in 0.3 % of cases with primary THA and in 0.4% of cases with revision THA.

Although DVT can occur in any deep vein, it most often occurs in pelvic, upper leg and lower leg veins. A number of factors can affect the blood flow in deep veins and increse the risk of occurence of blood clots. This includes:

- older age, pregnancy, obesity,
- personal or family anamnesis of DVT or pulmonary embolism, inherited coagulopathy,
- cancers,
- vein disease, such as varicose veins,
- smoking and
- use of contreceptive pills or hormone therapy.



Picture 6. Illustration of DVT. Accessible at: https://www.sonashomehealth.com/what-is-deep-vein-thrombosis/

Syptoms of DVT occur in leg affected by blood clot and include:

- Swelling,
- Pain and sensitivity,
- Distended veins,
- Red or discolored skin and
- Hard or thickened veins.

However, many patients have no symptoms at all. In some cases pulmonary embolism can be the first sighn of DVT. Symptoms of pulmonary embolism include:

- Shorthness of breath,
- Sudden chest pain,
- Coughing and
- Expectorating or vomiting blood.

Most often applied guidelines for DVT prophylaxis after arthroplasty are guidelines of American College of Chest Physicians (ACCP) (2012) and American Academy of Orthopaedic Surgeons (AAOS) (2011). ACCP recommends the undertake of pharmacological prophylaxis in THA and TKA, with 1B degree recommendation for low molecular heparins, fondaparinux, dabigatran, apixaban, rivaroxaban, unfractionated heparin, vitamin K antagonists and aspirin, minimum 10-14 days and up to 35 days. They recommend use of low molecular weight heparin relative to other agents (2C/2B degree recomendation). AAOS recomends use of pharmacological agents for prophylaxis in THA and TKA for as long as patients have no increased risk of bleeding, however they do not recommend any particular agents. The bottom line is that orthopaedic surgeons have to find a balance between increased risks for unwanted events that more powerful farmacological agents impose, and risk factors for DVT in each patient. One of the criticisms of current guidelines is towards their inability to give recommendations at the individual patient level. Globally, adherence of suplliers to guidelines is relatively poor, but it is an improvement; it has been recomended that adherence perhaps could be improved further if the guidelines become able to provide advice at the individual patient level.

NEUROLOGICAL COMPLICATIONS

Reported incidence runs from 0.08 % to 7.6 %. The incidence in primary THA runs from 0.09 % to 3.7 % and in revision THA from 0 % to 7.6 %. Reported etiologies include intraoperative injury to the nerve directly, significant leg lengthening, improper retractor placement, extravasation of cement, thermal damage associated with cement, positioning of patient, manipulation and postoperative hematoma.

The total frequency of nerve injury after THA is estimated to be around 1 %. Pareses of sciatic nerve make up 79 % of all cases, followed by pareses of femoral nerve (13 %), combined paresis of femoral and sciatic nerve (5.8 %) and paralysis of obturator nerve (1.6 %). In most cases (47 %), etiology is unknown. Other causes include pulling (20 %), contusion (19 %), hematoma (11 %) and dislocation (2 %), along with laceration which makes up only 1 % of all nerve pareses. Risk factors for nerve injury include female sex, revision surgery and developmental dysplasia of acetabulum.

When the sciatic nerve is affected, it most often includes common peroneal component. It is considered to be due to smaller amount of connective tissue present between the nerve and its relatively bound position in comparison to tibial branch. It is considered that these factors make peroneal branch more susceptible to trauma and pulling. Application of the rear access is traditionally associated with increased risk of sciatic nerve damage. However, Cochrane's examination from 2006, did not establish a difference in frequency of nerve paralysis between rear and direct side approach. Paralysis of femoral nerve is rarer and often secondary in relation to direct compression, usually as a result of incorrectly placed retractor.

Indications for surgical intervention in patients with nerve paralysis include hematoma which is causing compression, paralysis associated with excessive lengthening and paralysis that can be definitely assigned to implanted metal construction. Electrodiagnostic studies can be useful in determining the level of lesion. Outcomes of nerve paralyses are variable, 40 % of patients show good recovery, 45 % have mild residual motor or sensory symptoms and 15 % show intense motor or sensory deficiency. Partial nerve lesions and some motor function maintenance are good prognostic indicators, with possibility of recovery in up to 3 years since the start of injury.

Claudication

Claudication as a complication after total hip arthroplasty occurs relatively rarely. In some works it is associated with lateral approaches and abductor insufficiency (m. gluteus medius). Just like inequality, it can be a reson for dissatisfaction of patient if the patient was not familiar with it before the operation.

Inequality

Unequal length of lower extremities after total hip arthroplasty is a common and known complication that can be a reason for dissatisfaction of patient. It is also the most common reason for lawsuits against orthopaedic community.

Besides elimination of pain, restoration of the biomechanics of hip joint is also an important goal in total hip arthroplasty as it enables a normal walk and support. Key components of a successful hip arthroplasty are:

- Achievement of correct centre of rotation,
- Neat position and orientation of components,
- Adequate offset and
- Equality of lower extremities.

Lengthening of operated leg is a more common case than shortening. The incidence of inequality in literature has a wide span, from 1 % to 27 %. The length span is same, from 3 mm to 70 mm.

The cause of inequality is multifactorial. Surgical goals during operation are multiple and the most important is stability of prosthesis. These goals are sometimes in conflict, and in the end surgeon has to choose ”lesser evil”, in other words inequality in order to gain stable prosthesis with neat range of motion and good function. It is sometimes necessary to extend the neck so that soft tissues would get tightened and stability improved all at the cost of leg lengthening.

Informed acceptance by the patient is of great importance in this situation. Inequality has to be discussed as a possible complication. Discussion must be documented. It is also necessary to preoperatively measure lengths of lower extremities to be able to determine if it is real or apparent shortening of extremity.

It is almost impossible to measure lengths of legs intraoperatively if patient is in lateral decubitus. Critical moments during surgery are determining the level of neck resection, length of neck and femoral offset. This clearly points out the fact that a single component or prosthesis is not a fit for all patients. Inequality is commonly associated with pain in the lower back section, walking disorder, dislocations, component loosening and great dissatisfaction in general. Everyone is unhappy and extremely desperate including surgeon.

Without doubt, inequality as a complication can not be eliminated in total hip arthroplasty. The boundry between acceptable and unacceptable inequality is for now undefined. Some studies show good tolerance of 1 cm difference in leg length by the majority of patients.

On the other hand, patients detect with out error even smallest lengthening of leg and are mostly unhappy if they have to carry an elevetion in the contralateral shoe.

Greater lengthening of operated leg can turn great clinical results in terms of pain release, range of motion, and function of hip into surgical failure due to dissatisfaction of patient.

Techniques used to achieve equality in lower extremities during total hip arthroplasty are divided into three categories:

1. Preoperative ”templating”.
2. Intraoperative techniques with femoral and pelvic markers.
3. Complex mathematical calculations.

In this way, the incidence of this complication can be at least lowered if not completely eliminated.

CORROSION OF TAPER

The focus on taper corrosion was attracted by problems with the application of metal-metal in large head component to standard stem. Corrosion associated problems have been noticed in modular primary stems as well. Mainly used in Europe today is ”euro taper” or ”12/14” taper. It is important to highlight that taper dimensions have not been standardised so far and vary between manufacturers. Factors that influence occurance of taper corrosion:

- Design and material,
- Surgen factor (position) and
- Patient factor (burden).

Combination of CoCr head and titanium stem results in occurance of Co and Cr debris and corrosion process (Morlock et al., 2020).

FATAL OUTCOME

Life in itself is enough complicated. Death as an inevitable part of life makes it even more complicated. Fatal outcome as a complication in total hip arthroplasty can not be eliminated totally.

The authors have recorded mortality from 0.35 % in the first 30 days after total hip arthroplasty. Male patients, people over 70 years of age and patients with cardiac and renal diseases are at a higher risk of a lethal outcome.

CONCLUSION

In the past three decades, total hip arthroplasty has become one of the most common operational undertakings in orthopaedic surgery. By the number of implanted large joint endoprostheses, implantation of hip endoprosthesis is in the first place. The most common early complication after hip arthroplasty implantation is luxation. Postoperative infection in joint alloplasty is one of the most difficult complications that often requires a quick operative treatment. Treatment is comprised of incision and evacuation of purulent content. If it is a case of an infection followed by increased temperature, increased SE and CRP accompanied with signs of septic state, it is necessary to remove the arthroplasty. Occurance of extensive hematomata after hip operation is also a state of emergency that requires operational treatment in terms of hematoma evacuation to prevent further complications, primarily infection. An arthroplasty trunk fracture is one of the most difficult late complications in joint arthroplasty that requires urgent operational treatment in terms of endoprosthesis exchange. Althogh, state of emergency in hip endoprostheses are relatively rare, it is important to recognize described complications and to surgicaly take care of them as urgently as possible.

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